

“Where will our knowledge take you?”



# **New South Wales Marine Estate Threat and Risk Assessment Report Draft Report**

November 2016

## Document Control Sheet

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<p><b>Synopsis:</b> A DRAFT report summarising the threat and risk assessment (TARA) process and outcomes undertaken for the state of NSW by MEMA agencies and independent experts.</p>		

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## Executive Summary

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### Background

The Marine Estate Management Authority (MEMA) outlined a new approach to marine estate management via the release of the document, 'Managing the Marine Estate: Purpose, Underpinning Principles and Priority Setting' (the Principles Paper) in 2013. The Principles Paper outlines that the New South Wales (NSW) marine estate is to be managed as a single continuous system for the greatest well-being of the community. This initiative is based on maximising current and future economic, social and environmental benefits.

MEMA has developed a 5-step decision making framework under the new approach to marine estate management. The 5-step approach is shown in Figure ES-1-1.

The first step of the 5-step approach is to identify and define the community benefits derived from the marine estate across a broad range of social, economic and environmental values. MEMA undertook engagement with the NSW community and visitors by surveying their views on the marine estate as part of Step 1 in 2013. The Marine Estate Community Survey (Sweeney Research 2014) identified key environmental, social and economic values and benefits derived from the NSW marine estate as well as key threats and opportunities.

The second step of the 5-step approach includes a thorough assessment process, in order to consider and prioritise the social, economic and environmental threats to community benefits of the marine estate. This process is called the Threat and Risk Assessment or TARA. This report outlines the key findings of the TARA undertaken at a Statewide level.

Essentially, the TARA seeks to identify how various activities may affect environmental assets or social or economic benefits that accrue from the marine estate. A risk assessment process (in accordance with AS/NZS ISO 31000:2009) is embedded within the TARA process, and is used to assess the risk of a threat to a community benefit *being realised*. It also includes a consideration of the magnitude of the potential consequences and the likelihood that those consequences will occur given current management controls.

Accordingly, the TARA considers threats to the social benefits of the marine estate (such as public participation and enjoyment of various uses and activities), economic benefits derived from the marine estate (such as employment and the value of production) as well as stressors on a broad range of natural assets such as clean water, marine habitats and protected species and communities across both estuaries and open coasts.

The outputs of the TARA will be used as a key input to inform the development of management initiatives to address priority threats via the Marine Estate Management Strategy and new marine park management plans, starting with the Solitary Islands and Batemans Marine Park.

This process will include the review of existing management which will be undertaken in Step 3 and the development of management responses in Step 4 of the 5-step decision making process by MEMA agencies.

When completed, the Strategy will set policy directions for managing the marine estate as a single continuous system, identify management priorities, set actions for government and balance economic growth, use and conservation in the marine estate.



Figure ES-1-1 Five Step Decision Making Process for marine estate management in NSW

### **Statewide TARA**

The TARA has been applied across the State in three regions, namely:

- North region (From Tweed Heads to Stockton)
- Central region (From Stockton to Shellharbour)
- South region (From Shellharbour to NSW/Vic border)

This includes the coastal, estuaries, coastal lakes and lagoons, beaches and ocean waters to the limit of state waters, which is three nautical miles from the coast or relevant island baseline. The landward boundary of the planning area includes coastal and estuarine waters to the limit of tidal influence but also includes adjoining land uses and activities that could affect the marine estate. The assessment does not include the components of the marine estate on and surrounding Lord Howe Island.

Previous to this assessment, a TARA for the Hawkesbury Shelf Bioregion (HSB) (e.g. the Central region) was completed in 2015. A Discussion Paper including suggested management initiatives for the 'Hawkesbury Shelf Marine Bioregion Assessment' was released for public consultation in February 2016. The Discussion Paper identifies options for enhancing marine biodiversity conservation, while also achieving balanced outcomes including opportunities for other community benefits and uses of the marine estate within the bioregion.

The Statewide TARA is informed by the previous assessment undertaken for the HSB but has been revised and improved based on feedback received during community engagement on the Discussion Paper in early 2016 and the collection of new evidence, primarily related to social and economic benefits. In a small number of cases, risk levels within the HSB have changed as a result of further assessment and evaluation. Where this has occurred, the revised TARA as set out in this Statewide report takes precedence over the risk levels outlined in the HSB TARA.

### **Methodology**

The Statewide TARA is informed by a series of matrices (as set out in the Appendices to this report) that identify the threats to the marine estate and then determine the risk (e.g. consequence and likelihood) of the threat impacting upon the environmental assets and/or social and economic benefits derived from the marine estate.

The threat and risk matrix adopted for use in the assessment was taken from the document, 'Threat and Risk Assessment Framework for the NSW Marine Estate' (MEMA 2015a) and is shown generically in Table ES-1-1.

A series of background information reports were developed by the MEMA agencies and external consultants to inform the TARA assessment. The evidence outlined in these reports was used as the basis to identify and assess the threats through a series of workshops with MEMA agencies and independent experts. The workshops and outputs of the TARA were organised in the context of assessment of threats to environmental assets (the Environmental TARA) and threats to social and economic benefits (the Social and Economic TARA). The key findings of both processes were then reviewed to identify common and priority threats and stressors that affect the flow of benefits across the marine estate as whole.

**Table ES-1-1 Example of a Threat and Risk Assessment Matrix from MEMA (2015a)**

THREATS	BENEFIT 1	BENEFIT 2	BENEFIT 3	BENEFIT 4
THREAT 1	HIGH	HIGH	MINIMAL	LOW
THREAT 2	LOW	MINIMAL	MINIMAL	MINIMAL
THREAT 3	MODERATE	LOW	LOW	MINIMAL
THREAT 4	MODERATE	MODERATE	MINIMAL	MODERATE

### Key Findings

As shown in Figure ES-1-2, the TARA process recognises that many of the social and economic benefits generated across the marine estate are closely linked and interdependent with the maintenance of environmental assets that are, in turn, affected by environmental stressors. These stressors often result from multiple human uses and activities that are occurring both within and adjacent to the marine estate (for example, diffuse sources of water pollution flowing to estuaries from river catchments or reduced fish stocks as a result of fishing effort outside of State waters).

In framing future management options (in later stages of the 5-step decision making process), a key objective of the Statewide TARA has been to identify those stressors that have the greatest risk of producing adverse effects on the flow of benefits from the marine estate.

Table ES-1-2 sets out the priority threats to environmental assets and social and economic benefits identified by the TARA at a Statewide level (listed in descending order of significance). As shown by the Table, there are a number of shared threats that extend across both environmental and social and economic benefits such as climate change and various forms of water pollution.

To inform future planning at a sub-regional scale, priority threats have also been identified for each region (North, Central and South). In general, the priority order of threats varied subtly by region according to dominant activities and land uses (such as agriculture being more significant for the North region in comparison to urban stormwater for the Central region) as well as in response to spatial distribution of values (for example, higher abundancies of marine turtles in the North region).

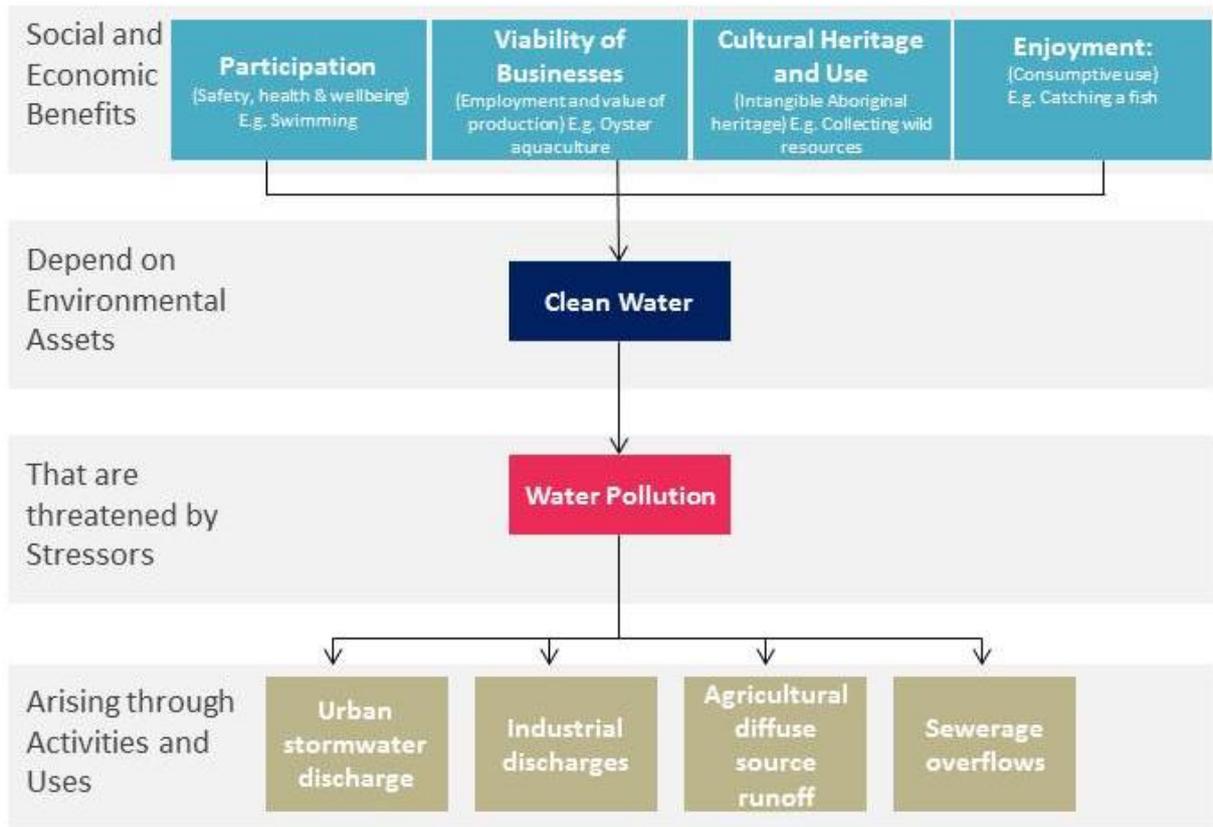


Figure ES-1-2 Example of the relationship between social and economic benefits, environmental assets, stressors and activities and uses

Table ES 1-2 Priority Threats for the Statewide Tara

Statewide TARA Assessment (Step 2 of the 5-step Decision Making Process)	
Priority Threats – Environmental Assets (in descending order of significance)	Priority Threats – Social and Economic Benefits (in descending order of significance)
<ul style="list-style-type: none"> <li>• Estuary entrance modifications</li> <li>• Urban stormwater discharge</li> <li>• Agricultural diffuse source runoff (in estuaries)</li> <li>• Clearing riparian and adjacent habitat including wetland drainage (in estuaries)</li> <li>• Climate Change (20yrs)</li> <li>• Recreation and tourism -Boating and boating infrastructure (in estuaries)</li> <li>• Navigation &amp; entrance management and modification, harbour maintenance (in estuaries)</li> <li>• Sewage effluent and septic runoff (in estuaries)</li> <li>• Stock grazing of riparian and marine vegetation (in estuaries)</li> <li>• Foreshore development</li> <li>• Modified Freshwater flows (in estuaries)</li> <li>• Recreation and tourism – Four wheel driving (in estuaries)</li> <li>• Commercial Fishing – Ocean Trawl</li> <li>• Commercial Fishing – Ocean Trap and Line</li> <li>• Commercial Fishing- Estuary General (in estuaries)</li> <li>• Recreational Fishing – Boat-based line and trap fishing</li> <li>• Oyster Aquaculture (in estuaries)</li> <li>• Commercial Fishing – Ocean Haul</li> <li>• Recreational Fishing – Shore-based line and trap fishing</li> <li>• Beach nourishment and grooming</li> <li>• Recreational Fishing – Hand gathering</li> <li>• Charter activities – whale and dolphin watching</li> <li>• Shipping – Small commercial vessels</li> </ul>	<ul style="list-style-type: none"> <li>• Climate change (20 years)</li> <li>• Inadequate social and economic information</li> <li>• Urban stormwater discharge</li> <li>• Agricultural diffuse source runoff</li> <li>• Anti-social behaviour and unsafe practices</li> <li>• Limited or lack of access infrastructure to the marine estate</li> <li>• Reductions in abundances of top and lower order trophic levels from commercial, recreational and charter fishing</li> <li>• Litter, solid waste, marine debris and microplastics</li> <li>• Lack of compliance with regulations (by users) or lack of compliance effort (by agencies)</li> <li>• Inadequate, inefficient regulation, over-regulation (agencies)</li> <li>• Loss of public access (either by private development or Government area closures)</li> <li>• Habitat (physical) disturbance (e.g. from foreshore development, commercial and recreational fishing methods, four wheel driving, and extractive industries (mining)).</li> <li>• Wildlife disturbance (Shorebirds, Turtles, Whales) by dog walkers, 4WD, marine vessels, etc.</li> <li>• Lack of community awareness of the marine estate, associated threats and benefits, regulations and opportunities for participation</li> <li>• Overcrowding/congestion</li> <li>• Loss or decline in marine industries</li> <li>• Pests/diseases</li> <li>• Modified hydrology/hydraulics and flow regime</li> <li>• Seafood contamination</li> <li>• Lack of or ineffective community engagement or participation in governance (lack of evidence; lack of political standing; casual users who may not have English as 1st language, too much/display of information)</li> </ul>

### **Specific Findings of the Environmental TARA**

When considering the risk of threats specifically to **environmental assets** (and associated environmental benefits) of the marine estate:

- For the environmental assessment component of the TARA the Statewide planning area was separated between threats and assets in 'Estuaries' and open 'Coast and Marine Areas'. The results of these separate TARAs were then combined to produce the Environmental TARA. The estuaries had a much greater proportion of 'Moderate' and 'High' threats compared to coastal and marine areas.
- In general, the more densely populated and developed nature of the Central region (i.e. the Hawkesbury Shelf Bioregion) has led to a higher level of risk to environmental assets being attributed for the estuaries. Within the Coastal and Marine Areas the distribution between geographic zones of High, Moderate, Low and Minimal threats is similar.
- In some cases, the level of risk for a particular threat or stressor is being driven by highly localised impacts (e.g. impacts from a point source or based on an impact within a single estuary) as opposed to broad scale impacts (such as those from climate change). Further detail on the justification for the risk levels (including their geographic scale) are set out in the evidence in the Appendices to the report.
- Most threats identified across the Statewide TARA are considered to be current issues happening now (e.g. at the present time) with the threat of the risk being realised expected to intensify or increase over time.

### **Specific Findings of the Social and Economic TARA**

When considering the risk of threats to the **social and economic benefits** derived from the marine estate:

- Attribution of threats to social and economic benefits of the marine estate were undertaken through a 'community well-being' lens for the Statewide assessment. This approach sought to consider the spatial effects, temporal effects and the number of parties affected by stressors - not just documenting a user conflict between two specific user groups of the marine estate.
- The social benefits were considered for six subcategories related to participation, enjoyment and cultural heritage and use of the marine estate. The economic benefits were considered for a further three subcategories related to indirect (intrinsic and bequest values), viability of businesses and direct economic values.
- Only two stressors were identified as having high risks to social and economic benefits. These were Climate Change and Reductions in abundances of species and trophic levels.
- Climate Change represented a significantly higher threat to social and economic benefits than any other stressor. The driver for this high rating across social and economic benefits was associated with wide scale loss of enjoyment and recreational opportunities associated with damage and loss of foreshore areas, changes in biodiversity values, loss of tangible cultural heritage and a range of flow on economic risks.

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- Many of the key threats to social and economic benefits were observed by participants to be operating at broad spatial scales (e.g. occurring in and across each region).
- In considering the temporal aspects of the threats identified, most are considered to be current issues happening now (e.g. at the present time) with the threat of the risk being realised expected to intensify or increase over time.

### **Risk Evaluation Process**

Building on the lessons learned from the Hawkesbury Shelf Bioregion TARA project, a formal risk evaluation process was also undertaken for the Statewide TARA by the Marine Estate Expert Knowledge Panel (MEEKP).

Some of the key issues discussed as part of the evaluation process were:

- Historic threats and shifted baselines (legacy issues) – reviewing how the initial TARA outputs had accounted for what has happened in the past both in terms of resource use and environmental condition, the sensitivity of environmental assets and/or social and economic benefits to further change, and to determine if assets or benefits were at some form of tipping point that needed specific consideration;
- Dealing with uncertainty/absence of evidence – reviewing how the initial TARA outputs addressed threats that were identified as having highly inferred risks and/or a poor evidence base. This included consideration of both whether the risk levels were seen as too conservative or not conservative enough given the level of uncertainty or lack of data presented in the evidence;
- Cumulative risks - taking a more systems level approach, identifying how cumulative impacts to assets and benefits were addressed by the initial TARA outputs and if detailed risk assessments might also be required if it was perceived the threat could interact or accumulate in a way that cannot be accurately evaluated on an individual threat vs. asset/benefit approach; and
- Future risks – reviewing how the initial TARA outputs sought to identify and assign risks to threats that were trending toward greater impact over time (i.e. climate change vulnerability or increasing use levels) or could change as a result to a change in management (for example a future decision to allow offshore mining) and how to address these matters in the current and future TARA processes.

Taken together with the priority threats identified in the TARA, the risk evaluation has identified the need for additional consideration of several cumulative risk issues including:

- Fisheries – in terms of management of fish assemblages and the uncertainty associated with potential impacts from fishing activities on trophic structure and function of marine ecosystems.
- Estuaries – in terms of their role as a receiving water quality environment and the need to avoid management of key stressors in isolation (e.g. diffuse agricultural, diffuse urban stormwater, point sources, microplastics, sediment contamination, and other sources of water pollution should be considered as part of systems-based management approach).

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- Climate change – noting the imperative to move toward practical adaptation/resilience building actions that can be taken now to protect the assets and benefits of the marine estate rather than waiting for impacts to occur.

The evaluation also recognised that there are key knowledge gaps associated with these cumulative issues as well as more generally in relation to understanding the risks to the flow of social and economic benefits from the marine estate.

Greater knowledge and awareness of the tangible and intangible benefits indigenous people derive from the marine estate was also recognised as a key knowledge gap.

### **Next Steps**

The TARA provides data and information on the likely magnitude and direction of change in benefits derived from the marine estate under existing management controls.

As outlined above, MEMA will review the outputs of the TARA and the outcomes and recommendations of the MEEKP risk evaluation process to further investigate how existing controls apply to the assigned risk levels, to determine appropriate tolerance levels to the identified risks and develop treatment options in subsequent steps of the 5-step decision making process.

However it should be recognised that the TARA and its outputs as outlined in this report is essentially a tool for the prioritisation of threats for treatment that needs to be further assessed in subsequent steps of the MEMA decision making process.

In this context, assignment of a 'High' or 'Moderate' risk level as part of the TARA process is a trigger for further interrogation of the threat but will not necessarily lead to a change to current management or regulations.

Likewise, rating as a 'Minimal' or 'Low' risk level indicates the threat is currently acceptable but still needs to be considered and tracked over time – particularly where there is poor information or evidence related to the threat and its effect.

This risk tolerance process is described generically in Table ES-1-3.

Finally, it needs to be recognised that it will not be feasible, practical or possible for MEMA to manage all threats to a 'Low' or 'Minimal' risk level and this will need to be considered in the context of the tolerance or acceptability of the risk level both at the current time and over the life of the Strategy.

**Table ES-1-3 Generic Risk Tolerance Table**

Risk Levels	Description	Likely Management Action
<b>Minimal</b>	Risk currently acceptable but trend in the risk to be tracked over time.	Existing control measures (if any) are suitable. Monitoring of risk likelihood and consequence over time to identify if risk is increasing, decreasing or staying the same.
<b>Low</b>	Risk likely to be acceptable but trend in the risk to be tracked over time.	Existing control measures (if any) are suitable. Monitoring of risk likelihood and consequence over time to identify if risk is increasing, decreasing or staying the same.
<b>Moderate</b>	Risk may be acceptable with suitable risk control measures in place.	Review of existing management controls or activities for the risk. Increased or different management controls or activities may be needed.
<b>High</b>	Risk less likely to be acceptable; additional risk control measures may need to be considered.	Review of existing management controls or activities for the risk. Increased or different management controls or activities are likely to be needed.

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# 1 Introduction

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## 1.1 Background

The New South Wales (NSW) Government commissioned an Independent Scientific Audit of Marine Parks in NSW (the Audit) in mid-2011 which concluded that management of the marine estate required changes to governance arrangements and policy objectives, particularly in order to reduce social conflict and improve effective management of coastal and marine resources beyond existing marine parks (Beeton et. al. 2012).

Consistent with the Audit recommendations, the NSW Government implemented a new approach to sustainable management of the NSW marine estate, including all marine waters, estuaries and coastal areas and the State's six marine parks. The *Marine Estate Management Act 2014* provides for strategic and integrated management of the whole marine estate.

In response to the findings of the Audit, the Government also established a new advisory Marine Estate Management Authority (MEMA or the Authority), which comprises representation from the four main government agencies involved in marine estate management and an independent Chair. The four government agencies are the Office of Environment and Heritage, Department of Primary Industries, Transport for NSW, and Department of Planning and Environment. It also appointed an independent Marine Estate Expert Knowledge Panel (MEEKP) to provide expert advice spanning ecological, economic and social sciences to underpin evidence based decision making.

The Authority outlined its new approach to marine estate management via the release of the document, *'Managing the Marine Estate: Purpose, Underpinning Principles and Priority Setting'* (the Principles Paper). The Principles Paper outlines that the NSW marine estate is to be managed as a single continuous system for the greatest well-being of the community. This initiative is based on maximising current and future economic, social and environmental benefits.

The Authority has developed a 5-step decision making framework under the new approach to marine estate management as shown in Figure 1-1.

In summary, these steps are to:

- (1) Identify key benefits and threats to those benefits that the estate provides to the NSW community;
- (2) Assess and assign risk levels to those threats so that management efforts can be focused on the most important issues;
- (3) Assess the adequacy of current management settings and alternative options for addressing priority threats;
- (4) Implement the most efficient management settings; and
- (5) Be accountable to the NSW community in terms of monitoring the effectiveness of management settings.

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<b>Step 1</b>	HOW THE COMMUNITY BENEFITS FROM THE ESTATE	Identify key economic, social and environmental benefits, and perceived threats and opportunities derived from the Estate	Develop ongoing engagement strategy: <ul style="list-style-type: none"> <li>■ community consultation</li> <li>■ expert input</li> <li>■ stakeholder surveys</li> </ul>	<i>Principle 1</i>
<b>Step 2</b>	ASSESS THREATS AND RISKS TO BENEFITS	Expert assessment of threats and opportunities to the key economic, social and environmental benefits	Prioritise threats based on their likelihood and consequence and consider relevant scale: <ul style="list-style-type: none"> <li>■ local</li> <li>■ regional</li> <li>■ state-wide</li> </ul>	<i>Principle 2</i>
<b>Step 3</b>	ASSESS MANAGEMENT OPTIONS TO MAXIMISE BENEFITS	Identify and assess current and potential management settings in delivering benefits to the community	Apply values to economic, social and environmental benefits of alternative uses.  Assess which options deliver maximum benefit to the community.	<i>Principles 1, 3, 4, 5, 6 &amp; 7</i>
<b>Step 4</b>	IMPLEMENT PREFERRED MANAGEMENT OPTIONS	Implement options that maximise overall benefits to the NSW community as a whole	Identify the most efficient and cost-effective management options.  Design measurable performance indicators.  <i>Develop strategic monitoring program to measure outcomes relative to the vision.</i>	<i>Principles 1 &amp; 8</i>
<b>Step 5</b>	BE ACCOUNTABLE	Monitor, measure and report on performance   <i>Review progress</i>	Report transparently to the community.  Promote strategic research to inform management and enhance future outcomes.  <i>Examine performance, including benefit, threat and risk status periodically.</i>  <i>Review management arrangements for those not achieving adequate performance.</i>	<i>Principles 1, 9 &amp; 10</i>

**Table 1-1 MEMA Five Step Decision Making Process**

The decision making process is being applied to the marine estate at a Statewide level (this report), as well as at the regional level, with an initial study focussed on the Hawkesbury Shelf Marine Bioregion (HSB). A Discussion Paper including suggested management initiatives for the 'Hawkesbury Shelf Marine Bioregion Assessment' was released for public consultation in February 2016. The Discussion Paper identified options for enhancing marine biodiversity conservation, while also achieving balanced outcomes including opportunities for other community benefits and uses of the marine estate within the bioregion.

To inform both the bioregional and State wide process, the Authority undertook engagement with the NSW community and visitors by surveying their views on the marine estate as part of Step 1 in 2013. The Marine Estate Community Survey (Sweeney Research 2014) identified key environmental, social and economic values and benefits derived from the NSW marine estate as well as key threats and opportunities.

The community survey was an important first step in identifying the environmental, social, cultural and economic key values, benefits and threats. The results of the survey have been collated by

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MEMA at both the State wide and Hawkesbury Shelf bioregional scales (MEMA 2015b). Peak stakeholder workshops and Aboriginal engagement workshops were also held in Step 1 by MEMA agencies to inform bioregion-specific views on values, benefits, threats and opportunities.

Step 2 of the 5-step approach includes a thorough assessment process, in order to consider and prioritise the social, cultural, economic and environmental threats to community benefits to inform future management responses at varying scales. This process is called the Threat and Risk Assessment or TARA. A pilot TARA was completed for the Hawkesbury Shelf Marine Bioregion and reported on previously (BMT WBM 2015). The current report outlines the key findings of the TARA undertaken for the Statewide level. It should be noted that this second iteration of the TARA has refined a small number of the risk levels for the Hawkesbury Shelf (e.g. Central Region) based on reconsideration by the agencies and experts and in some cases, improved availability of information.

## 1.2 Purpose and Structure of this Report

The key steps of the decision making process for the Statewide assessment are shown graphically in Figure 1-2, with this report representing the box in the diagram called 'threat and risk assessment report'. As shown in the diagram, the report follows the preparation of extensive background reports on the threats to the key benefits of the marine estate for the bioregion and a series of interactive workshops with MEMA agencies and independent experts to identify the risk of these threats to the benefits being realised.

Accordingly, the purpose of this report is to document the methodologies used, workshop proceedings and key outputs of the TARA process in the form of evidence-based risk levels for threats to the environment, social and economic benefits provided by the marine estate for the state.

This process has been used to assess and assign risks to the key threats operating in the state such that management options and responses can be focused on the most important issues in the next phase of planning for the marine estate.

The report is set out as follows:

- Section 2 Methods
- Section 3 Findings of the Environment Threat and Risk Assessment
- Section 4 Findings of the Social and Economic Threat and Risk Assessment
- Section 5 Integrating the Environmental, Social and Economic Assessments
- Section 6 Conclusions and Recommendations
- Section 7 References

## 1.3 Planning Area

This assessment covers the entire marine estate of NSW. The TARA has been applied to three regions, which includes the state coastal waters limit of the relevant bioregions, namely:

- North region (From Tweed Heads to Stockton)

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- Central region (From Stockton to Shellharbour)
- South region (From Shellharbour to NSW/Vic border)

This includes the coastline, estuaries, coastal lakes and lagoons, beaches and ocean waters to the limit of state waters, which is three nautical miles from the coast or relevant island baseline. The landward boundary of the planning area includes coastal and estuarine waters to the limit of tidal influence but also includes adjoining land uses and activities that could affect the marine estate. The assessment does not include the components of the marine estate on and surrounding Lord Howe Island.

The Planning Area is shown in Figure 1-2.

### 1.4 Glossary

A glossary of key terms (produced by MEMA) is provided in Appendix E of this report.

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NSW Marine Estate Expert Knowledge Panel

Key steps for state-wide threat and risk assessment, and Marine Estate Management Strategy

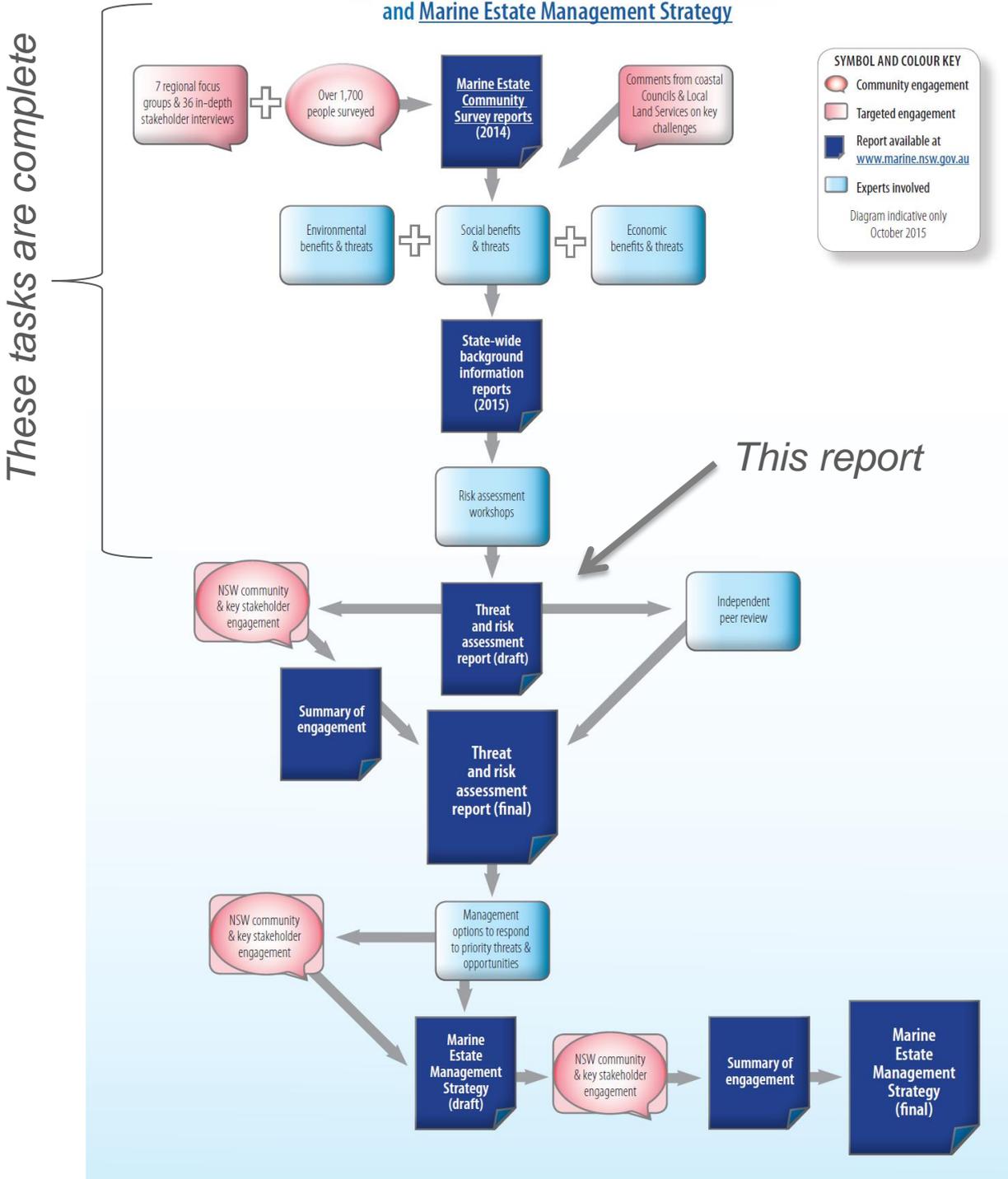


Figure 1-1 Key Steps in the Statewide Decision Making Process

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Figure 1-2 Planning Area for the Statewide Assessment

## 2 Methods

### 2.1 Threat and Risk Assessment Process (TARA)

The TARA is designed to:

- Be undertaken at a range of scales from Statewide down to the geographic region that best aligns with the activity or management issue being investigated;
- Provide transparency and ease of understanding to stakeholders;
- Draw on a range of credible and accepted information sources; and
- Accommodate whatever level of analysis is ‘fit for purpose’, from broad, qualitative, ‘scanning’ assessments, down to in-depth quantitative analyses, where more detailed assessments provide necessary further information for decision making.

Further information about the TARA process can be sourced from the document entitled, ‘*Threat and Risk Assessment Framework for the NSW Marine Estate*’ (MEMA 2015a) available from <http://www.marine.nsw.gov.au/key-initiatives/threat-and-risk-assessment-framework>.

Essentially, the TARA seeks to identify how various activities may affect environment, social or economic benefits that accrue from the marine estate (as shown in Table 2-1). A risk assessment process (in accordance with AS/NZS ISO 31000:2009) is embedded within the TARA process, and is used to assess the risk of a threat to a community benefit *being realised*. It also includes a consideration of the magnitude of the potential consequences and the likelihood that those consequences will occur given current management controls.

**Table 2-1 Example of a Threat and Risk Assessment Matrix from MEMA (2015a)**

THREATS	BENEFIT 1	BENEFIT 2	BENEFIT 3	BENEFIT 4
THREAT 1	HIGH	HIGH	MINIMAL	LOW
THREAT 2	LOW	MINIMAL	MINIMAL	MINIMAL
THREAT 3	MODERATE	LOW	LOW	MINIMAL
THREAT 4	MODERATE	MODERATE	MINIMAL	MODERATE

As outlined in MEMA 2015, the overall role of TARA is to help determine whether existing management controls maximise, in aggregate, the estate’s community benefits. MEMA’s threat and risk assessments are, therefore, more appropriately framed in terms of risk being the effect of uncertainty on community wellbeing.

The findings of the TARA will provide data on the likely magnitude and direction of change in benefits under existing management controls. This is vital information for assessing proposed management options in step 3 of the MEMA 5-step decision making process.

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## 2.2 Risk Tables and Assessment Matrix

The risk goals, objectives and definitions of consequence and likelihood that were used in the TARA were drafted by MEMA agencies with input from the MEEKP.

Appendix A sets out the overall goals and objectives, consequence and likelihood definitions that were used in the Statewide TARA.

To reflect the triple bottom line nature of the assessment, specific goal statements, objective statements and consequence definitions were prepared for the environmental, social and economic aspects of the TARA, with a common likelihood definitions used across all three assessments. The risk goals and objectives are consistent with the legislative objectives administered by MEMA agencies and the vision for NSW marine estate of a “healthy coast and sea, managed for the greatest well-being of the NSW community, now and into the future (MEMA 2015) (refer Appendix A).

The risk matrix adopted for use in all assessments was taken from the document, ‘Threat and Risk Assessment Framework for the NSW Marine Estate’ (MEMA 2015a) and is reproduced in Table 2-2.

Using this risk matrix, four ‘risk levels’ are possible – ‘Minimal’ (green), ‘Low’ (yellow), ‘Moderate’ (orange) or ‘High’ (red).

**Table 2-2 Risk Levels Used in Assessments**

LIKELIHOOD	LEVEL OF RISK				
ALMOST CERTAIN	MINIMAL	LOW	MODERATE	HIGH	HIGH
LIKELY	MINIMAL	LOW	MODERATE	HIGH	HIGH
POSSIBLE	MINIMAL	MINIMAL	LOW	MODERATE	HIGH
UNLIKELY	MINIMAL	MINIMAL	MINIMAL	LOW	MODERATE
RARE	MINIMAL	MINIMAL	MINIMAL	MINIMAL	LOW
CONSEQUENCE LEVEL	INSIGNIFICANT	MINOR	MODERATE	MAJOR	CATASTROPHIC

## 2.3 Benefit Categories

The TARA uses the term ‘community benefit’ and defines this term as anything that contributes to the wellbeing of the community. There are three separate categories of community benefits: economic, social and environmental benefits. Community benefits are based on what people think is important (what they value). A community benefit of the marine estate can include:

- Swimming at the beach;
  - Boating in an estuary;
  - Doing something as a hobby (e.g. fishing, kayaking, surfing, bird watching, etc.);
  - Running a business (e.g. whale watching business, charter fishing, commercial fishing, etc.);
- and

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- Clean waters and marine biodiversity.

For the purpose of the TARA, a carefully considered categorisation of benefits was identified across the environment, social and economic matrices.

These benefit categories were developed and agreed by the MEMA agencies based on the community survey and other information sources and then further refined as part of the workshop processes.

The agreed benefit categories were as follows:

### Environmental Assets that Provide Environmental Benefits

Environmental assets are the natural attributes, components and living resources of the marine estate. Environmental benefits are those benefits derived by the community from the marine estate's environmental assets and can include, for example, products obtained from the estate such as food, benefits related to the regulation of ecosystem processes such as climate regulation and nutrient cycling, and ecosystem services such as biodiversity.

The environmental asset categories adopted for the TARA included the following:

- **Clean Waters** (with sub-categories of estuarine and marine (e.g. oceanic) waters)
- **Habitats and Assemblages** (with sub-categories of oceanic beaches, saltmarsh, mangroves, seagrass, estuarine beach and mud flats, shallow and deep soft sediments, rocky shores, shallow reefs, deep reefs, planktonic assemblages\* and fish assemblages\*).

*\*note these categories were added in the Statewide TARA as it was recognised that they provided an improved categorisation of environmental assets for the purpose of risk assessment compared to those used in the Hawkesbury Marine Bioregion TARA.*

- **Threatened and Protected Species** (with sub-categories of species, populations and ecological communities listed as protected or threatened under the *NSW Fisheries Management Act 1994* [fish, marine invertebrates and marine vegetation] (FMA), the *NSW Threatened Species Conservation Act 1995* [such as cetaceans, turtles, shorebirds, and other marine megafauna] (TSC Act). More detailed information on specific species is included in the environmental background report (MEMA, 2016).

### Uses and Activities that Provide Social and Economic Benefits

In determining the social and economic benefits derived from the marine estate, the uses and activities that occur in the marine estate were identified and benefits were identified under the following standard categories:

#### *Social*

- **Participation benefits** (with further sub-categories of 'Safety, Health & Wellbeing [including relaxation]' and 'Socialising & Sense of Community')
- **Enjoyment benefits** (with further sub-categories of 'Enjoying the Biodiversity & Beauty of the Marine Estate- social intrinsic value' and 'Consumptive Use [e.g. extracting]')

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- **Cultural heritage & use benefits** (with sub-categories of 'Tangible Aboriginal Cultural Heritage [historic objects, places, items, and source of food]' and 'Intangible Aboriginal Heritage [traditions, practices, knowledge, spiritual values]').

### *Economic*

- Benefits related to '**Indirect economic values**' which was further defined as 'Intrinsic & bequest values'
- Benefits related to employment and the value of production which was further defined as '**Viability of Businesses**'
- Benefits related to '**Direct economic values**' which was further defined as the 'Individual enjoyment value or consumer surplus' (e.g. an economic term for the difference between what a consumer or user is willing to pay for a benefit or services versus what they actually pay for a benefit or service).

## 2.4 Threats to Community Benefits

Threats to community benefits arise from a range of stressors that result in impacts on the environmental assets, and social and economic values.

The activities identified in the TARA matrices were grouped and categorised differently between the environmental and the social and economics assessments.

For the *environmental assessment* this included:

- Resource uses and activities resulting in stressors to environmental assets arising from these activities including, for example, recreational fishing, commercial fishing, recreation and tourism, boating and other water uses and activities;
- 'Land Based Impacts' including, for example, stressors associated with urban stormwater discharge, beach nourishment and coastal development; and
- 'Climate Change', including, for example, sea level rise and ocean acidification.

For the *social and economic assessment*, the focus was placed on stressors rather than the uses and activities. Many uses and activities that give rise to stressors also generate significant social and economic benefits. Benefits can also be impacted by other stressors (environmental, public safety, MEMA regulation and lack of access availability etc.). The stressors were considered through a community wellbeing lens. The stressors identified for the social and economic TARA included:

- Those related to various 'Resource Uses or Activities' (such as anti-social behaviour and unsafe practices, overcrowding/congestion, loss or decline of marine industries);
- Those related to 'Environmental Impacts' (such as water pollution, depletion of fish stocks, wildlife disturbance and climate change);
- Those associated with 'Governance of the marine estate' (such as regulation, community engagement and compliance);

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- Those associated with 'Public Safety Impacts' (such as adverse wildlife interactions and seafood contamination);
- Critical knowledge gaps; and
- Those related to the effect of 'Lack of access availability', which includes the effects of public access and infrastructure.

The common stressors to both the environmental and social and economic assessments (which form the basis for the comparison of threats across the marine estate as a whole in the state) are discussed further in Section 5 of this report.

It was also recognised as part of the TARA process that there are a range of external factors that can affect the level of use occurring in the marine estate. Nevertheless, it was agreed the primary focus of the TARA should be on:

- What MEMA can and does manage in the marine estate; and
- Threats to the *actual* flow of environmental, social and environmental benefits to the marine estate, but not how these benefits are actually used unless their level of use specifically relates to MEMA's management regulations.

Example issues that could affect how benefits are used but that are outside of control of MEMA (and therefore not considered explicitly in the TARA) include:

- Economic downturn;
- Increased fuel and other base costs;
- Rising fares;
- Market saturation; and
- Reduced land availability for settlement.

## 2.5 Evidence Based Approach

The TARA seeks to ensure all relevant and credible information sources are used to identify the risk of a threat being realised. This is recognised to include multiple sources of information, for example, scientific literature, scientist expert opinion, media, community and stakeholder views, etc.

The Marine Estate Community Survey is a key piece of social research used to inform the social and economic threat and risk assessment.

Four information reports were developed to inform the Social and Economic TARA assessment:

- Community Engagement Information Report – MEMA (2015b) 'Background to the Hawkesbury Shelf Marine bioregion assessment Report 1 – community engagement'.
- Social and Economic Information Report – Vanderkooi Consulting (2015) 'Social and economic background information report on the NSW marine estate'.

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- Aboriginal Cultural Heritage Information Report – Feary, S. (2015) Sea Countries of New South Wales: benefits and threats to Aboriginal people’s connections with the marine estate.
- Schneider, S. (2015) Peer Review of Draft Report "Sea countries of New South Wales: benefits and threats to Aboriginal people’s connections to the marine environment" for the Marine Estate Expert Knowledge Panel. Suffolk Park, 7pp.

A single background report was developed by MEMA agencies to inform the environmental TARA:

- NSW Marine Estate – Background Environmental Information Report 1 – MEMA (2016)

In general, evidence presented as part of the TARA (as set out in full in Appendix C and Appendix D of this report) can be sourced from one or more of the following sources:

- The five background information reports prepared by the MEMA agencies and external consultants (outlined above);
- Additional information, research and academic papers identified by MEMA agencies and independent experts; or
- Expert opinion of subject matter experts – particularly in the context of the independent experts that participated in the workshops and MEEKP as part of the risk evaluation workshop.

## 2.6 Stressors Underpinning Threats

Uses and activities within the marine estate can adversely impact environmental assets by generating various stressors, and this may have flow on effects for dependent social and economic benefits. The evidence has been used to identify the full range of stressors that activities may generate, then determine the key stressors that are responsible for impacts on environmental threats and related risks to community benefits. A simplified matrix showing the stressors common to the activities is shown in Table 2-3.

**Table 2-3 Key Stressors Driving Environmental Threats**

Activity Category	Specific Activity	Key Stressors
Shipping	Large commercial vessels and associated port activities and industries (trade ships, cruise ships, etc.)	Water pollution (toxic contaminants, Marine debris, Physical disturbance, Wildlife disturbance)
	Small commercial vessels (ferries, charter boats, commercial fishing, whale watching etc.)	Water pollution (toxic contaminants, sediments resuspension), Marine debris, Physical disturbance, , Wildlife disturbance
Commercial fishing	Ocean Trap and Line	Reduction in abundances of species and trophic levels, Marine debris, Incidental catch of species of conservation concern, Physical disturbance
	Ocean Trawl	Reduction in abundances of species and trophic levels. Incidental catch of species of conservation concern, Physical disturbance
	Ocean Haul	Reduction in abundances of species and trophic levels, Incidental catch of species of conservation concern
	Sea urchin and turban shells	Reduction in abundances of species and trophic level
	Lobster	Reduction in abundances of species and trophic level

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Activity Category	Specific Activity	Key Stressors
	Abalone	Reduction in abundances of species and trophic level
	Estuary General	Reduction in abundances of species and trophic levels, Incidental bycatch, Physical disturbance, Wildlife disturbance
	Estuary Prawn Trawl	Reduction in abundances of species and trophic levels, Incidental bycatch,
Charter fishing	Line fishing	Physical disturbance, Harvest, Incidental bycatch,
Recreational fishing	Shore-based line and trap fishing	Reduction in abundances of species and trophic levels, Physical disturbance, Marine debris, Incidental bycatch, Wildlife disturbance
	Boat-based line and trap fishing	Physical disturbance, Reduction in abundances of species and trophic levels, Incidental bycatch, Wildlife disturbance
	Spearfishing	Reduction in abundances of species and trophic levels
	Hand Gathering	Physical disturbance, Reduction in abundances of species and trophic levels
	Estuary Fish Stocking	Physical disturbance
Aboriginal Cultural fishing (including permitted as well as native title rights)	Line fishing, spearfishing, hand gathering, traditional fishing methods, related cultural traditions	
Charter activities	Whale and dolphin watching	Wildlife disturbance, Marine Debris
Bait and aquarium trade	Imported baits, imported fish and other aquatic sp.	Pests / Disease
Estuary Based Aquaculture	Oyster aquaculture	Water pollution, Physical disturbance, Wildlife disturbance
	Mussel aquaculture	
	Prawn aquaculture	Water pollution, Sediment resuspension,
Research and education	Collecting, sampling and tagging	
Recreation and tourism	Boating and boating infrastructure	Physical disturbance, Marine debris, Wildlife disturbance, Water pollution
	Snorkelling and diving	
	Swimming and surfing and passive use including dog walking	Physical disturbance, Wildlife disturbance, Marine debris
	Four wheel driving	Physical disturbance, Wildlife disturbance, Marine debris
	Shark meshing of swimming beaches	Incidental bycatch, Incidental catch of species of conservation concern
Dredging (includes placement)	Navigation & entrance management and modification, harbour maintenance etc.	Physical disturbance, Wildlife disturbance, Water pollution (sediment resuspension), Changes to tidal flow velocity and patterns f
Modified freshwater flows	Extraction, artificial barriers to estuarine flow	Changes to tidal flow velocity and patterns, Water pollution
Mining and extractive industries	Oil, gas, minerals, sand, aggregate, mining coal	Water pollution, Physical disturbance
Service infrastructure	Pipelines, cables, trenching and boring	Physical disturbance, Water pollution
Land use intensification	Urban stormwater discharge	Water pollution, Physical disturbance, Marine debris
	Foreshore development	Physical disturbance, Changes to tidal flows

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Activity Category	Specific Activity	Key Stressors
	Beach nourishment and grooming	Physical disturbance, Wildlife disturbance
	Clearing riparian and adjacent habitat including wetland drainage	Physical disturbance, Water Pollution (acid sulphate soils),
	Agricultural diffuse source runoff	Water pollution (nutrients and organic matter)
Point discharges	Industrial discharges	Water pollution, Sediment contamination
	Thermal discharges	Thermal pollution
	Sewage effluent and septic runoff	Water pollution (toxic contaminants, nutrients and organic matter)
Hydrologic modifications	Estuary entrance modifications + Breakwaters	Physical disturbance, Changes in tidal flow and patterns, Changes in tidal prism
Climate change	Altered currents & nutrient inputs	Altered ocean currents & nutrient inputs
	Climate and sea temperature rise	Physical disturbance, Wildlife disturbance
	Ocean acidification	Acidification
	Altered storm/cyclone activity	Physical disturbance, Wildlife disturbance, Water pollution
Extreme storm events	Sea level rise	Physical disturbance
	Flooding, storm surge, inundation	Physical disturbance, Water pollution

Many of these environmental stressors also are relevant to the Social and Economic TARA, where the impacts from uses and activities on environmental assets affect the flow of social and economic benefits from the marine estate. However, there are also a small number of purely social and economic stressors that have been developed to describe impacts and conflicts between or among the uses and users of the marine estate. These include, for example, access availability, overcrowding, anti-social behaviour and levels of regulation and are listed in Table 2-4

**Table 2-4 Stressors for the Social and Economic TARA**

Threats	Stressors
Resource Use Conflicts	<ul style="list-style-type: none"> <li>Conflict over resource access and use</li> <li>Anti-social behaviour and unsafe practices</li> <li>Overcrowding/congestion</li> <li>Loss or decline of marine industries</li> <li>Excessive or illegal extraction</li> </ul>
Environmental	<ul style="list-style-type: none"> <li>Water pollution on environmental values - point source pollution and sewage overflows (such as outfalls, STPs, etc.)</li> <li>Water pollution on environmental values - urban stormwater discharge</li> <li>Water pollution on environmental values - Agricultural diffuse source runoff</li> <li>Water pollution on environmental values - litter, solid waste, marine debris and microplastics</li> <li>Wildlife disturbance (Shorebirds, Turtles, Whales) by dog walkers, 4WD, marine vessels, etc.</li> <li>Habitat (physical) disturbance from foreshore development, commercial and recreational fishing methods, boating and boating infrastructure, recreation and tourism (four wheel driving, beach grooming) and extractive industries (mining).</li> <li>Reductions in abundances of top and lower order trophic levels from commercial, recreational and charter fishing</li> <li>Pests/diseases</li> </ul>

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Threats	Stressors
	<ul style="list-style-type: none"> <li>Modified hydrology/hydraulics and flow regime</li> <li>Sediment contamination (toxicants in sediment; dioxins in Sydney Harbour, Cooks River)</li> <li>Climate change stressors</li> </ul>
Governance of the Marine Estate	<ul style="list-style-type: none"> <li>Inadequate, inefficient regulation, over regulation (agencies)</li> <li>Lack of or ineffective community engagement or participation in governance</li> <li>Lack of community awareness of the marine estate, associated threats and benefits, regulations and opportunities for participation (too much information - to synthesise; are we providing information in right format?)</li> <li>Lack of compliance with regulations (by users) or lack of compliance effort (by agencies)</li> </ul>
Public Safety	<ul style="list-style-type: none"> <li>Wildlife interactions (e.g. shark bite, jellyfish, boat striking a whale)</li> <li>Seafood contamination</li> <li>Other water pollution/contamination affecting human health and safety (such as toxic algal blooms, <i>e.coli</i> concentrations, etc.)</li> </ul>
Critical Knowledge Gaps	<ul style="list-style-type: none"> <li>Inadequate social and economic information</li> </ul>
Lack of Access Availability	<ul style="list-style-type: none"> <li>Limited or lack of access infrastructure to the marine estate</li> <li>Loss of public access (either by private development or Government area closures)</li> </ul>

## 2.7 Spatial Scale

A key attribute of the TARA is that it should be scalable from Statewide down to the geographic region that best aligns with the management issue being investigated.

For the Statewide assessment, the spatial extent of the risk of the threat to a benefit being realised was examined at the following scales:

- Highly Localised Risk
- Localised Risk
- Regional Risk
- Region-specific Risk
- Statewide Risk

Local scale in this context included considering threats in particular estuaries, beaches, for localised fisheries or other similar features. Where the occurrence of the threat was occurring across multiple localities, this was considered in the risk level and documented as part of the evidence presented.

The terminology adopted for the spatial extents of a risk being realised is given in Table 2-5.

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Table 2-5 Spatial Extent of Risk (being realised)

Term	Definition	Example
Highly Localised Risk	Occurring at a site/premises scale or otherwise only occurring at a very small number of defined locations along the coast	<ul style="list-style-type: none"> <li>Impacts of thermal discharges from a power station</li> </ul>
Localised Risk	Occurring within or across regions but at a localised scale (e.g. effecting parts of an estuary) or otherwise a limited number of locations (operating in a small number of estuaries)	<ul style="list-style-type: none"> <li>Impacts from 4WD vehicles on beaches</li> <li>Impacts on the marine environment from port and shipping operations</li> </ul>
Regional Risk	Generally occurring across the whole or large parts of a region but does not constitute Statewide risk.	<ul style="list-style-type: none"> <li>Foreshore development on saltmarsh <i>Note: the majority of impacts will be in this category</i></li> </ul>
Region-specific Risk	A regional risk that is occurring in one region	<ul style="list-style-type: none"> <li>Impacts to from shipping on deep soft sediments and rocky reefs (central)</li> <li>Impacts from shark meshing (central)</li> </ul>
Statewide Risk	A regional risk that is occurring in a widespread manner at a similar scale and intensity across all three regions	<ul style="list-style-type: none"> <li>Water pollution associated with urban stormwater runoff</li> </ul>

Despite being a Statewide scale assessment, it was agreed that a 'high' risk of impact at the local scale was important to capture as part of the TARA process (See Box 2-1 below). The next stages of marine estate planning under the 5-step decision making process may recommend these highly localised issues are best addressed by existing management regimes and do not need to be addressed by the Marine Estate Management Strategy but noting identification in the risk set out in the TARA is a flag for this further evaluation.

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### Box 2-1 Local Threats Influencing Regional Risk Scores

Despite being a Statewide scale assessment, 'high' risks of impact to assets and benefits at the local scale were sought to be captured as part of the TARA process. In some cases, it was agreed between the agencies and experts that these highly localised threats are significant enough to influence an overall risk level at a regional scale. In these instances, the evidence and justification for the risk level (as outlined in the Appendices to this report) provide further detail to what are the specific issues, stressors and/or examples that underpin the risk level in the bioregion.

Some examples from the TARA of highly localised threats to benefits for the marine estate that have influenced regional risk levels included:

- Southern Right whale (*Eubalaena australis*) strikes in the vicinity of Twofold Bay in the Southern Region (in relation to shipping and boating);
- Thermal pollution for Lake Macquarie and Lake Illawarra in the Central region (in relation to point sources of water pollution);
- Illegal catch of undersized abalone on the south coast of NSW, primarily from Narooma to the Victorian border (in relation to commercial fishing).

Ultimately, these threats may not need to be addressed by MEMA as part of the Marine Estate Management Strategy, but it was considered important by participants that they are recorded as part of TARA. This will allow the threats to be further considered in local scale management plans and policies such as Coastal Management Programs or elevated for consideration by MEMA where existing local management is not seen as effective to manage the risk to benefits from the marine estate.

## 2.8 Temporal Scale

The TARA seeks to identify when the risk of the threat being realised will occur (and over what time-frame), and presents the following options within the 20 year planning horizon for the MEMA decision making process:

- Current or in the short term (1-2 years);
- In the medium term (10 years);
- In the longer term (20 years).

Participants in the workshop processes also included a timeframe of 50 years when considering the possible risks of threats from climate change being realised. This was based on the collective view that the risk profile for threats such as sea level rise and ocean acidification may be still be emerging in 20 years but become more severe and widespread when considering a 50 year time horizon, with a need to consider these longer term trajectories as part of current management.

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### 2.9 Priority Threats for Treatment

Consistent with the 5-step decision making process (refer Figure 2-1), the TARA and its outputs are a tool for the prioritisation of threats for further consideration that will be assessed as part of the management options stage of marine planning for the state in Steps 3 and 4 of the process.

However, the threats identified by MEMA agencies and the independent experts as described in this report are an initial assessment and are not 'cast in bronze'. They will very likely change over time with the presentation of additional evidence and following further engagement with the community and stakeholders of the marine estate.

That said, a key advantage of having completed this initial TARA approach for the State will be the ability to re-visit the risk levels and evidence over time. This process can be used to track and confirm the likelihood of the consequence of the threat occurring which can inform a more adaptive approach to management.

In this context, assignment of a 'High' or 'Moderate' risk level is a trigger for further examination of the threat to an asset or benefit but will not necessarily lead to a change to current management or regulations. In some cases, it will not be feasible, practical or possible to manage all threats to low or minimal risk levels and this will need to be considered in the context of the tolerance of the risk both at the current time and over the ten year planning horizon.

Likewise, rating as a 'Minimal' or 'Low' risk level indicates the threat is currently acceptable but still needs to be considered and tracked over time – particularly where there is poor information or evidence related to the threat or stressors and its effect is not well known.

This risk tolerance approach is described in Table 2-6.

Consistent with this approach, MEMA agencies will further evaluate the assigned risk levels with a view to determining appropriate tolerance levels and treatment options consistent with the TARA framework and adopted standards for risk management in Steps 3 and 4 of the decision making process.

Ultimately though, it will not be feasible, practical or possible for MEMA to manage all threats to a 'Low' or 'Minimal' risk level and this will need to be considered in the context of the acceptability of the risk both at the current time and over the life of the Strategy.



Figure 2-1 Five Step Decision Making Process for marine estate management in NSW

## Methods

Table 2-6 Example of a Generic Risk Tolerance Table

Risk Levels	Description	Likely Management Action
<b>Minimal</b>	Risk currently acceptable but trend in the risk to be tracked over time	Existing control measures (if any) are suitable. Monitoring of risk likelihood and consequence over time to identify if risk is increasing, decreasing or staying the same.
<b>Low</b>	Risk likely to be acceptable but trend to be tracked over time	Existing control measures (if any) are suitable. Monitoring of risk likelihood and consequence over time to identify if risk is increasing, decreasing or staying the same.
<b>Moderate</b>	Risk may be acceptable with suitable risk control measures in place	Review of existing management controls or activities for the risk. Increased or different management controls or activities may be needed.
<b>High</b>	Risk less likely to be acceptable; additional risk control measures may need to be considered	Review of existing management controls or activities for the risk. Increased or different management controls or activities are likely to be needed.

## 2.10 Level of Confidence in Risk Levels

The initial TARA assessment for the State (as outlined in this report) has drawn upon the best available information from a range of sources in order to identify priorities for further attention.

These are likely to include threats for which the relevant MEMA agencies need a more detailed application of the framework.

To convey the level of confidence in this knowledge in terms of assigning a risk level, the following ratings were adopted for use in the TARA:

- **Adequate** (there is adequate high quality evidence), often available specifically from the NSW Marine Estate;
- **Limited** (there is limited evidence, often from either studies in other regions or local scale studies in the NSW Marine Estate);
- **Inferred** (there is very limited evidence, often from local scale studies in other regions and/or overseas).

Risk levels that are inferred generally represent knowledge gaps for consideration in future stages of the process. However, a more detailed risk assessment should only be pursued when the additional information will improve our understanding of the threat and what can be done to manage it.

## Methods

### 2.11 Workshops

Further information about the workshop process and proceedings that underpins the TARA for the Statewide assessment is contained in Appendix B.

In addition to the threat and risk workshops undertaken with MEMA agencies and independent experts, a risk evaluation workshop with MEEKP was also held as part of the process to review and evaluate the completed risk matrices and to discuss contested cells.

The outcomes and recommendations of the MEEKP evaluation workshop are discussed in Section 6 of this report.

### 2.12 Limitations

There are a number of limitations that should be noted in reading or reviewing this report:

- The risk levels and threat and benefit information have been derived directly from the advice and views of the MEMA agency staff and independent experts that participated in the workshops. The assigned risk levels and other information presented in the report do not necessarily represent the views of the authors of the report (BMT WBM as the independent risk assessment facilitator) or represent NSW Government policy.
- Instead, it should be recognised that the TARA and its outputs as outlined in this report are a tool for the prioritisation of threats that can then be assessed as part of the management options and response stage in Steps 3-4 of the MEMA decision making process.
- The consideration of social and economic benefits alongside environmental assets is complex with many interrelated threats and benefits identified as part of the workshop process. As a result, there are a range of inconsistencies that have been identified between the environmental and social and economic threat and risk assessments that will need to be further discussed and resolved as part of subsequent assessments.
- Lastly, it should be noted that the threat and risk assessment has been completed based on a perception of the effectiveness of the current regulations and management regimes for addressing the threats identified. This has inherent bias depending on who is undertaking the assessment (e.g. the regulator versus the person or entity being regulated) and is an issue that will be further examined as part of the management options process in Step 3 of the 5-step decision making process.

### 2.13 Second Iteration Methodology Refinement

The recommended TARA approach is designed to be iterative with the threats and risks assessed in a hierarchical manner. Through implementation and filling of key data gaps, it is expected that the methods will be continually refined. As this Statewide assessment represents the second TARA undertaken, some key learning from the HSB pilot have been used to refine the methodology. These refinements are summarised in the sections below.

## Methods

### 2.13.1 Relationship of the likelihood and consequence statements to fish stocks

A key issue raised by scientific experts during the TARA environmental workshop was the relationship of the likelihood and consequence statements to the assessment of threats to fish populations.

The TARA seeks to identify and assign a risk level with respect to the effect of various stressors on the values of the marine estate. In a fisheries management context, this can include both the assessment of the effect of catch on a particular fish species as well as the broader effect of catch of one or more stocks may have on community/trophic structure.

While there are defined categories for the exploitation status for harvested species, which includes 'overfished' 'growth overfished', 'fully fished', 'moderately fished', 'uncertain' and 'undefined', many species are in these last two categories, and status is not defined across trophic groups. , It was noted that the risk assessment must take into account existing management controls but also the uncertainty of the broader effects of fishing on marine ecological communities and trophic structure as required by the TARA consequence tables. Hence, while stock harvest information can be used to inform the TARA, it was recognised that the stock harvest data in many cases does not provide the critical information needed for assessing how that stressor affects marine community/trophic structure.

### 2.13.2 Contested Cells

There were a small number of contested cells within the Statewide assessment where MEMA agencies and/or independent experts could not resolve a single risk level. These contested cells were discussed as part of the MEEKP evaluation process.

#### **Environment TARA**

There are four cells related to commercial fishing that were identified as a 'High' risk level by the independent experts based on the interpretation of the consequence categories but noted to be considered 'Moderate' risk by DPI. These cells are shown as blue in the matrix in Appendix C. For the purposes of the assessment, they have been kept as a 'High' risk for further consideration in future steps of the decision making process.

#### **Social and Economic TARA**

Following the social and economic expert workshop, there were changes proposed by the NSW Environment Protection Authority about the risk levels assigned to the threat of "point source pollution and sewage overflows" on social and environmental benefits. This was mostly due to some of the risk levels being incorrectly translated from the Environmental TARA. These risk levels have been reviewed and amended within the Social and Economic TARA to achieve consistency between the assessments

### 2.13.3 Aggregation Considerations

As the Statewide workshops focussed on giving a risk level for the three regions of the coast (North, Central and South), a decision needed to be made regarding aggregation of risk at the Statewide level.

## Methods

Rather than developing 'rules' for aggregation, it was agreed that the information is presented wherever possible with reference to the relevant region and that for a more detailed understanding of the risk levels, the reader should consult the matrices and evidence presented in the Appendices to this report.

### 2.13.4 Response to Minimal and Low Risks

Workshop discussion around 'Minimal' and 'Low' risks included concerns that these may be dismissed. An important discussion point related to the tendency of some of these to have high consequences but are only assessed as minimal and low based on current likelihood. In this regard the risk tolerance table has been modified from the table presented as part of the HSB pilot project to include assessing trend and monitoring over time (refer to Table 2-6)

### 2.13.5 Changes to Threat and Benefit Categories

The following agreed inclusions were made to threat and benefit categories in the matrices:

- The identification of specific uses and activities (commercial fishing, aquaculture, etc.) in the Social and Economic TARA was replaced with consideration of the common stressors (e.g. habitat disturbance.) from those uses and activities that may impact on the flow of benefits from the marine estate. These stressors are listed and discussed in section 2.6 of this report;
- A new asset category for the environmental TARA, called "Fish assemblages" was added. The introduction of this asset category was made to allow a more effective assessment of risk from the stressors relating to the harvest and bycatch of fish species and trophic levels independent of the dominant habitat they are associated with. This reflects the fact that the majority of species are not associated with one particular habitat type (e.g. seagrass, shallow rocky reef). Hence, threats to the environmental habitat asset categories in the Statewide TARA does not include that relating to harvest and bycatch of relevant species (e.g. sea urchins and shallow rocky reefs), and differs to the threat and risk assessment in the Hawkesbury Shelf bioregion where harvest and bycatch stressors were attributed to specific habitats;
- A new asset category for the environmental TARA, called "Planktonic assemblages" was added. The introduction of this asset category was made to allow a specific assessment of the component of planktonic assemblages within estuaries and coastal and marine waters (e.g. zooplankton, phytoplankton, fish larvae);
- "Rocky Shores" environmental assets were taken to include artificial rocky habitat in the Environmental TARA;
- Passive recreation and dog walking is now included in the surfing and swimming activity category within the Environmental TARA;
- Grazing was added as a threat activity in the Estuary section of the Environmental TARA (principally affecting saltmarsh communities);
- Naval vessels were considered to be included in the context of large vessels and commercial vessels category of the Environmental TARA.

## 3 Findings of the Environmental Threat and Risk Assessment

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### 3.1 Introduction

For the environmental assessment component of the TARA a decision was made to split the Statewide marine planning area between:

- The 'coastal and marine waters' area - incorporating open coast beaches and foreshores, waters and marine habitats and associated flora and fauna assemblages to the 3 nm limit of State jurisdiction; and
- The 'estuarine' area - incorporating an area defined by a straight line across the two closest points on opposing headlands. Although this is an arbitrary separation in terms of marine ecological processes, it conveniently divides these two ecosystem types for the purpose of this threat and risk assessment. It also allows a specific assessment of threats from activities that occur specifically within these areas and many activities are exclusive to estuaries (e.g. oyster aquaculture), or principally occur in estuaries (e.g. boating infrastructure).

Each of these areas was then assessed in three regions: South, Central and North. The Central region relates specifically to the area of the Hawkesbury Shelf Bioregion (southern Stockton Bight to Shellharbour), the North region included areas from Queensland border to the southern Stockton Bight, and the South region includes the area from Shellharbour to the Victoria border.

The fully completed 'coastal and marine waters' and 'estuarine waters' matrices for the environment component of the TARA are contained in Appendix C of this report, which also contains the full evidentiary justification for the risk levels as compiled by the MEMA agencies and independent experts.

### 3.2 Summary of Priority Threats – Environmental

#### 3.2.1 High and Moderate Threats

In reviewing the outputs of the TARA undertaken for environmental assets in Appendix C, many of the risks to the threats being realised were 'Low' (denoted by yellow boxes) or 'Minimal' (denoted by green boxes). This was particularly the case for the coastal and marine areas compared to the estuaries which had a much greater proportion of 'Moderate' and 'High' risks.

In general there are a much greater number of risks from threats to environmental assets in the estuaries compared to coastal and marine waters and a proportionately larger number of 'High' and 'Moderate' risk levels in the estuaries compared to the coastal and offshore areas. This is largely a function of: (i) the greater levels of human use and occupation of estuaries; and (ii) their smaller size and reduced resilience to impact relative to the much larger offshore area which has lower levels of use and access beyond the ocean beaches and nearshore zone. Similarly, except for a few highly localised risks, the more developed nature of the Central zone (i.e. the HSB) has a higher level of risk to environmental assets attributed for the estuaries. Within the Coastal and Marine Areas the distribution between geographic zones of High, Moderate, Low and Minimal Risks is similar.

The general distribution of risk levels from the risk matrices for the coastal and marine waters and estuaries presented in Appendix C is shown in pie graphs below:

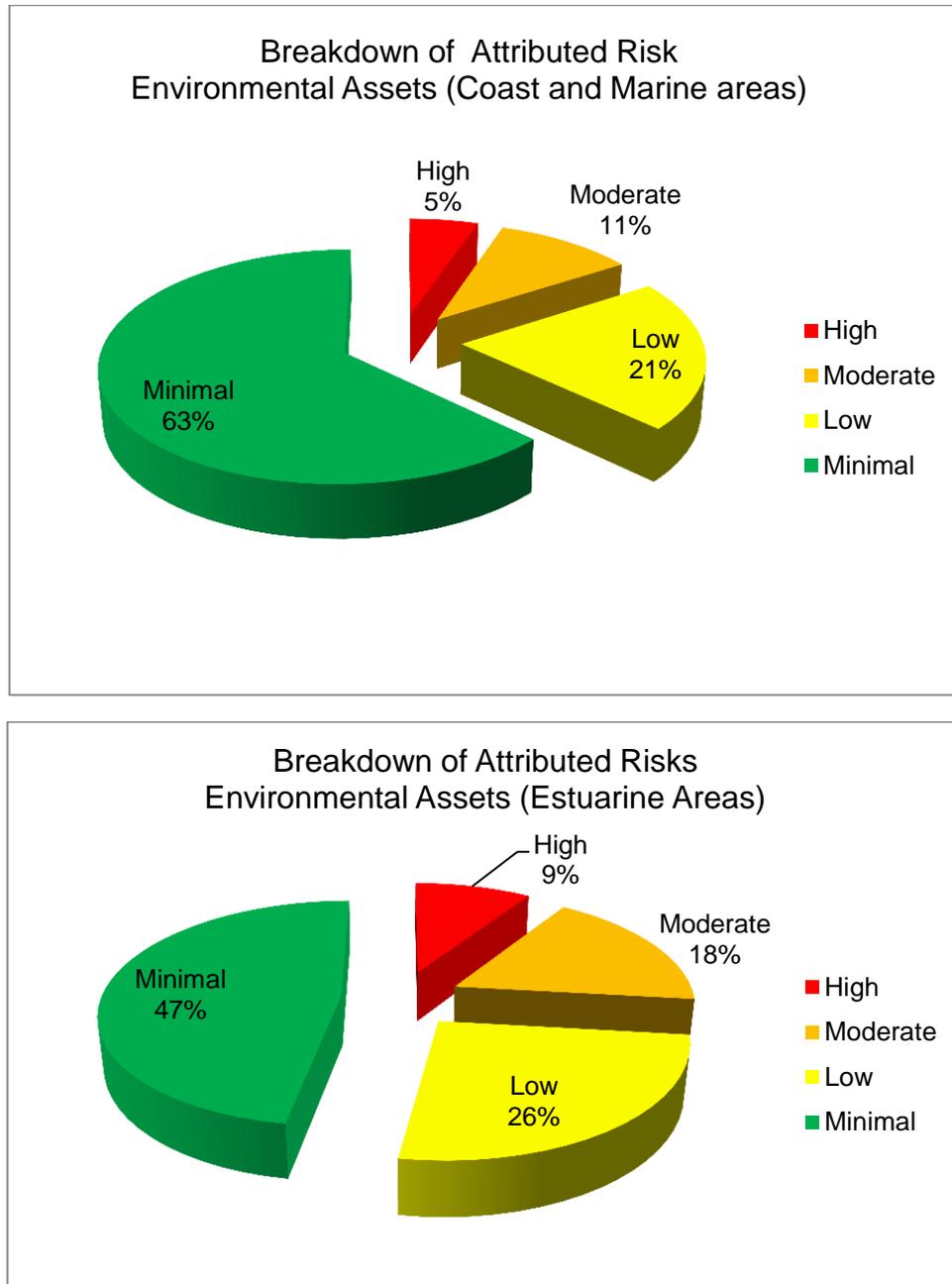


Figure 3-1 Distribution of risk levels for threats to the coastal and marine waters and estuaries

### 3.2.2 Spatial Scale of Threats

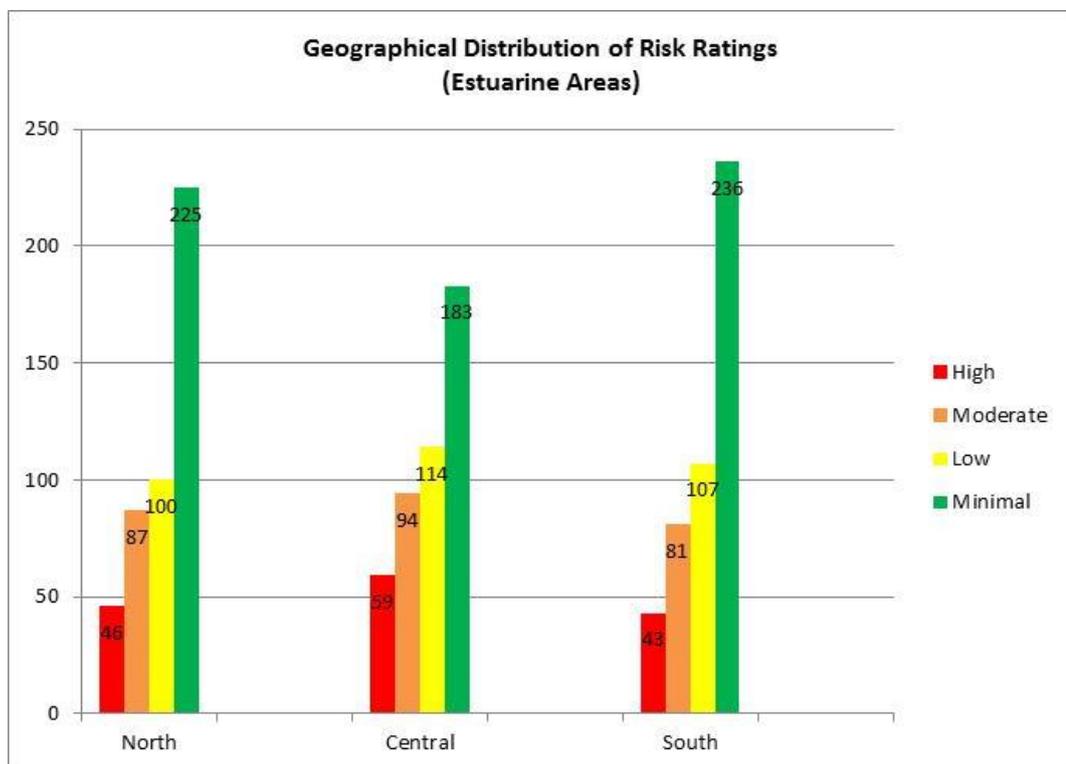
In general terms, most threats from the identified uses, activities and stressors are operating at a broad spatial scale (e.g. across the whole state or at many locations across the state). Spatial extent of risk is described in 2.7)

Activities where risks to benefits were identified as only operating at highly localised (e.g. site specific) scale included:

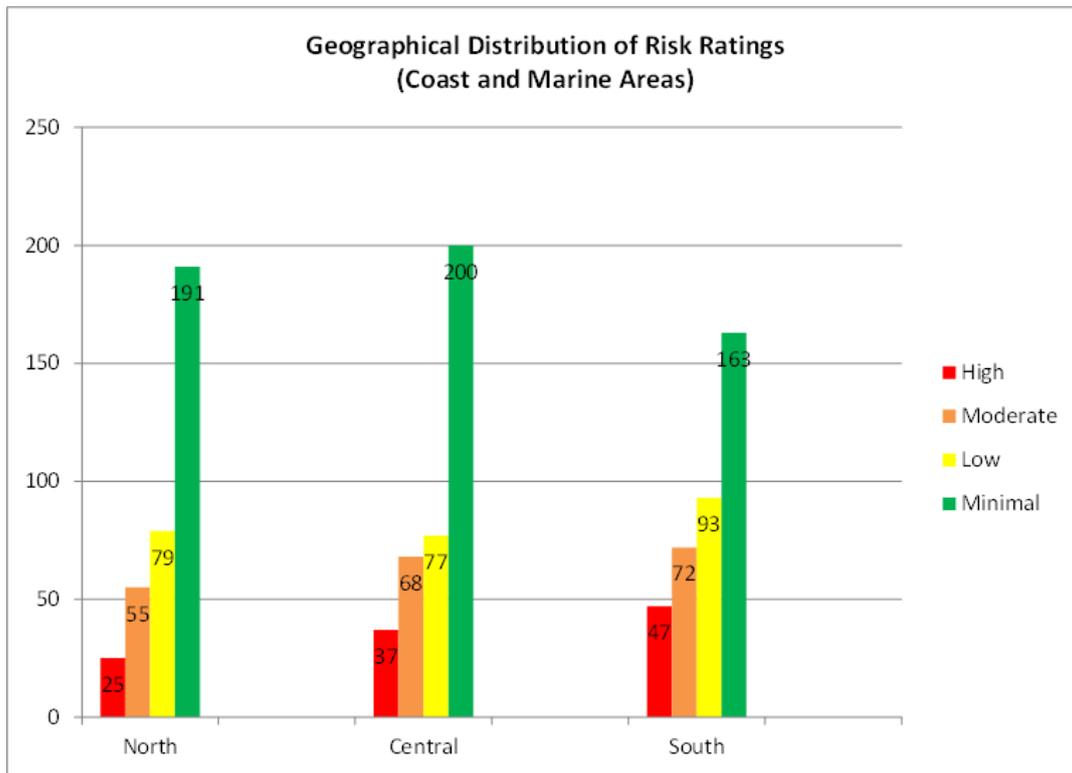
- Legal 4WD on select beaches in the North and Central Regions (for example Stockton Beach, Lighthouse Beach, Crescent Beach, Sandon Beach);
- Impacts of small commercial vessels (ferries) on mangroves in the upper Parramatta River;
- Whale and Dolphin watching charters in Port Stephens; and
- Hand gathering of nippers on the North Coast.

There are also considerable variations in the spatial extent of commercial fishing activities reflecting the distribution of fish stocks, fishing fleets and management arrangements. For example, commercial fishing is permitted in only 85 of the 184 estuaries along the NSW coast, with the majority of catch taken from a small number in each region. Also, this assessment is restricted to commercial fishing activities that occur within state coastal waters, even though fishing activity can also occur in Commonwealth waters due to shared stock management for some species.

The geographic distribution of risk levels for the estuarine areas and coast and marine areas are shown in Figure 3-2 and Figure 3-3. Note that the total number of risks is different for each region as some threats were not applicable for specific regions (for example 'Fish Stocking' in the North region).



**Figure 3-2 Geographical Distribution of Environmental Risk Attributions for Threats in the Estuarine Areas**



**Figure 3-3 Geographical Distribution of Environmental Risk Attributions for threats in the Coastal and Marine Waters Area**

### 3.2.3 Temporal Aspects of Risks and Trends

In considering the temporal aspects of the risks, most risks are considered to be current issues happening now (e.g. at the present time) with the threat of the risk being realised expected to intensify or increase over time.

Various aspects of Climate Change (ocean acidification, sea level rise and others), were specifically noted by participants to be an issue that needed to be considered for management as part of the current planning process (in the context of understanding vulnerability and building resilience to future impacts). However, it was also noted that the timing of threat realisation will be in the 20+ year category, with the extent and severity impacts only able to be inferred at the current time.

### 3.2.4 Priority Threats for Treatment

In looking at those resource uses, activities and issues that had an incidence of high or moderate risks to an environmental asset provided by the marine estate, a hierarchical list has been generated based on the number of high and moderate level risks and collected information about the risk trends (e.g. activities where the risks were increasing were given the highest priority, followed by risks that were stable and then risks that were decreasing). This was undertaken on a Statewide basis, and then individually for each of the three regions. The scoring system weighted higher risks. Each high risk gave the activity or threat a score of 3, moderate risks were given a score of 2. The cumulative risk score for each row could then be calculated. An activity was considered a Statewide priority only if it had a moderate or high risk level for each of the three

regions across the state (north, central and south). For high or moderate risks in only one or two regions, the risk was considered a priority just for that region. Note that some variations of activities, such as different commercial and recreational fishing techniques, are assessed separately to ensure the detail of activity is retained and useful for future management assessment. However, if all fishing effort was combined this would increase the priority of the overall activity. This has implications for cumulative impacts on shared resources, such as fish stocks. Conversely, climate change impacts have been aggregated in the prioritisation as the ability to address the individual stressors is not practical in the same manner as fishery management. These cumulative issues are discussed further in Section 6.2.3. For further information on the prioritisation methodology, please see Appendix F.

All of the threats that represent high or moderate risks to estuaries and a brief reference to the evidence supporting risk levels is given in Table 3-2. However the priority risks at a Statewide level for estuaries in ranked order are shown in Table 3-1.

**Table 3-1 Moderate and High (Priority) Threats to Estuaries Statewide**

Ranked Priority Threats to Estuaries - Statewide
<ul style="list-style-type: none"> <li>• Estuary entrance modifications</li> <li>• Urban stormwater discharge</li> <li>• Agricultural diffuse source runoff</li> <li>• Clearing riparian and adjacent habitat including wetland drainage</li> <li>• Recreation and tourism -Boating and boating infrastructure</li> <li>• Climate Change (20yrs)</li> <li>• Navigation &amp; entrance management and modification, harbour maintenance, etc.</li> <li>• Sewage effluent and septic runoff</li> <li>• Stock grazing of riparian and marine vegetation</li> <li>• Modified Freshwater flows</li> <li>• Foreshore development</li> <li>• Recreation and tourism – Four wheel driving</li> <li>• Commercial Fishing- Estuary General</li> <li>• Oyster Aquaculture</li> <li>• Recreational Fishing – Shore-based line and trap fishing</li> <li>• Recreational Fishing – Boat-based line and trap fishing</li> <li>• Beach nourishment and grooming</li> </ul>

Table 3-2 Moderate and High Threats to Environmental Assets for Estuarine Areas

Use, Activity or Stressor (Threats)	Environmental Assets in Estuaries that are at 'High' risk from the use/activity/stressor	Environmental Assets in Estuaries that are at 'Moderate' risk from the use/activity/stressor	Summary of Evidence
<b>Shipping</b> (includes Large and Small Commercial Vessels)	<ul style="list-style-type: none"> <li>● Mangrove(Central only)</li> </ul>	<ul style="list-style-type: none"> <li>● Estuarine waters (Central only)</li> <li>● Saltmarsh (Central only)</li> <li>● Seagrass (Central only)</li> <li>● Beach and Mudflats (Central only)</li> <li>● Shallow and Soft Sediments</li> <li>● Rocky Shores (Central only)</li> <li>● Species and Populations Protected under FMA (Central only)</li> <li>● Species Protected under TSCA (Central and South only)</li> </ul>	<ul style="list-style-type: none"> <li>• Antifouling paint can pollute water ways</li> <li>• Vessels as vectors of pests and disease</li> <li>• Oil spills (very high consequence)</li> <li>• Vessel impacts in the Parramatta River such as sediment resuspension and community composition change from vessel wake.</li> </ul>
<b>Commercial Fishing</b> (includes Estuary General and Estuary Prawn Trawl)	<ul style="list-style-type: none"> <li>● Fish assemblages (harvest and bycatch) (North and South only)</li> </ul>	<ul style="list-style-type: none"> <li>● Species Protected under TSCA (North and Central)</li> <li>● Fish Assemblages (Central only)</li> <li>● Shallow and Soft Sediments</li> <li>● Species protected under FMA (North and South only)</li> </ul>	<ul style="list-style-type: none"> <li>• Related to impacts on <i>Posidonia</i> and associated protected species (e.g. sygnathids)</li> <li>• Impacts on TSC - inferred from seabirds and dolphins in SA</li> <li>• Impact on habitat and associated biota as a result of the estuary prawn trawl fishery on shallow soft sediments (e.g. harvest, by-catch, physical disturbance)</li> <li>• Impact on pelagic assemblages as a result of estuary general fishery and estuary prawn trawl (e.g. harvest, by-catch) against background variations, and moderate resilience characteristics of many species.</li> <li>• Entanglement of shorebirds, marine mammals, turtles</li> </ul>
<b>Recreational Fishing</b> (includes Shore-based line and trap fishing, Boat-based line and trap fishing, Hand Gathering)	Nil	<ul style="list-style-type: none"> <li>● Beaches and mudflats (North)</li> <li>● Fish Assemblages</li> <li>● Species protected under TSCA (North and Central only)</li> </ul>	<ul style="list-style-type: none"> <li>• Mortalities of turtles in crab gear</li> <li>• Physical disturbance of shorebirds, seabirds and marine mammals</li> <li>• Marine debris</li> <li>• Harvest</li> <li>• Bycatch</li> </ul>
<b>Boating and Boating Infrastructure</b>	<ul style="list-style-type: none"> <li>● Seagrass</li> <li>● Beach and Mudflats (Central only)</li> <li>● Shallow and Soft Sediments (Central only)</li> <li>● Species and Populations Protected under FMA</li> </ul>	<ul style="list-style-type: none"> <li>● Estuarine Waters</li> <li>● Beach and Mudflats (North and South only)</li> <li>● Shallow and Soft Sediments (North and South only)</li> <li>● Rocky Shores (Central only)</li> <li>● Subtidal Reefs (Central only)</li> <li>● Species Protected under TSCA</li> </ul>	<ul style="list-style-type: none"> <li>• Copper pollution - significantly elevated concentrations in organisms from areas with high concentrations of moored boats.</li> <li>• Physical disturbance, propeller / anchoring / mooring combined with low resilience of components of the habitat to these impacts (i.e. <i>Posidonia seagrass population</i>).</li> <li>• Sediment resuspension – light limitation</li> <li>• Shading from boats and jetties</li> <li>• Bank erosion linked to wakeboarding in upper estuary areas</li> <li>• Soft corals and sponges not mapped but thought to be highly susceptible</li> <li>• Vessel strike, disturbance from boats, feeding of seabirds</li> </ul>
<b>Recreation and Tourism</b> (includes, 4WD, , and charter activities)	Nil	<ul style="list-style-type: none"> <li>● Saltmarsh</li> <li>● Beach and Mudflats</li> <li>● Species Protected under the FMA</li> <li>● Species Protected under TSCA</li> </ul>	<ul style="list-style-type: none"> <li>• 4WD damage to saltmarsh</li> <li>• General wildlife disturbance</li> </ul>
<b>Foreshore / urban development</b> (includes beach nourishment and grooming)	<ul style="list-style-type: none"> <li>● Beach and mudflats (Central only)</li> <li>● Shallow and soft sediments (Central only)</li> <li>● Species Protected under TSCA (Central only)</li> </ul>	<ul style="list-style-type: none"> <li>● Seagrass</li> <li>● Mangrove (Central only)</li> <li>● Saltmarsh</li> <li>● Beaches and mudflats (North and South only)</li> <li>● Rocky shores (Central only)</li> </ul>	<ul style="list-style-type: none"> <li>• Foreshore development physically destroys habitats and biota,</li> <li>• Changed wave patterns damage habitat and alter grain size</li> <li>• Impacts high on nesting shorebirds and turtles from permanent loss of near shore habitat</li> <li>• Direct habitat disturbance or removal</li> <li>• Impacts to seagrass through physical damage, change in light</li> </ul>

Use, Activity or Stressor (Threats)	Environmental Assets in Estuaries that are at 'High' risk from the use/activity/stressor	Environmental Assets in Estuaries that are at 'Moderate' risk from the use/activity/stressor	Summary of Evidence
		<ul style="list-style-type: none"> <li>Species and Populations Protected under FMA</li> </ul>	<ul style="list-style-type: none"> <li>Removal of wrack sometimes damages living seagrass beds.</li> </ul>
<p><b>Water pollution and sediment contamination</b>                      (includes urban stormwater, agricultural runoff, industrial discharges, sewage effluent and thermal discharges)</p>	<ul style="list-style-type: none"> <li>Estuarine Waters</li> <li>Seagrass</li> <li>Beach and Mudflats (Central only)</li> <li>Shallow and soft sediments</li> <li>Subtidal Reefs</li> <li>Rocky Shores (Central only)</li> <li>Planktonic Assemblages</li> <li>Species and Populations Protected under FMA</li> <li>Species Protected under TSCA (Central only)</li> </ul>	<ul style="list-style-type: none"> <li>Mangroves</li> <li>Saltmarsh</li> <li>Beach and Mudflats (North and South only)</li> </ul>	<ul style="list-style-type: none"> <li>Stormwater transports bioavailable nutrients, toxins (heavy metals), suspended sediments and marine debris</li> <li>Agricultural runoff transports sediments, nutrients and potentially agricultural chemicals</li> <li>Industrial runoff transports nutrients, contaminants and enriched sediments</li> <li>These contaminants impact seagrass diversity and abundance and disrupt other ecological processes</li> </ul>
<p><b>Clearing, dredging and excavation activities</b>                      (includes vegetation clearing, dredging, service infrastructure, mining and extraction and cattle grazing)</p>	<ul style="list-style-type: none"> <li>Estuarine Waters</li> <li>Saltmarsh</li> <li>Mangroves</li> <li>Seagrass</li> <li>Shallow and soft sediments</li> <li>Species and Populations Protected under FMA</li> <li>Species Protected under TSCA (Central only)</li> </ul>	<ul style="list-style-type: none"> <li>Beach and Mudflats</li> <li>Planktonic Assemblages</li> <li>Species Protected under TSCA (North and South only)</li> </ul>	<ul style="list-style-type: none"> <li>Black water events after floods</li> <li>Altering water tables and connectivity</li> <li>Loss of habitat for migratory shorebirds</li> <li>Physical disturbance from cattle grazing</li> </ul>
<p><b>Estuary openings/modified freshwater flows</b>                      (includes Hydrological modifications/estuary entrance/modified freshwater flows)</p>	<ul style="list-style-type: none"> <li>Saltmarsh</li> <li>Mangrove (North only)</li> <li>Seagrass</li> <li>Species and Populations Protected under FMA</li> </ul>	<ul style="list-style-type: none"> <li>Estuarine Waters</li> <li>Mangroves (Central and South only)</li> <li>Beaches and mudflats</li> <li>Shallow and soft sediments</li> <li>Planktonic Assemblages</li> <li>Species Protected under TSCA</li> </ul>	<ul style="list-style-type: none"> <li>Changed water table and inundation regimes results in very broad overall impacts.</li> <li>Changes result in mangrove encroachment on other habitat (e.g. saltmarsh)</li> <li>Modified freshwater flows result in impacts /ASS leaching</li> </ul>
<p><b>Aquaculture</b>                      (includes Oyster Aquaculture)</p>		<ul style="list-style-type: none"> <li>Seagrass</li> <li>Species and Populations Protected under FMA</li> </ul>	<ul style="list-style-type: none"> <li>Impacts to seagrass and associated biota, and specifically <i>Posidonia</i> and saltmarsh, from physical disturbance at highly localised areas in estuaries where aquaculture occurs resulting principally from propellers, sediment re-suspension, and shading from boats/structures resulting in light limitation.</li> </ul>
<p><b>Climate Change</b>                      (includes all components)                      (based on a 50 year projection of impacts)</p>	<ul style="list-style-type: none"> <li>Saltmarsh</li> <li>Mangrove</li> <li>Seagrass</li> <li>Beach and Mudflats</li> <li>Shallow and Soft Sediments</li> <li>Rocky Shores</li> <li>Subtidal Reefs</li> <li>Planktonic assemblages</li> </ul>	<ul style="list-style-type: none"> <li>Estuarine Waters</li> </ul>	<ul style="list-style-type: none"> <li>Saltmarsh to show changes greater than thresholds</li> <li>Acidification an issue for sa molluscs (and other calcifying organisms) associated with most estuarine habitats, including planktonic assemblages</li> <li>Seagrass (<i>Zostera</i>) is sensitive to decreased salinity, increased wave action and increased turbidity</li> <li>Loss of habitat and nesting sites for shorebirds and turtles. Loss of shorebirds foraging habitat. Loss of intertidal foraging habitat including seagrass.</li> <li>Most habitats impacted by physical disturbance from sea level rise, increased storms, flooding, inundation etc</li> </ul>

Use, Activity or Stressor (Threats)	Environmental Assets in Estuaries that are at 'High' risk from the use/activity/stressor	Environmental Assets in Estuaries that are at 'Moderate' risk from the use/activity/stressor	Summary of Evidence
	<ul style="list-style-type: none"> <li>● Species and Populations Protected under FMA</li> <li>● TSC Protected species</li> </ul>		

Equivalent to the estuary analysis above, a coastal and marine waters activity was considered a Statewide priority only if it had a moderate or high risk level for each of the three regions across the state (north, central and south). For high or moderate risks in only one or two regions, the threat was considered a priority just for that region. Note that some variations of activities, such as different commercial and recreational fishing techniques, are assessed separately to ensure the detail of activity is retained and useful for future management assessment. However, if all fishing effort was combined this would increase the priority of the overall activity. This has implications for cumulative impacts on shared resources, such as fish stocks. Conversely, climate change impacts have been aggregated in the prioritisation as the ability to address the individual stressors is not practical in the same manner as fishery management. These cumulative issues are discussed further in Section 6.2.3. For further information on the prioritisation methodology, please see Appendix F.

All of the threats that represent high or moderate risks to coasts and marine waters and a brief reference to the evidence supporting risk levels is given in Table 3-4. However the priority threats at a Statewide level for estuaries in ranked order are shown in Table 3-3.

**Table 3-3 Moderate and High (Priority) Threats to Coastal and Marine Waters Statewide**

Ranked Priority Threats to Coastal and Marine Waters - Statewide
<ul style="list-style-type: none"> <li>• Climate Change (20yrs)</li> <li>• Commercial Fishing – Ocean Trawl</li> <li>• Commercial Fishing – Ocean Trap and Line</li> <li>• Recreational Fishing – Boat-based line and trap fishing</li> <li>• Foreshore development</li> <li>• Urban stormwater discharge</li> <li>• Commercial Fishing – Ocean Haul</li> <li>• Recreational Fishing – Shore-based line and trap fishing</li> <li>• Estuary entrance modification and breakwaters</li> <li>• Beach nourishment and grooming</li> <li>• Recreational Fishing – Hand gathering</li> <li>• Charter activities – whale and dolphin watching</li> <li>• Shipping – Small commercial vessels</li> </ul>

Table 3-4 Moderate and High Threats to Environmental Assets for Coastal and Marine Areas

Use, Activity or Stressor (Threats)	Environmental assets along the Coastal and in Marine Areas that are at 'High' risk from the use/activity/stressor	Environmental Assets of the Coastal and in Marine Areas that are at 'Moderate' risk from the use/activity/stressor	Summary of Evidence
<b>Shipping and Commercial Vessels</b> (includes Large and Small Commercial Vessels)	<ul style="list-style-type: none"> <li>● Deep Soft Sediments (Central only)</li> <li>● Species protected under TSCA (Central only)</li> </ul>	<ul style="list-style-type: none"> <li>● Deep Reefs (Central only)</li> </ul>	<ul style="list-style-type: none"> <li>• Most ships anchor outside 3nm, however, anchor chains drag inside 3nm impacting deep soft-sediment habitat, deep rocky reef habitat and associated biota</li> <li>• Vessel strike, noise and wildlife disturbance and subsequent changes in wildlife behaviour. Data show 10 year history of interactions. Increased numbers contributing to increase in strikes</li> <li>• Marine Debris</li> <li>• Possible spills</li> </ul>
<b>Commercial Fishing</b> (includes Ocean Trap and Line, Ocean Trawl, Ocean Haul, Sea urchin and turban shells, Abalone)	<ul style="list-style-type: none"> <li>● Fish Assemblages (harvest and bycatch) (South and North only)</li> <li>● Species protected under FMA (North only)</li> </ul>	<ul style="list-style-type: none"> <li>● Beaches (North and South only)</li> <li>● Deep Soft Sediments (North and South only)</li> <li>● Fish Assemblages (harvest and bycatch) (Central only)</li> <li>● Species protected under FMA (Central and South only)</li> <li>● Species protected under TSCA (North and Central only)</li> </ul>	<ul style="list-style-type: none"> <li>• Ocean trawl gear type used can result on certain habitats in measurable impacts on benthic biota and result in moderate levels of bycatch</li> <li>• Sea Urchin and turban shells have life history characteristics that result in mod-low resilience.</li> <li>• Impacts on pelagic assemblages as a result of the ocean haul fishery e.g. targeting by purse-seiners of sweep</li> <li>• Ocean trap and line catch and ocean trawl effort occurs in coastal waters and catch of threatened and protected fish and sharks considered likely</li> <li>• Highly localised issues include abalone on the south coast</li> <li>• Wildlife and physical disturbance on marine mammals, birds and reptiles considered likely</li> <li>• Disturbance of birds by beach activities.</li> </ul>
<b>Recreational Fishing</b> (includes Shore-based line and trap fishing, Boat-based line and trap fishing, Hand Gathering)	<p>Nil</p>	<ul style="list-style-type: none"> <li>● Beaches (North only)</li> <li>● Fish Assemblages (harvest and bycatch)</li> <li>● Species protected under FMA</li> </ul>	<ul style="list-style-type: none"> <li>• Harvest and bycatch</li> <li>• Marine debris</li> <li>• Damage from anchors</li> <li>• 4WD impacts from physical compaction and disturbance (e.g. pipis, beachworms)</li> <li>• Hand collection (and trampling)</li> <li>• Catch of threatened and protected fish species</li> <li>•</li> </ul>
<b>Recreation and Tourism</b> (includes 4WD, swimming and surfing, shark meshing of beaches and charter activities)	<ul style="list-style-type: none"> <li>● Beaches (North and Central only)</li> <li>● Species protected under TSCA (North and Central only)</li> <li>● Species protected under FMA (Central only)</li> </ul>	<p>Nil</p>	<ul style="list-style-type: none"> <li>• 4WD on beaches impacting nesting and foraging of shorebirds / nesting of turtles on the north and central regions</li> <li>• Whale tourism impacts (noise, disturbance, displacement, stress, behavioural change)</li> <li>• Shark meshing known to catch white sharks, grey nurse sharks and now identified as a Key Threatening Process</li> <li>• Shark meshing associated with entanglement of cetaceans and turtles</li> </ul>
<b>Foreshore / urban development</b> (includes beach nourishment and grooming)	<ul style="list-style-type: none"> <li>● Beaches (Central only)</li> <li>● Species protected under TSCA (Central only)</li> </ul>	<ul style="list-style-type: none"> <li>● Beaches (North and South only)</li> <li>● Rocky Shores (Central only)</li> </ul>	<ul style="list-style-type: none"> <li>• Foreshore development completely alters habitat (including loss of nearshore habitat for shorebirds and turtles)</li> <li>• Nourishment and grooming of beach can alter / remove habitat characteristics, impacting biota and processes</li> <li>• Some aspect are a legacy issues -new foreshore development on rocky shores is unlikely to occur with current management settings e.g. zonings, SEPP 71, CZMPs etc.</li> </ul>
<b>Water pollution and sediment contamination</b> (includes urban stormwater, agricultural runoff, industrial discharges, sewage effluent)	<ul style="list-style-type: none"> <li>● Species protected under TSCA (Central only)</li> </ul>	<ul style="list-style-type: none"> <li>● Beaches</li> <li>● Rocky shores (Central only)</li> <li>● Shallow Reefs (Central only)</li> <li>● Deep Reefs (Central only)</li> </ul>	<ul style="list-style-type: none"> <li>• Contaminants in urban stormwater have been shown to alter biota, microbial assemblages and can result in local production of nuisance microalgae</li> <li>• Evidence of micro-plastics, marine debris and other contaminants impacting marine turtles and dolphins</li> <li>• Localised impact of sewage discharge on rocky shore and assemblages surrounding discharge area</li> </ul>
<b>Clearing, dredging and excavation activities</b> (includes vegetation clearing, dredging, service infrastructure, mining and extraction)	<ul style="list-style-type: none"> <li>● Species protected under TSCA (Central only)</li> </ul>	<ul style="list-style-type: none"> <li>● Beaches (Central)</li> <li>● Deep soft sediments</li> </ul>	<ul style="list-style-type: none"> <li>• Loss of habitat for shorebirds likely to lead to local extinctions / declines to threatened species.</li> <li>• Physical disturbance, sediment resuspension and re-distribution (incl. contaminated sediments) associated with dredging impacting habitat and biota</li> <li>• Loss of coastal vegetation is a legacy issue</li> </ul>

Use, Activity or Stressor (Threats)	Environmental assets along the Coastal and in Marine Areas that are at 'High' risk from the use/activity/stressor	Environmental Assets of the Coastal and in Marine Areas that are at 'Moderate' risk from the use/activity/stressor	Summary of Evidence
<b>Estuary openings/modified freshwater flows</b> (includes hydrological modifications/estuary entrance/modified freshwater flows)	<ul style="list-style-type: none"> <li>● Beaches</li> </ul>	Nil	<ul style="list-style-type: none"> <li>• Dredging, mechanical openings, construction of walls change natural habitat characteristics and sand movement</li> <li>• Increased water levels and frequency of inundation of intertidal areas</li> </ul>
<b>Climate Change</b> (all components) (based on a 50 year projection of impacts) <sup>1</sup>	<ul style="list-style-type: none"> <li>● Ocean Waters</li> <li>● Beaches</li> <li>● Shallow and Soft Sediments</li> <li>● Deep soft sediments</li> <li>● Planktonic Assemblages</li> <li>● Species protected under TSCA</li> </ul>	<ul style="list-style-type: none"> <li>● Rocky shores</li> <li>● Shallow Reefs</li> <li>● Deep Reefs</li> <li>● Species protected under FMA</li> </ul>	<ul style="list-style-type: none"> <li>• Acidification impacts for calcifying organisms and sensitive organisms (urchins, molluscs, colicophores, pteropods)</li> <li>• Beaches lost where capacity to extend inland is limited, impacts for foraging shorebirds</li> <li>• Changes in primary production due to changed currents &amp; nutrient inputs</li> <li>• Changes to East Australia Current and temperatures likely to impact migration of turtles, whales and dolphins</li> <li>• Changes to nutrients and fish abundance likely to impact higher order predators (seabirds, marine mammals, turtles)</li> <li>• Changes in temperature likely to impact turtles nesting success and sex composition</li> <li>• Dynamics of coastal wetlands likely to change, impacting shorebirds</li> <li>• Increased mortality of marine fauna after extreme events, particularly kelp</li> <li>• Limited capacity for biota to move in most places. Shore platforms particularly vulnerable to modest increases in sea level, leading to displacement of habitat and biota</li> </ul>

### 3.2.5 Combined Statewide Priority Threats

An overall priority list for the Environmental TARA has been developed by combining the results from the Statewide estuary and coastal and marine areas priorities (refer to Table 3-5). This used the same scoring system as the individual TARA priority threats above. Where threats were a priority for both, they were combined (for example, climate change). Where they were only an issue for one of the areas, this is noted in brackets (for example Estuary entrance modifications (in estuaries)). As the estuaries had a much greater proportion of 'Moderate' and 'High' risk levels compared to coastal and marine areas, the estuary threats tend to dominate the combined environmental list. All activities that have been identified as High or Medium risks at the Statewide level will be considered further during parts 3 and 4 of the process, however this will not necessarily lead to a change to current management or regulations.

Note that some variations of activities, such as different commercial and recreational fishing techniques, are assessed separately to ensure the detail of activity is retained and useful for future management assessment. However, if all fishing effort was combined this would increase the priority of the overall activity. This has implications for cumulative impacts on shared resources, such as fish stocks. Conversely, climate change impacts have been aggregated in the prioritisation as the ability to address the individual stressors is not practical in the same manner as fishery management. These cumulative issues are discussed further in Section 6.2.3. Further information on the combination methodology between the Estuary and Coastal and Marine Waters results is available in Appendix F.

### 3.2.6 Regional Priority Threats

Region specific data from the Estuary and Coast and Marine Waters TARAs has been combined to determine regional priorities. The priority environmental threats vary subtly by region according to dominant activities and land uses (such as agriculture being more significant for the North region in comparison to urban stormwater for the Central region) as well as in response to spatial distribution of values (for example, higher turtle abundances in the North region). The results also differ from the Statewide priorities as some regional only priorities are captured in this analysis, for example commercial abalone fishing on the south coast. The ranked priority environmental threats for each of the three regions of the State are given in Table 3-6, with detailed data in Appendix F..

Table 3-5 Combined Moderate and High (Priority) Threats to Environmental Assets Statewide

Ranked Priority Threats to Environmental Assets - Statewide
<ul style="list-style-type: none"><li>• Estuary entrance modifications</li><li>• Urban stormwater discharge</li><li>• Agricultural diffuse source runoff (in estuaries)</li><li>• Clearing riparian and adjacent habitat including wetland drainage (in estuaries)</li><li>• Climate Change (20yrs)</li><li>• Recreation and tourism -Boating and boating infrastructure (in estuaries)</li><li>• Navigation &amp; entrance management and modification, harbour maintenance (in estuaries)</li><li>• Sewage effluent and septic runoff (in estuaries)</li><li>• Stock grazing of riparian and marine vegetation (in estuaries)</li><li>• Foreshore development</li><li>• Modified Freshwater flows (in estuaries)</li><li>• Recreation and tourism – Four wheel driving (in estuaries)</li><li>• Commercial Fishing – Ocean Trawl</li><li>• Commercial Fishing – Ocean Trap and Line</li><li>• Commercial Fishing- Estuary General (in estuaries)</li><li>• Recreational Fishing – Boat-based line and trap fishing</li><li>• Oyster Aquaculture (in estuaries)</li><li>• Commercial Fishing – Ocean Haul</li><li>• Recreational Fishing – Shore-based line and trap fishing</li><li>• Beach nourishment and grooming</li><li>• Recreational Fishing – Hand gathering</li><li>• Charter activities – whale and dolphin watching</li><li>• Shipping – Small commercial vessels</li></ul>

**Table 3-6 Ranked Priority Threats to Environmental Assets (by region)**

Threats to environmental assets for the North region	Threats to environmental assets for the Central Region	Threats to environmental assets for the South Region
<ul style="list-style-type: none"> <li>• Agricultural diffuse source runoff (in estuaries)</li> <li>• Estuary entrance modifications (in estuaries)</li> <li>• Clearing riparian and adjacent habitat including wetland drainage (in estuaries)</li> <li>• Climate Change (20yrs)</li> <li>• Urban stormwater discharge (in estuaries)</li> <li>• Recreation and tourism -Boating and boating infrastructure (in estuaries)</li> <li>• Navigation &amp; entrance management and modification, harbour maintenance, etc. (in estuaries)</li> <li>• Modified Freshwater flows (in estuaries)</li> <li>• Sewage effluent and septic runoff</li> <li>• Stock grazing of riparian and marine vegetation (in estuaries)</li> <li>• Recreation and tourism - Four wheel driving</li> <li>• Foreshore development</li> <li>• Commercial fishing - Ocean Trap and Line</li> <li>• Commercial fishing - Ocean Trawl</li> <li>• Commercial fishing – Estuary General</li> <li>• Recreational fishing - Shore-based line and trap fishing</li> <li>• Recreational fishing - Boat-based line and trap fishing</li> <li>• Recreational fishing - Hand Gathering</li> <li>• Oyster aquaculture (in estuaries)</li> <li>• Commercial fishing – Ocean Haul</li> <li>• Commercial fishing – Estuary Prawn Trawl</li> <li>• Charter activities – whale and</li> </ul>	<ul style="list-style-type: none"> <li>• Urban stormwater discharge</li> <li>• Estuary entrance modifications (in estuaries)</li> <li>• Recreational Boating - Boating and boating infrastructure (in estuaries)</li> <li>• Foreshore development</li> <li>• Agricultural diffuse source runoff (in estuaries)</li> <li>• Clearing riparian and adjacent habitat including wetland drainage (in estuaries)</li> <li>• Shipping - Large commercial vessels and associated port activities and industries (trade ships, cruise ships, etc.)</li> <li>• Climate Change (20yrs)</li> <li>• Sewage effluent and septic runoff</li> <li>• Industrial discharges (in estuaries)</li> <li>• Navigation &amp; entrance management and modification, harbour maintenance, etc.</li> <li>• Stock grazing of riparian and marine vegetation (in estuaries)</li> <li>• Modified Freshwater flows - Extraction, artificial barriers to riverine and estuarine flow (e.g. dams, weirs, waterway crossings, floodgates), urban drainage, impervious surfaces; flood mitigation (in estuaries)</li> <li>• Small commercial vessels (ferries, charter boats, whale watching vessels, fishing vessels etc) (in estuaries)</li> <li>• Service infrastructure – pipes, cables trenching and boring (in estuaries)</li> <li>• Recreation and tourism – Four wheel driving</li> <li>• Beach nourishment and grooming</li> </ul>	<ul style="list-style-type: none"> <li>• Estuary entrance modifications</li> <li>• Agricultural diffuse source runoff (in estuaries)</li> <li>• Climate Change (20yrs)</li> <li>• Urban stormwater discharge</li> <li>• Clearing riparian and adjacent habitat including wetland drainage (in estuaries)</li> <li>• Recreation and tourism -Boating and boating infrastructure (in estuaries)</li> <li>• Navigation &amp; entrance management and modification, harbour maintenance, dredging etc. (in estuaries)</li> <li>• Stock grazing of riparian and marine vegetation (in estuaries)</li> <li>• Sewage effluent and septic runoff (in estuaries)</li> <li>• Modified Freshwater flows - Extraction, artificial barriers to riverine and estuarine flow (e.g. dams, weirs, waterway crossings, floodgates), urban drainage, impervious surfaces; flood mitigation (in estuaries)</li> <li>• Recreation and Tourism – four wheel driving (in estuaries)</li> <li>• Foreshore development</li> <li>• Commercial fishing – Estuary General</li> <li>• Oyster aquaculture (in estuaries)</li> <li>• Recreational fishing - Boat-based line and trap fishing</li> <li>• Commercial fishing - Ocean Haul</li> <li>• Shipping – Large commercial (in estuaries)</li> <li>• Recreational fishing – Shore-based line and trap fishing</li> <li>• Beach nourishment and grooming</li> <li>• Commercial fishing – Abalone</li> </ul>

Threats to environmental assets for the North region	Threats to environmental assets for the Central Region	Threats to environmental assets for the South Region
<p>dolphin watching</p> <ul style="list-style-type: none"> <li>• Beach nourishment and grooming (in estuaries)</li> <li>• Shipping - Small commercial vessels (ferries, charter boats, commercial fishing, whale watching etc.) (in coast and marine)</li> </ul>	<ul style="list-style-type: none"> <li>• Thermal discharges (in estuaries)</li> <li>• Commercial fishing - Ocean Trawl</li> <li>• Recreation and tourism - Shark meshing of swimming beaches</li> <li>• Commercial fishing – Estuary general (in estuaries)</li> <li>• Recreational fishing – Shore-based line and trap fishing</li> <li>• Recreational fishing – Boat-based line and trap fishing</li> <li>• Recreational fishing – Hand gathering</li> <li>• Oyster aquaculture (in estuaries)</li> <li>• Mining and extractive industries (in estuaries)</li> <li>• Commercial fishing - Ocean Trap and Line (in coastal and marine waters)</li> <li>• Estuary entrance modifications (in coastal and marine waters)</li> <li>• Shipping - Small commercial vessels (ferries, charter boats, commercial fishing, whale watching etc.) (in coastal and marine waters)</li> <li>• Commercial fishing – Ocean Haul (in coastal and marine waters)</li> <li>• Commercial fishing – Sea urchin and turban shells (in coastal and marine waters)</li> <li>• Charter activities – Charter whale and dolphin watching (in coastal and marine waters)</li> <li>• Recreation and tourism – Swimming, surfing, dog walking etc (in coastal and marine waters)</li> </ul>	<p>(in coastal and marine waters)</p> <ul style="list-style-type: none"> <li>• Commercial fishing – Sea urchin and turban shells (in coastal and marine waters)</li> <li>• Recreational fishing - Hand Gathering (in coastal and marine waters)</li> <li>• Charter activities – Whale and dolphin watching (in coastal and marine waters)</li> <li>• Shipping - Small commercial vessels (ferries, charter boats, commercial fishing, whalewatching etc.) (in coastal and marine waters)</li> <li>• Commercial fishing - Ocean Trap and Line (in coastal and marine waters)</li> </ul>

### 3.2.7 Key Knowledge Gaps

The following key knowledge gaps were discussed during the Statewide environmental workshop:

- Extent of wildlife disturbance impacts (including noise) on protected species
- Impacts on fish trophic levels and gear loss from recreational and commercial fishing

## 4 Findings of the Social and Economic Threat and Risk Assessment

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### 4.1 Introduction

For the Statewide social and economic component of the TARA, a decision was made to simplify the 17 mutually exclusive categories reported on in the HSB report (refer BMT WBM 2015, attributed at the first workshop in July 2015) into a single risk matrix that was applied through the lens of community wellbeing.

The simplified matrix for the Statewide assessment presents threats in six key 'Tier 1' threat categories, namely:

- Resource Use Conflict
- Environmental
- Governance of the marine estate
- Public safety
- Critical knowledge gaps
- Lack of access availability

The marine estate community survey was an important information source for understanding the social and economic benefits derived from the marine estate.

As discussed in Section 2.4, the social and economic benefits for the marine estate were identified under the following standard categories:

#### **Social**

- Participation benefits (with further sub-categories of 'Safety, Health & Wellbeing [including relaxation]' and 'Socialising & Sense of Community')
- Enjoyment benefits (with further sub-categories of 'Enjoying the Biodiversity & Beauty of the Marine Estate- social intrinsic value' and 'Consumptive Use [e.g. extracting]')
- Cultural heritage & use benefits (with sub-categories of 'Tangible Aboriginal Cultural Heritage [historic objects, places, items, and source of food]' and 'Intangible Aboriginal Heritage [traditions, practices, knowledge, spiritual values]')

#### **Economic**

- Benefits related to 'Indirect economic values' which was further defined as 'Intrinsic & bequest values'
- Benefits related to employment and the value of production which was further defined as 'Viability of Businesses'
- Benefits related to 'Direct economic values' which was further defined as the 'Individual enjoyment value or consumer surplus' (e.g. an economic term for the difference between what a

consumer or user is willing to pay for a benefit or services versus what they actually pay for a benefit or service).

The revised TARA matrix for the social and economic uses and activities at a Statewide level was prepared by MEMA agencies based on the data collected from the original Social and Economic workshop held in July (which considered risk at both a Statewide and HSB level) and a subsequent verification workshop held in July 2016 with agencies and independent experts.

The amended summary of evidence underpinning the risk levels is contained in Appendix D of this report.

## 4.2 Summary of Key Threats – Social and Economic

### 4.2.1 High and Moderate Risks

In reviewing the outputs of the TARA undertaken for social and economic benefits in Appendix D, there were a higher proportion of 'Low' risks compared to 'High' and 'Moderate' and 'Minimal' risks for the social and economic benefits.

The general distribution of risk levels from the risk matrices presented in Appendix D is shown in pie graph below:

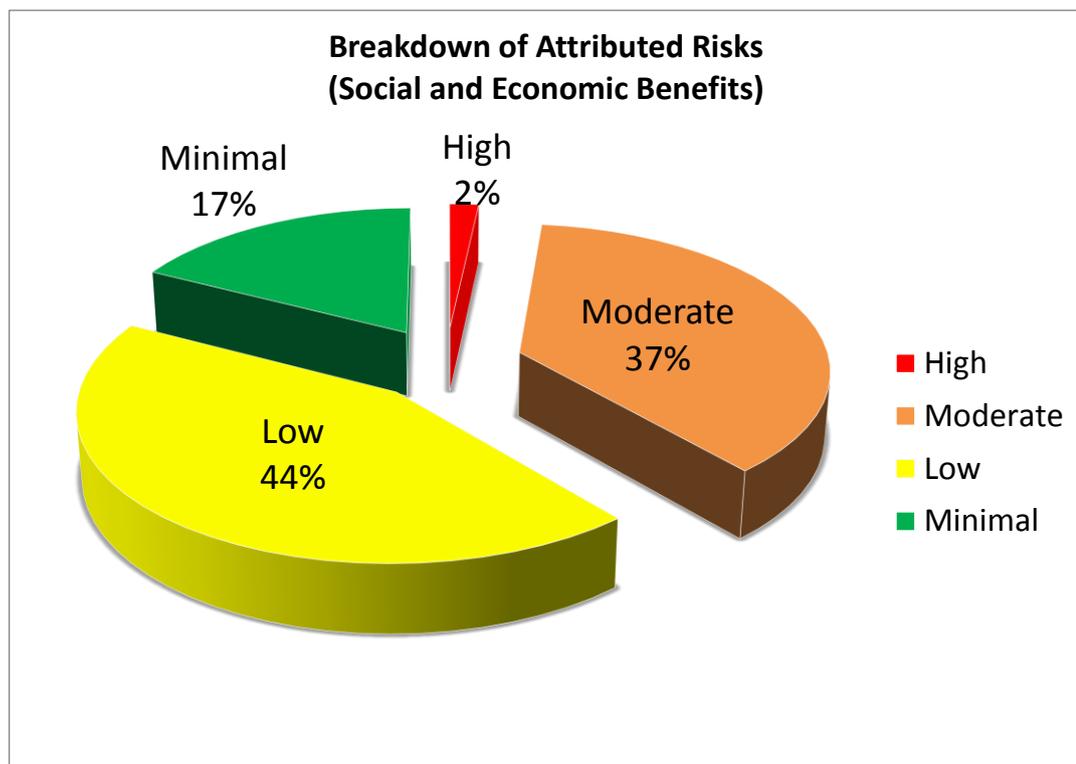


Figure 4-1 Distribution of risk levels for the threats to Social and Economic Benefits

In the context of high and moderate risk levels, there were:

- 12 instances where the risk of the threat being realised was identified as a 'High' risk;

## Findings of the Social and Economic Threat and Risk Assessment

- 260 instances where the risk of the threat being realised was identified as a 'Moderate' risk.

All of the threats attributed a high and moderate risk level are summarised in Table 4-2

More comprehensive information about the threats and evidence can be sourced from Appendix D.

### 4.2.2 Spatial Scale of Threats

In general terms, all of the key threats (identified in the previous section) to social and economic benefits were observed by participants to be operating at a broad spatial scale (e.g. occurring throughout the region or Statewide).

Some threats received higher risk levels in one region (for example sediment contamination in the Central region was higher than for the North and South). This information is also presented in Table 4-1.

### 4.2.3 Temporal Aspects of Threats and Trends

In considering the temporal aspects of the risk levels identified, most are considered to be current issues happening now (e.g. at the present time) with the threat of the risk being realised expected to intensify or increase over time. Several other uses and activities were considered to be stable or uncertain over time.

As with the Environmental TARA, various aspects of climate change (ocean acidification, sea level rise and others) were specifically noted by participants to be an issue that needed to be considered for management as part of the current planning process (in the context of understanding vulnerability and building resilience to future impacts), but also noting the timing of threat realisation will be in the 20+ year category, with the extent and severity impacts only able to be inferred at the current time.

### 4.2.4 Statewide Priority Threats for Treatment

In looking at the stressors that arise from resource uses, activities and issues that had an incidence of high or moderate risks to a social or economic benefit provided by the marine estate, a hierarchical list of these priority threats has been generated based on the number of high versus moderate risks and collected information about the risk trends (e.g. activities where the risk level was increasing were given the highest priority, followed by risks that were stable then risks that were decreasing). The scoring system weighted higher risks. For each high risk the stressor was attributed a score of 3, moderate risks were given a score of 2. The cumulative risk score for each row could then be calculated. For further information on the prioritisation methodology, please see Appendix F. Based on this, the stressors generating the greatest threat to social and economic benefits across the state (in descending order) are presented in Table 4-1:

**Table 4-1 Priority Threats to Social and Economic Benefits Statewide**

<b>Ranked Priority Threats to Social and Economic Benefits - Statewide</b>
<ul style="list-style-type: none"> <li>• Climate change (20 years)</li> <li>• Inadequate social and economic information</li> <li>• Urban stormwater discharge</li> <li>• Agricultural diffuse source runoff</li> <li>• Anti-social behaviour and unsafe practices</li> <li>• Limited or lack of access infrastructure to the marine estate</li> <li>• Reductions in abundances of top and lower order trophic levels from commercial, recreational and charter fishing</li> <li>• Litter, solid waste, marine debris and microplastics</li> <li>• Lack of compliance with regulations (by users) or lack of compliance effort (by agencies)</li> <li>• Inadequate, inefficient regulation, over-regulation (agencies)</li> <li>• Loss of public access (either by private development or Government area closures)</li> <li>• Habitat (physical) disturbance (e.g. from foreshore development, commercial and recreational fishing methods, four wheel driving, and extractive industries (mining).</li> <li>• Wildlife disturbance (Shorebirds, Turtles, Whales) by dog walkers, 4WD, marine vessels, etc.</li> <li>• Lack of community awareness of the marine estate, associated threats and benefits, regulations and opportunities for participation</li> <li>• Overcrowding/congestion</li> <li>• Loss or decline in marine industries</li> <li>• Pests/diseases</li> <li>• Modified hydrology/hydraulics and flow regime</li> <li>• Seafood contamination</li> <li>• Lack of or ineffective community engagement or participation in governance (lack of evidence; lack of political standing; casual users who may not have English as 1st language, too much/display of information)</li> </ul>

Table 4-2 High and Moderate Threats to Social and Economic Benefits of the Marine Estate

Use, Activity or Stressor (Threats)	Social and Economic benefits of the marine estate that are at 'High' risk from the use/activity/stressor	Social and Economic benefits of the marine estate that are at 'Moderate' risk from the use/activity/stressor	Summary of Evidence
<b>Antisocial behaviour and unsafe practices</b>	Nil	<ul style="list-style-type: none"> <li>• Participation: Safety, health and wellbeing</li> <li>• Participation: Socialising and sense of community</li> <li>• Enjoyment: Enjoying the biodiversity and beauty of the marine estate</li> <li>• Cultural Heritage and Use: Tangible Aboriginal heritage</li> <li>• Cultural Heritage and Use: Intangible Aboriginal heritage</li> <li>• Intrinsic &amp; bequest values (Central only)</li> <li>• Viability of businesses (Central only)</li> <li>• Direct Values (Central only)</li> </ul>	<ul style="list-style-type: none"> <li>• Largely associated with inappropriate use of powered vessels</li> <li>• Continued and ongoing experiences of anti-social behaviour are likely to deter community use of the marine estate.</li> <li>• Different sections of the community seek different benefits from their recreational activities, some of the activities are incompatible (e.g. jet skis vs quiet contemplation), and increased population and increasing competition for use of the marine estate is likely to impact some individuals/groups more than others.</li> <li>• Anti-social behaviour and unsafe practices can impact on tangible Aboriginal cultural heritage such as source of food and damage or vandalism of significant cultural heritage places or artefacts and on Intangible Aboriginal heritage including ability to practice cultural or traditional use of sites</li> <li>• Anti-social behaviour may have significant impacts on the viability of businesses and on employment in situations where people are deterred from visiting the marine estate.</li> </ul>
<b>Overcrowding / Congestion</b>	Nil	<ul style="list-style-type: none"> <li>• Participation: Socialising and sense of community</li> <li>• Participation: Safety, health &amp; wellbeing (including relaxation)</li> <li>• Intrinsic &amp; bequest values (Central only)</li> <li>• Direct Values (Central only)</li> </ul>	<ul style="list-style-type: none"> <li>• Threats related to resource conflict and anti-social behaviour is likely to be exacerbated by overcrowding or congestion issues. Drivers include reduced access (regulatory or physical) for some or all sectors, causing concentration of use, and increasing population.</li> <li>• The 'loss of appeal due to overcrowding' was identified as the third most significant social threat to the marine estate as identified in the Marine Estate Community Survey</li> </ul>
<b>Loss or decline of marine industries</b>	Nil	<ul style="list-style-type: none"> <li>• Participation: Safety, health &amp; wellbeing (North and South only)</li> <li>• Enjoyment: Consumptive use (North and South only)</li> <li>• Viability of businesses</li> </ul>	<ul style="list-style-type: none"> <li>• Marine industries deliver a range of social and economic benefits to community wellbeing, including the mental and physical wellbeing associated with employment and income, potential health benefits associated with seafood consumption and the possibility of future health benefits associated with marine biotechnology and pharmaceuticals.</li> <li>• The cumulative threats on viability of particularly the commercial fishing sector relating to social licence, competition with other sectors and regulatory pressure has potentially significant sectoral specific consequences for that industry and wider implications for the availability of goods or services to local communities. The most likely marine industries facing significant viability challenges in NSW at present appear to be commercial fishing and aquaculture.</li> </ul>
<b>Water Pollution (on Environmental Values-urban stormwater discharge)</b>	Nil	<ul style="list-style-type: none"> <li>• Participation: Safety, health &amp; wellbeing</li> <li>• Participation: Socialising and sense of community</li> <li>• Enjoyment: Enjoying the biodiversity and beauty of the marine estate</li> <li>• Enjoyment: Consumptive use</li> <li>• Cultural Heritage and Use: Intangible Aboriginal heritage</li> <li>• Cultural Heritage and Use: Tangible Aboriginal heritage</li> <li>• Intrinsic &amp; bequest values (Central only)</li> <li>• Viability of businesses (Central</li> </ul>	<ul style="list-style-type: none"> <li>• Impacts on safety, health and wellbeing relates mostly to impacts on recreation and enjoyment from short term and localised beach closures following storm events. For the health implications of potential impacts on seafood quality (especially aquaculture).</li> <li>• Impacts on consumptive use from stormwater discharge relates mostly to impacts on seafood quality (especially aquaculture), scientific reference sites and participation in marine tourism.</li> <li>• Environmental degradation can impact on intangible Aboriginal heritage in particular on spiritual connections. This also includes damage to places associated with cultural practices and traditions</li> </ul>

Findings of the Social and Economic Threat and Risk Assessment

Use, Activity or Stressor (Threats)	Social and Economic benefits of the marine estate that are at 'High' risk from the use/activity/stressor	Social and Economic benefits of the marine estate that are at 'Moderate' risk from the use/activity/stressor	Summary of Evidence
<p><b>Water Pollution (on Environmental Values-agricultural diffuse runoff)</b></p>	<p>Nil</p>	<p>only)</p> <ul style="list-style-type: none"> <li>• Direct Values (Central only)</li> <li>• Participation: Safety, health &amp; wellbeing (North and South only)</li> <li>• Participation: Socialising and sense of community (North and South only)</li> <li>• Enjoyment: Enjoying the biodiversity and beauty of the marine estate</li> <li>• Enjoyment: Consumptive use (North and South only)</li> <li>• Cultural Heritage and Use: Intangible Aboriginal heritage</li> <li>• Cultural Heritage and Use: Tangible Aboriginal heritage</li> <li>• Intrinsic &amp; bequest values (North and South only)</li> <li>• Viability of businesses (North and South only)</li> <li>• Direct Values (North and South only)</li> </ul>	<ul style="list-style-type: none"> <li>• The environmental TARA found that agricultural sources had major impacts almost certain due to elevated nutrients, sediments, potential contaminants and turbidity, and sedimentation. The risk levels were sometimes higher in the north and south regions due to a higher portion of estuaries with agricultural activity in their catchment compared to the Central region.</li> <li>• The impacts of these pollution events on community health, safety and enjoyment are likely to relate mostly to decreased opportunities for use for recreational activities associated with short term and localised 'blackwater' events and a general loss in wellbeing associated with concern over environmental decline.</li> <li>• Environmental degradation can impact on intangible Aboriginal heritage in particular on spiritual connections. This also includes damage to places associated with cultural practices and traditions</li> </ul>
<p><b>Water Pollution (on Environmental Values-litter, solid waste, marine debris and microplastics)</b></p>	<p>Nil</p>	<ul style="list-style-type: none"> <li>• Participation: Safety, health &amp; wellbeing (Central only)</li> <li>• Participation: Socialising and sense of community (Central only)</li> <li>• Enjoyment: Enjoying the biodiversity and beauty of the marine estate</li> <li>• Enjoyment: Consumptive use (Central only)</li> <li>• Cultural Heritage and Use: Intangible Aboriginal heritage</li> <li>• Cultural Heritage and Use: Tangible Aboriginal heritage</li> <li>• Intrinsic &amp; bequest values (Central only)</li> <li>• Viability of businesses (Central only)</li> <li>• Direct Values (Central only)</li> </ul>	<ul style="list-style-type: none"> <li>• The environmental TARA considered marine debris and littering from a range of sources and references evidence of microplastics, marine debris and other contaminants impacting marine fauna.</li> <li>• The impacts of marine debris and littering on health safety and wellbeing refer mostly to impacts on enjoyment and recreation associated with activities in the marine estate. Encountering rubbish can impact on safety (e.g. exposure to glass and other sharp objects, syringes, human or animal waste etc.) and relaxation (e.g. marine estate users interviewed in a number of forums indicated annoyance and anger about encountering other people's rubbish when enjoying the coast).</li> <li>• Environmental degradation can impact on intangible Aboriginal heritage in particular on spiritual connections. This also includes damage to places associated with cultural practices and traditions</li> <li>• Impact on businesses that that are dependent on the marine estate for their viability, such as commercial fishers and tourist operators,</li> </ul>
<p><b>Wildlife disturbance (Shorebirds, Turtles, Whales by dog walkers, 4WD, marine vessels, etc.)</b></p>		<ul style="list-style-type: none"> <li>• Enjoyment: Enjoying the biodiversity and beauty of the marine estate</li> <li>• Cultural Heritage and Use: Intangible Aboriginal heritage</li> <li>• Cultural Heritage and Use:</li> </ul>	<ul style="list-style-type: none"> <li>• Impacts on people's relationship with the coast (e.g. loss of appeal due to decline in wildlife) will also impact social connections.</li> <li>• Wildlife disturbance can impact on totemic or culturally significant species.</li> </ul>

Findings of the Social and Economic Threat and Risk Assessment

Use, Activity or Stressor (Threats)	Social and Economic benefits of the marine estate that are at 'High' risk from the use/activity/stressor	Social and Economic benefits of the marine estate that are at 'Moderate' risk from the use/activity/stressor	Summary of Evidence
<b>Habitat (physical) disturbance</b> <i>(Including foreshore development, commercial and recreational fishing methods, vessel moorings and anchors, four wheel driving, mining and beach grooming)</i>	Nil	Tangible Aboriginal heritage <ul style="list-style-type: none"> <li>• Enjoyment: Enjoying the biodiversity and beauty of the marine estate</li> <li>• Enjoyment: Consumptive use</li> <li>• Cultural Heritage and Use: Tangible Aboriginal heritage</li> <li>• Cultural Heritage and Use: Intangible Aboriginal heritage</li> </ul>	<ul style="list-style-type: none"> <li>• Impacts to enjoyment due to depletion of fish stocks through overfishing and wildlife connectivity.</li> <li>• Physical disturbance limits 'undisturbed' control sites required for scientific research and education.</li> <li>• Preference for undisturbed sites for tourism/ charter activities such as snorkelling and diving.</li> <li>• Physical disturbance impacts on cultural heritage sites the cultural landscape and spiritual connection through recreational activities and shoreline visitors (e.g. 4WD on beaches, dive boat anchors on wrecks). While most activities contributing to physical disturbance are more common in the Hawkesbury region, 4WD is more commonly allowed on the North Coast Beaches, and is limited within the Hawkesbury Region to one or two locations.</li> </ul>
<b>Reductions in abundances of top and lower order trophic levels</b> <i>(Including commercial, recreational and charter fishing)</i>	<ul style="list-style-type: none"> <li>• Enjoyment: Consumptive Use</li> </ul>	<ul style="list-style-type: none"> <li>• Enjoyment: Enjoying the biodiversity and beauty of the marine estate</li> <li>• Cultural Heritage and Use: Tangible Aboriginal heritage</li> <li>• Intrinsic &amp; bequest values (North and South only)</li> <li>• Viability of businesses</li> </ul>	<ul style="list-style-type: none"> <li>• Evidence suggests a loss of enjoyment for visitors accessing locally caught seafood, including as a tourism product associated with coastal holidays.</li> <li>• Enjoyment at risk following depletion of fish stocks.</li> <li>• Reduction in abundances of fish can impact cultural heritage and use through threatening spiritual connections (e.g. totemic species, culturally significant species, links to Country, food sources).</li> <li>• Overfishing, or the localised depletion of fish stocks, may contribute to measurable and ongoing negative economic impacts for the commercial/recreational fishing industry. This threat may have further implications for other industries, who are reliant upon healthy and biodiverse ecosystems, such as the dolphin watch industry, scuba diving, snorkelling and charter vessels.</li> </ul>
<b>Pests/diseases</b> <i>(Including shipping, aquaculture and the aquarium trade)</i>	Nil	<ul style="list-style-type: none"> <li>• Participation: Safety, health &amp; wellbeing</li> <li>• Enjoyment: Consumptive use</li> </ul>	<ul style="list-style-type: none"> <li>• Historical evidence of impacts to participation (food safety) and enjoyment through consumptive use concerns related to oysters in the Hawkesbury, Wallis Lake and Georges River</li> <li>• There is a history of pest and disease outbreaks in the Hawkesbury Bioregion having major adverse impacts on aquaculture, production, employment and the quality and reputation of seafood.</li> </ul>
<b>Modified hydrology / hydraulics and freshwater flow regime</b>	Nil	<ul style="list-style-type: none"> <li>• Participation: Socialising and sense of community</li> <li>• Enjoyment: Consumptive use</li> </ul>	<ul style="list-style-type: none"> <li>• Participation and enjoyment in terms of consumption of local seafood related to commercial and recreational fishing.</li> <li>• Evidence includes closures related to acid sulphate events following floods in the northern rivers.</li> </ul>
<b>Sediment contamination</b> <i>(toxicants in sediment; dioxins in Sydney Harbour, Cooks River)</i>	Nil	<ul style="list-style-type: none"> <li>• Participation: Safety, health &amp; wellbeing (Central only)</li> <li>• Participation: Socialising and sense of community (Central only)</li> <li>• Enjoyment: Enjoying the biodiversity and beauty of the marine estate (Central Only)</li> <li>• Enjoyment: Consumptive use (Central Only)</li> <li>• Intrinsic &amp; bequest values (Central Only)</li> <li>• Viability of businesses (Central Only)</li> <li>• Direct Values (Central Only)</li> </ul>	<ul style="list-style-type: none"> <li>• Threats are likely to be greater in the Hawkesbury Bioregion due to larger population and greater levels of resource use and pollution which are widely documented.</li> <li>• Sediment contamination and pollution will continue to restrict viability of businesses including aquaculture development. (employment and value of production)</li> </ul>
<b>Climate change (20yrs)</b>	<ul style="list-style-type: none"> <li>• Participation: Safety, health &amp; wellbeing</li> </ul>	<ul style="list-style-type: none"> <li>• Enjoyment: Consumptive use</li> <li>• Cultural Heritage and Use:</li> </ul>	<ul style="list-style-type: none"> <li>• Consequences of climate change include impacts on health, safety and wellbeing associated with loss of beach amenity through increased frequency of dangerous storm events, potential increase in abundance of jellyfish and changes in abundance of valued marine species.</li> </ul>

Findings of the Social and Economic Threat and Risk Assessment

	Use, Activity or Stressor (Threats)	Social and Economic benefits of the marine estate that are at 'High' risk from the use/activity/stressor	Social and Economic benefits of the marine estate that are at 'Moderate' risk from the use/activity/stressor	Summary of Evidence
		<ul style="list-style-type: none"> <li>● Participation: Socialising and sense of community</li> <li>● Enjoyment: Enjoying the biodiversity and beauty of the marine estate</li> </ul>	<ul style="list-style-type: none"> <li>● Tangible Aboriginal heritage</li> <li>● Intrinsic &amp; bequest values</li> <li>● Viability of businesses</li> <li>● Direct Values</li> </ul>	<ul style="list-style-type: none"> <li>● Climate change is affecting ocean temperatures, the supply of nutrients, ocean chemistry, food chains, wind systems, ocean currents and extreme events such as cyclones. All of these variables have the potential to affect the distribution, abundance, breeding cycles and migrations of marine plants and animals that people rely on for food, income and enjoyment.</li> <li>● Climate change stressors such as sea level rise can cause the benefit of tangible cultural heritage not being realised as environmental degradation can impact on spiritual connections e.g. totemic species, culturally significant species, links to Country and food sources</li> <li>● Impacts on specific businesses and employment maybe significant. Structural adjustments will occur in the economy in response to climate change and the net economic impact is likely to be moderate (e.g. some livelihoods may be significantly impacted).</li> </ul>
Governance of the marine estate	<b>Inadequate, inefficient regulation, overregulation (agencies)</b>	Nil	<ul style="list-style-type: none"> <li>● Participation: Safety, health &amp; wellbeing</li> <li>● Enjoyment: Enjoying the biodiversity and beauty of the marine estate (Central only)</li> <li>● Enjoyment: Consumptive use</li> <li>● Cultural Heritage and Use: Tangible Aboriginal heritage</li> <li>● Cultural Heritage and Use: Intangible Aboriginal heritage</li> </ul>	<ul style="list-style-type: none"> <li>● Safety implications of current restrictions on commercial fishing activities (e.g. crew limits in Estuary General).</li> <li>● Consequences of regulatory approaches which have focused principally on ecological sustainability at the expense of social and economic considerations leading to conflict and in some cases damaging economic viability</li> <li>● Conservation management (especially marine parks) can come into conflict with existing recreational fishing uses and this can impact on the social acceptability of those measures, cause conflict and division within the community and exacerbate existing tensions between users</li> <li>● Extensive qualitative data set that suggests that current wellbeing amongst commercial fishers in NSW is low. Commercial fishing infrastructure (e.g., co-ops) on some parts of the coast has limited capacity to withstand further reductions in fisher numbers or fishing effort</li> <li>● Past regulatory changes have impacted on the ability of the Aboriginal community to obtain/maintain commercial fishing licences despite strong historic links to the industry. Current restrictions inhibit community involvement in Aboriginal commercial fishing, practices particularly the beach haul fishery, and place considerable constraints on the ability of Aboriginal commercial fishers to pass on their cultural and environmental knowledge to the next generation, causing reductions in wellbeing. Licences in the commercial fishing industry are now largely out of reach for many within Indigenous communities of NSW despite the likely social and economic benefits of engaging more Aboriginal people in the fishing industry</li> </ul>
	<b>Lack of or ineffective community engagement or participation in governance</b>	Nil	<ul style="list-style-type: none"> <li>● Cultural Heritage and Use: Intangible Aboriginal heritage</li> </ul>	<ul style="list-style-type: none"> <li>● Restrictions on access to resources due to government regulations has impacted on the continuation of cultural traditions and practices and transfer of traditional knowledge (intangible cultural heritage).</li> <li>● Inadequate regulation to protect significant species has impacted on the benefit of religious/spiritual significance being realised</li> </ul>
	<b>Lack of community awareness of the marine estate, associated threats and benefits,</b>	Nil	<ul style="list-style-type: none"> <li>● Enjoyment: Enjoying the biodiversity and beauty of the marine estate</li> <li>● Cultural Heritage and Use:</li> </ul>	<ul style="list-style-type: none"> <li>● A lack of knowledge and awareness of the marine estate may detract from the full extent to which people can appreciate and enjoy the benefits it provides. It may also influence the extent to which the community supports difficult management decisions considered necessary for environmental protection</li> </ul>

Findings of the Social and Economic Threat and Risk Assessment

	Use, Activity or Stressor (Threats)	Social and Economic benefits of the marine estate that are at 'High' risk from the use/activity/stressor	Social and Economic benefits of the marine estate that are at 'Moderate' risk from the use/activity/stressor	Summary of Evidence
	regulations and opportunities for participation		<ul style="list-style-type: none"> <li>Tangible Aboriginal heritage</li> <li>Cultural Heritage and Use: Intangible Aboriginal heritage</li> </ul>	<ul style="list-style-type: none"> <li>While there is widespread recognition of the importance of sacred places within coastal planning and management more complex cultural practices and relationships with landscape and community are less well understood and this may lead to unintentional impacts on intangible values</li> </ul>
	Lack of compliance with regulations (by users) or lack of compliance effort (by agencies)	Nil	<ul style="list-style-type: none"> <li>Participation: Safety, health &amp; wellbeing</li> <li>Participation: Socialising and sense of community</li> <li>Enjoyment: Enjoying the biodiversity and beauty of the marine estate</li> <li>Enjoyment: Consumptive use</li> <li>Viability of businesses</li> </ul>	<ul style="list-style-type: none"> <li>Key concerns include a lack of compliance with social norms (e.g. acceptable noise levels, appropriate behaviour) and secondly a lack of compliance with regulations (littering, fisheries regulations etc.).</li> <li>Perceptions about illegal fishing activities can impact community cohesion and harmony</li> <li>Illegal activities have the potential to create long-term negative impacts on businesses and employment, Commercial fishers may also be significantly impacted where their livelihoods are under threat from overfishing and habitat destruction related to illegal activities.</li> </ul>
Public Safety	Adverse wildlife interactions	Nil	<ul style="list-style-type: none"> <li>Participation: Safety, health &amp; wellbeing (North only)</li> </ul>	<ul style="list-style-type: none"> <li>Sharks and others; cumulative and threshold effect (hysteria and builds from a political and news perspective)</li> </ul>
	Seafood contamination		<ul style="list-style-type: none"> <li>Participation: Safety, health &amp; wellbeing (Central only)</li> <li>Enjoyment: Consumptive use</li> </ul>	<ul style="list-style-type: none"> <li>The major impacts of seafood contamination on commercial fishers in the Williamstown area suggests that this could have overall moderate consequences for communities</li> <li>Seafood contamination can have major impacts on consumptive use including the viability of fishing and aquaculture industries as demonstrated in Williamstown (prawns) and Hawkesbury River (oysters). These impacts are largely sectoral but can have broader impacts across the community if it lowers community trust in seafood quality (moderate). These consequences are almost certain if contamination does occur.</li> </ul>
Knowledge Gaps	Inadequate social and economic information		<ul style="list-style-type: none"> <li>Participation: Safety, health and wellbeing</li> <li>Participation: Socialising and sense of community</li> <li>Enjoyment: Enjoying the biodiversity and beauty of the marine estate</li> <li>Enjoyment: Consumptive use</li> <li>Cultural Heritage and Use: Tangible Aboriginal heritage</li> <li>Cultural Heritage and Use: Intangible Aboriginal heritage</li> <li>Intrinsic &amp; bequest values</li> <li>Viability of businesses</li> <li>Direct Values</li> </ul>	<ul style="list-style-type: none"> <li>The cumulative impacts of socio economic threats is an area that has received limited research attention to date and this is recognised as a current data gap in the TARA process.</li> <li>A lack of understanding of the way the marine estate facilitates and builds community cohesion and division may limit the ability of management responses to be sensitive to protecting or enhancing social relationships.</li> <li>There is a knowledge gap around the views and aspirations of Aboriginal people in regard to the NSW marine estate</li> </ul>
Lack of access availability	Limited or lack of access infrastructure to the marine estate		<ul style="list-style-type: none"> <li>Participation: Safety, health and wellbeing</li> <li>Participation: Socialising and sense of community</li> <li>Enjoyment: Enjoying the biodiversity and beauty of the marine estate</li> <li>Enjoyment: Consumptive use</li> </ul>	<ul style="list-style-type: none"> <li>Many of the social and economic benefits rely on people being able to access the State's waterways by boat, either through land based infrastructure (e.g. boat ramps) or water based infrastructure (e.g. moorings). Vessel ownership in NSW is forecast to grow placing increased pressure on the need for boat storage and waterways access infrastructure.</li> <li>The negative impacts on current employment or production of a lack of access infrastructure are unlikely to be widespread, as businesses will only operate where there is access (and therefore customers). The opportunity costs are more significant and likely.</li> </ul>

Findings of the Social and Economic Threat and Risk Assessment

	Use, Activity or Stressor (Threats)	Social and Economic benefits of the marine estate that are at 'High' risk from the use/activity/stressor	Social and Economic benefits of the marine estate that are at 'Moderate' risk from the use/activity/stressor	Summary of Evidence
	<p><b>Loss of public access (either by private development or government closures)</b></p>		<ul style="list-style-type: none"> <li>• Viability of businesses</li> <li>• Direct Values (Central only)</li> <li>• Enjoyment: Consumptive use</li> <li>• Cultural Heritage and Use: Tangible Aboriginal heritage</li> <li>• Cultural Heritage and Use: Intangible Aboriginal heritage</li> <li>• Intrinsic &amp; bequest values</li> </ul>	<ul style="list-style-type: none"> <li>• Changes or limitations on community use and access to particular areas associated with physical closures e.g. of national park campgrounds, day use areas or access tracks may impact the ability of the community to enjoy the beauty and biodiversity values of those locations.</li> <li>• Private development on the coast or in properties surrounding estuaries is likely to have moderate consequence on consumptive use if it restricts the ability of recreational and commercial fishers to make use of public waterways</li> <li>• Access issues impact on intangible Aboriginal cultural heritage. For example unable to access places associated with cultural practices and traditions. Loss of traditional knowledge, such as creation stories and dreaming tracks. Reduced community capacity to undertake cultural practices i.e. knowledge is not being transferred, elders are unwell etc.</li> </ul>

## Findings of the Social and Economic Threat and Risk Assessment

## 4.2.5 Regional Priority Threats for Treatment

The priority order of social and economic threats varies subtly by region according to dominant activities and land uses (such as agriculture being more significant for the North region in comparison to urban stormwater for the central region) as well as in response to spatial distribution of benefits (for example, concentration of economic activities in the central region). The priority social and economic threats for each of the three regions of the state are given in Table 4-3.

Table 4-3 Ranked Priority Threats to Social and Economic Benefits (by region)

Threats to Social and Economic Benefits for the North region	Threats to Social and Economic Benefits for the Central Region	Threats to Social and Economic Benefits for the South Region
<ul style="list-style-type: none"> <li>• Climate change (20 years)</li> <li>• Agricultural diffuse source runoff</li> <li>• Inadequate social and economic information</li> <li>• Urban stormwater discharge</li> <li>• Reductions in abundances of top and lower order trophic levels from commercial, recreational and charter fishing</li> <li>• Anti-social behaviour and unsafe practices</li> <li>• Lack of compliance with regulations (by users) or lack of compliance effort (by agencies)</li> <li>• Loss of public access (either by private development or Government area closures )</li> <li>• Litter, solid waste, marine debris and microplastics</li> <li>• Habitat (physical) disturbance (e.g. from foreshore development, commercial and recreational fishing methods, four wheel driving, and extractive industries (mining).</li> <li>• Inadequate, inefficient regulation, over-regulation (agencies)</li> <li>• Pests/diseases</li> <li>• Modified hydrology/hydraulics and flow regime</li> </ul>	<ul style="list-style-type: none"> <li>• Climate change (20 years)</li> <li>• Urban stormwater discharge</li> <li>• Litter, solid waste, marine debris and microplastics</li> <li>• Inadequate social and economic information</li> <li>• Anti-social behaviour and unsafe practices</li> <li>• Sediment contamination (toxicants in sediment; dioxins in Sydney Harbour, Cooks River)</li> <li>• Reductions in abundances of top and lower order trophic levels from commercial, recreational and charter fishing</li> <li>• Inadequate, inefficient regulation, over-regulation (agencies)</li> <li>• Lack of compliance with regulations (by users) or lack of compliance effort (by agencies)</li> <li>• Loss of public access (either by private development or Government area closures</li> <li>• Overcrowding/congestion</li> <li>• Agricultural diffuse source runoff</li> <li>• Habitat (physical) disturbance (e.g. from foreshore development, commercial and recreational fishing methods,</li> </ul>	<ul style="list-style-type: none"> <li>• Climate change (20 years)</li> <li>• Agricultural diffuse source runoff</li> <li>• Inadequate social and economic information</li> <li>• Urban stormwater discharge</li> <li>• Reductions in abundances of top and lower order trophic levels from commercial, recreational and charter fishing</li> <li>• Anti-social behaviour and unsafe practices</li> <li>• Lack of compliance with regulations (by users) or lack of compliance effort (by agencies)</li> <li>• Loss of public access (either by private development or Government area closures</li> <li>• Litter, solid waste, marine debris and microplastics</li> <li>• Habitat (physical) disturbance (e.g. from foreshore development, commercial and recreational fishing methods, four wheel driving, and extractive industries (mining).</li> <li>• Inadequate, inefficient regulation, over-regulation (agencies)</li> <li>• Pests/diseases</li> <li>• Modified hydrology/hydraulics and flow regime</li> </ul>

## Findings of the Social and Economic Threat and Risk Assessment

Threats to Social and Economic Benefits for the North region	Threats to Social and Economic Benefits for the Central Region	Threats to Social and Economic Benefits for the South Region
<ul style="list-style-type: none"> <li>Limited or lack of access infrastructure to the marine estate</li> <li>Overcrowding/congestion</li> <li>Wildlife disturbance (Shorebirds, Turtles, Whales) by dog walkers, 4WD, marine vessels, etc.</li> <li>Lack of community awareness of the marine estate, associated threats and benefits, regulations and opportunities for participation</li> <li>Loss or decline of marine industries</li> <li>Lack of or ineffective community engagement or participation in governance (lack of evidence; lack of political standing; casual users who may not have English as 1st language, too much/display of information)</li> <li>Wildlife interactions (e.g. shark bite, jellyfish, boat striking a whale)</li> <li>Seafood contamination</li> </ul>	<ul style="list-style-type: none"> <li>four wheel driving, and extractive industries (mining).</li> <li>Limited or lack of access infrastructure to the marine estate</li> <li>Pests/diseases</li> <li>Modified hydrology/hydraulics and flow regime</li> <li>Wildlife disturbance (Shorebirds, Turtles, Whales) by dog walkers, 4WD, marine vessels, etc.</li> <li>Lack of community awareness of the marine estate, associated threats and benefits, regulations and opportunities for participation</li> <li>Seafood contamination</li> <li>Lack of or ineffective community engagement or participation in governance (lack of evidence; lack of political standing; casual users who may not have English as 1st language, too much/display of information)</li> <li>Loss or decline of marine industries</li> </ul>	<ul style="list-style-type: none"> <li>Limited or lack of access infrastructure to the marine estate</li> <li>Overcrowding/congestion</li> <li>Wildlife disturbance (Shorebirds, Turtles, Whales) by dog walkers, 4WD, marine vessels, etc.</li> <li>Lack of community awareness of the marine estate, associated threats and benefits, regulations and opportunities for participation</li> <li>Sediment contamination (toxicants in sediment; dioxins in Sydney Harbour, Cooks River)</li> <li>Loss or decline of marine industries</li> <li>Lack of or ineffective community engagement or participation in governance (lack of evidence; lack of political standing; casual users who may not have English as 1st language, too much/display of information)</li> <li>Seafood contamination</li> </ul>

#### 4.2.6 Key Knowledge Gaps

The majority of ratings in the Social and Economic TARA were based on information sources that were judged as 'limited'.

The least confident ratings (e.g. inferred) were assigned to the following categories:

- Effect of 'Climate Change' on social and economic benefits of the marine estate
- Effect of 'Public Safety' considerations on social and economic benefits of the marine estate

Risk levels related to Governance of the marine estate were also considered by the participants to be highly inferred; but noting that these issues will be further evaluated as part of the next phase of decision making when assessing management options for identified risk levels.

## 5 Integrating the Environmental, Social and Economic Assessments

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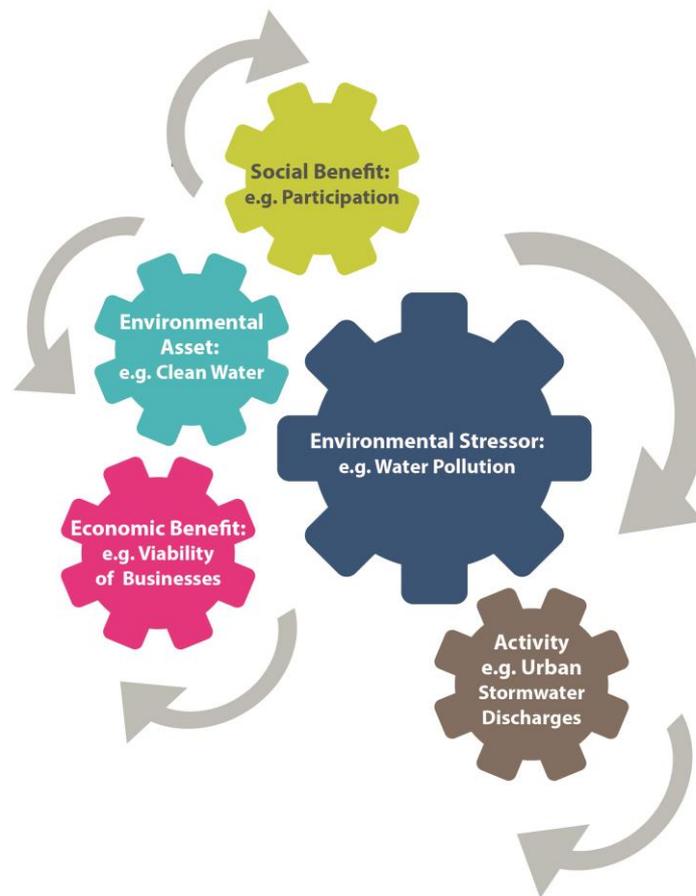
### 5.1 Linkages between the Assessments

It is recognised by the TARA process that many of the environmental, social and economic benefits generated across the marine estate are closely linked and interdependent.

This was also demonstrated by the risk levels applied by MEMA agencies and experts as part of the workshop process, noting the key environmental assets and their benefits (such as clean water and healthy ecosystems) underpin social and economic uses of the marine estate which, in turn, provide social and economic benefits to both direct users, visitors and the NSW community as a whole.

In framing future management options, a key objective of the Statewide TARA has been to identify those stressors that are having the most negative effects on environmental, social and economic benefits.

For example, as shown in Figure 5-1, an activity (such as urban stormwater discharge), can adversely impact environmental assets through several key stressors (such as water pollution, marine debris, micro plastics), and have flow on effects for dependent social and economic benefits (such as participation and enjoyment of them marine estate as key social values).



**Figure 5-1 The Social and Economic Benefits of the Marine Estate are highly dependent upon Environmental Assets, which in turn are threatened by defined Stressors arising from a range of activities**

## 5.2 Shared Risks across Environmental Assets and Social and Economic Benefits

Through tabulating the data obtained from the TARA process, the combined list of environmental stressors across the marine estate can be viewed through a social and economic lens with a view to identifying those stressors that have high and moderate risk to environmental assets [output of Environmental TARA] and that pose high and moderate risks to social and economic benefits if realised [output of the Social and Economic TARA], with the linkages between activities and stressors documented in the evidence (refer to Appendix C and D). The prioritisation methods are detailed in Appendix F.

Figure 5-2 shows graphically how priority stressors (in this case urban stormwater discharges) affect environmental and social and economic benefits of the marine estate.

When considering this Figure from right to left, the dependencies between social and economic benefits derived from the marine estate and environmental assets can be more clearly identified as

well as identification of the key stressors that ‘flow through’ to impact these social and economic benefits indirectly. An example of this flow is shown in Figure 5-3 for the stressor ‘Water Pollution’

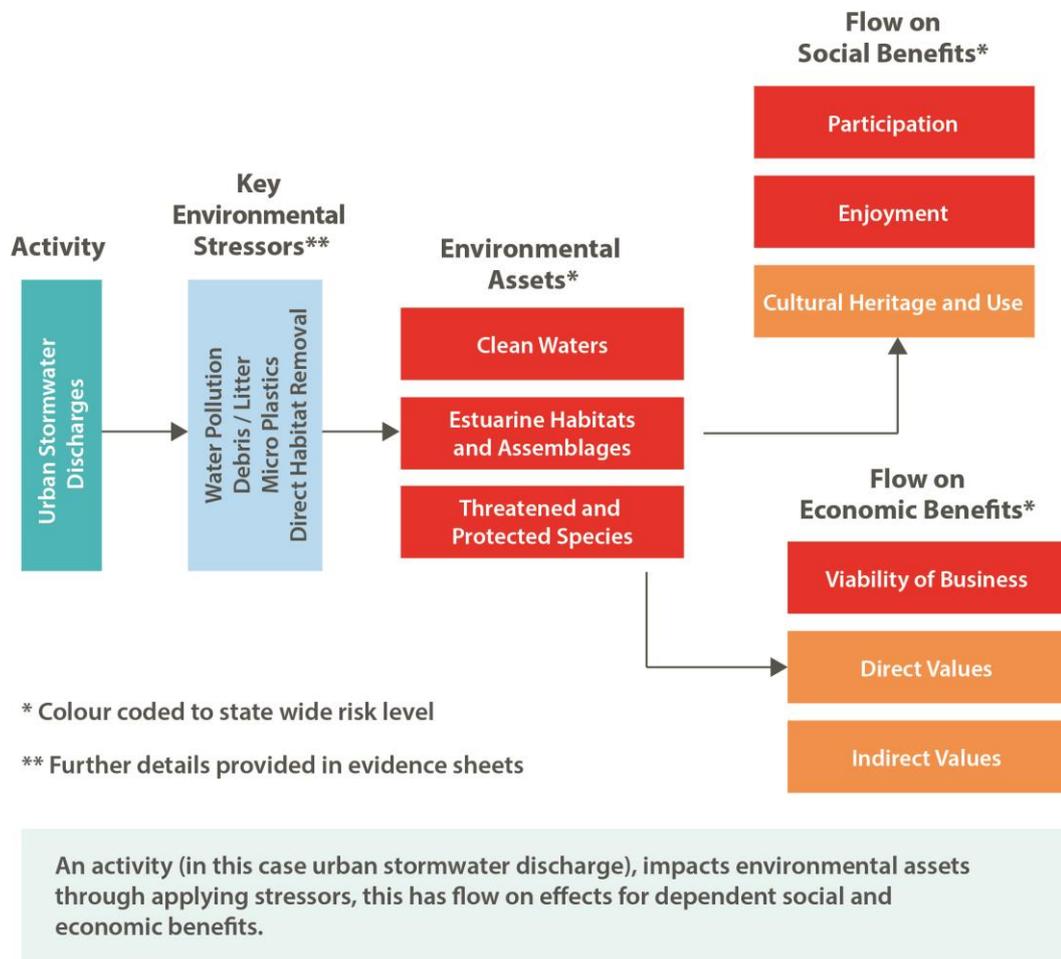
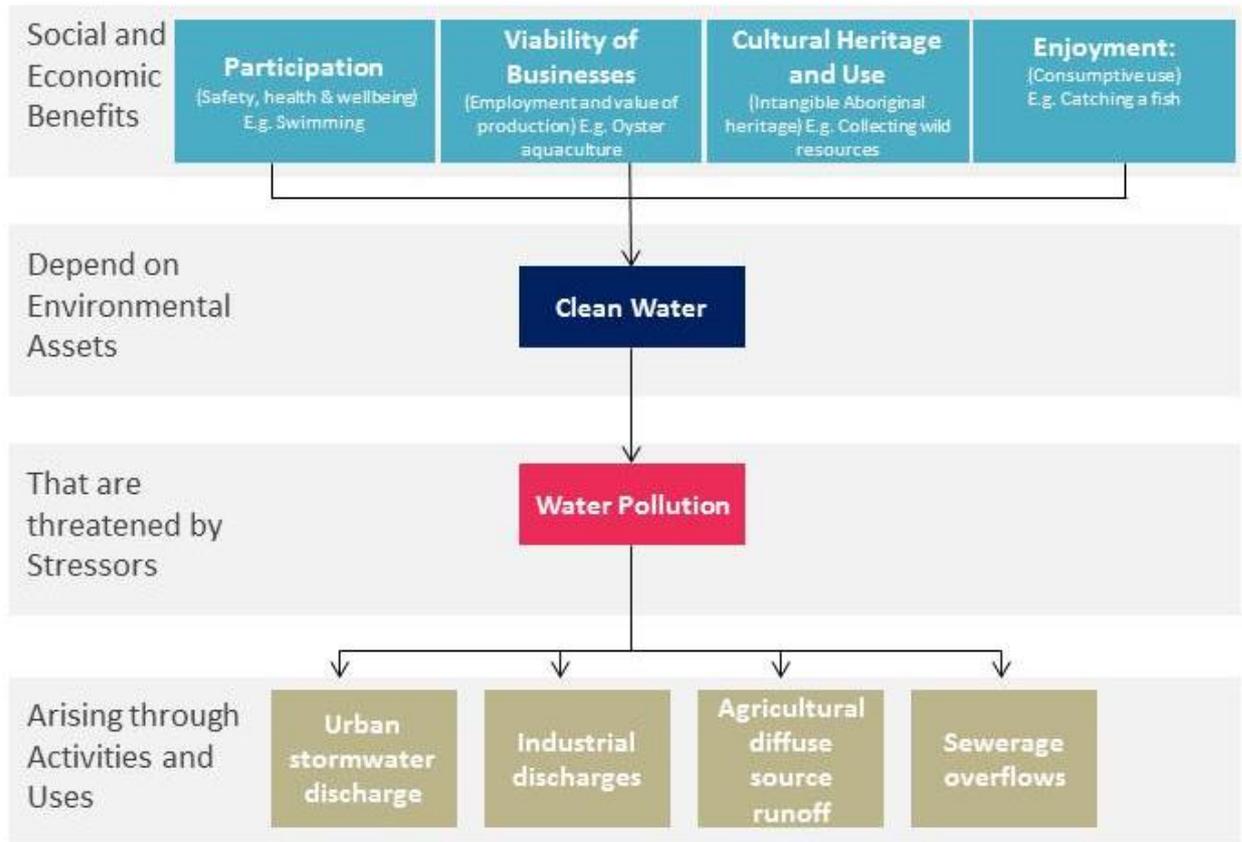


Figure 5-2 Relationship between Activities, Stressors, Environmental Assets and flow on Social and Economic Benefits



**Figure 5-3 Social and Economic Benefit Dependencies and Threats**

As discussed in Section 1, the TARA risk levels identified in this report will be used to inform the development of management initiatives at varying scales including new marine park management plans, beginning with Batemans and Solitary Islands marine parks. The following four tables (Table 5-1, Table 5-2, Table 5-3 and Table 5-4) indicate the priority threats for the environmental TARA and Social and Economic TARA at a Statewide scale, and then for North region, the Central region and the South region, respectively. Within the tables, shared risks (that are priorities across both the Environmental and Social and Economic assessments) are also listed.

Table 5-1 Ranked Statewide Priority Threats

Ranked Priority Threats to Environmental Assets - Statewide	Ranked Priority Threats to Social and Economic Benefits - Statewide	Shared Priority Threats across Assets and Benefits Statewide
<ul style="list-style-type: none"> <li>• Estuary entrance modifications</li> <li>• Urban stormwater discharge</li> <li>• Agricultural diffuse source runoff (in estuaries)</li> <li>• Clearing riparian and adjacent habitat including wetland drainage (in estuaries)</li> <li>• Climate Change (20yrs)</li> <li>• Recreation and tourism -Boating and boating infrastructure (in estuaries)</li> <li>• Navigation &amp; entrance management and modification, harbour maintenance (in estuaries)</li> <li>• Sewage effluent and septic runoff (in estuaries)</li> <li>• Stock grazing of riparian and marine vegetation (in estuaries)</li> <li>• Foreshore development</li> <li>• Modified Freshwater flows (in estuaries)</li> <li>• Recreation and tourism – Four wheel driving (in estuaries)</li> <li>• Commercial Fishing – Ocean Trawl</li> <li>• Commercial Fishing – Ocean Trap and Line</li> <li>• Commercial Fishing- Estuary General (in estuaries)</li> <li>• Recreational Fishing – Boat-based line and trap fishing</li> <li>• Oyster Aquaculture (in estuaries)</li> <li>• Commercial Fishing – Ocean Haul</li> <li>• Recreational Fishing – Shore-based line and trap fishing</li> <li>• Beach nourishment and grooming</li> <li>• Recreational Fishing – Hand gathering</li> <li>• Charter activities – whale and dolphin watching</li> <li>• Shipping – Small commercial vessels</li> </ul>	<ul style="list-style-type: none"> <li>• Climate change (20 years)</li> <li>• Inadequate social and economic information</li> <li>• Urban stormwater discharge</li> <li>• Agricultural diffuse source runoff</li> <li>• Anti-social behaviour and unsafe practices</li> <li>• Limited or lack of access infrastructure to the marine estate</li> <li>• Reductions in abundances of top and lower order trophic levels from commercial, recreational and charter fishing</li> <li>• Litter, solid waste, marine debris and microplastics</li> <li>• Lack of compliance with regulations (by users) or lack of compliance effort (by agencies)</li> <li>• Inadequate, inefficient regulation, over-regulation (agencies)</li> <li>• Loss of public access (either by private development or Government area closures)</li> <li>• Habitat (physical) disturbance (e.g. from foreshore development, commercial and recreational fishing methods, four wheel driving, and extractive industries (mining)).</li> <li>• Wildlife disturbance (Shorebirds, Turtles, Whales) by dog walkers, 4WD, marine vessels, etc.</li> <li>• Lack of community awareness of the marine estate, associated threats and benefits, regulations and opportunities for participation</li> <li>• Overcrowding/congestion</li> <li>• Loss or decline in marine industries</li> <li>• Pests/diseases</li> <li>• Modified hydrology/hydraulics and flow regime</li> <li>• Seafood contamination</li> <li>• Lack of or ineffective community engagement or participation in governance (lack of evidence; lack of political standing; casual users who may not have English as 1st language, too much/display of information)</li> </ul>	<ul style="list-style-type: none"> <li>• Climate change stressors (sea level rise, altered storm/cyclone activity, flooding, climate and sea temperature rise, altered ocean currents and nutrient inputs)</li> <li>• Agricultural diffuse source runoff (in estuaries)</li> <li>• Urban stormwater discharge</li> <li>• Habitat (physical) disturbance</li> </ul> <p><i>Please note that this column includes only those priority threats that are directly comparable between the environmental and social and economic TARAs. Other threats will overlap between the two TARA priority lists however they are not directly equivalent.</i></p>

Table 5-2 Ranked Priority Threats to inform management initiatives for the North Region

Ranked Priority Threats to Environmental Assets for the North Region	Ranked Priority Threats to Social and Economic Benefits for the North Region	Shared Priority Threats across Assets and Benefits for the North Region
<ul style="list-style-type: none"> <li>• Agricultural diffuse source runoff (in estuaries)</li> <li>• Estuary entrance modifications (in estuaries)</li> <li>• Clearing riparian and adjacent habitat including wetland drainage (in estuaries)</li> <li>• Climate Change (20yrs)</li> <li>• Urban stormwater discharge (in estuaries)</li> <li>• Recreation and tourism -Boating and boating infrastructure (in estuaries)</li> <li>• Navigation &amp; entrance management and modification, harbour maintenance, etc. (in estuaries)</li> <li>• Modified Freshwater flows (in estuaries)</li> <li>• Sewage effluent and septic runoff</li> <li>• Stock grazing of riparian and marine vegetation (in estuaries)</li> <li>• Recreation and tourism - Four wheel driving</li> <li>• Foreshore development</li> <li>• Commercial fishing - Ocean Trap and Line</li> <li>• Commercial fishing - Ocean Trawl</li> <li>• Commercial fishing – Estuary General</li> <li>• Recreational fishing - Shore-based line and trap fishing</li> <li>• Recreational fishing - Boat-based line and trap fishing</li> <li>• Recreational fishing - Hand Gathering</li> <li>• Oyster aquaculture (in estuaries)</li> <li>• Commercial fishing – Ocean Haul</li> <li>• Commercial fishing – Estuary Prawn Trawl</li> <li>• Charter activities – whale and dolphin watching</li> <li>• Beach nourishment and grooming (in estuaries)</li> <li>• Shipping - Small commercial vessels (ferries, charter boats, commercial fishing, whale watching etc.) (in coast and marine)</li> </ul>	<ul style="list-style-type: none"> <li>• Climate change (20 years)</li> <li>• Agricultural diffuse source runoff</li> <li>• Inadequate social and economic information</li> <li>• Urban stormwater discharge</li> <li>• Reductions in abundances of top and lower order trophic levels from commercial, recreational and charter fishing</li> <li>• Anti-social behaviour and unsafe practices</li> <li>• Lack of compliance with regulations (by users) or lack of compliance effort (by agencies)</li> <li>• Limited or lack of access infrastructure to the marine estate</li> <li>• Habitat (physical) disturbance (e.g. from foreshore development, commercial and recreational fishing methods, four wheel driving, and extractive industries (mining).</li> <li>• Inadequate, inefficient regulation, over-regulation (agencies)</li> <li>• Loss of public access (either by private development or Government area closures )</li> <li>• Loss or decline of marine industries</li> <li>• Litter, solid waste, marine debris and microplastics</li> <li>• Wildlife disturbance (Shorebirds, Turtles, Whales) by dog walkers, 4WD, marine vessels, etc.</li> <li>• Lack of community awareness of the marine estate, associated threats and benefits, regulations and opportunities for participation</li> <li>• Overcrowding/congestion</li> <li>• Pests/diseases</li> <li>• Modified hydrology/hydraulics and flow regime</li> <li>• Lack of or ineffective community engagement or participation in governance (lack of evidence; lack of political standing; casual users who may not have English as 1st language, too much/display of information)</li> <li>• Wildlife interactions (e.g. shark bite, jellyfish, boat striking a whale)</li> <li>• Seafood contamination</li> </ul>	<ul style="list-style-type: none"> <li>• Agricultural diffuse source runoff</li> <li>• Climate change stressors (sea level rise, altered storm/cyclone activity, flooding, climate and sea temperature rise, altered ocean currents and nutrient inputs)</li> <li>• Habitat (physical) disturbance</li> <li>• Urban stormwater discharge</li> </ul> <p><i>Please note that this column includes only those priority threats that are directly comparable between the environmental and social and economic TARAs. Other threats will overlap between the two TARA priority lists however they are not directly equivalent.</i></p>

Table 5-3 Ranked Priority Threats to inform management initiatives for the Central Region

Ranked Priority Threats to Environmental Assets for the Central Region	Ranked Priority Threats to Social and Economic Benefits for the Central Region	Shared Priority Threats across Assets and Benefits for the Central Region
<ul style="list-style-type: none"> <li>• Urban stormwater discharge</li> <li>• Estuary entrance modifications (in estuaries)</li> <li>• Recreational Boating - Boating and boating infrastructure (in estuaries)</li> <li>• Foreshore development</li> <li>• Agricultural diffuse source runoff (in estuaries)</li> <li>• Clearing riparian and adjacent habitat including wetland drainage (in estuaries)</li> <li>• Shipping - Large commercial vessels and associated port activities and industries (trade ships, cruise ships, etc.)</li> <li>• Climate Change (20yrs)</li> <li>• Sewage effluent and septic runoff</li> <li>• Industrial discharges (in estuaries)</li> <li>• Navigation &amp; entrance management and modification, harbour maintenance, etc.</li> <li>• Stock grazing of riparian and marine vegetation (in estuaries)</li> <li>• Modified Freshwater flows - Extraction, artificial barriers to riverine and estuarine flow (e.g. dams, weirs, waterway crossings, floodgates), urban drainage, impervious surfaces; flood mitigation (in estuaries)</li> <li>• Small commercial vessels (ferries, charter boats, whale watching vessels, fishing vessels etc) (in estuaries)</li> <li>• Service infrastructure – pipes, cables trenching and boring (in estuaries)</li> <li>• Recreation and tourism – Four wheel driving</li> <li>• Beach nourishment and grooming</li> <li>• Thermal discharges (in estuaries)</li> <li>• Commercial fishing - Ocean Trawl</li> <li>• Recreation and tourism - Shark meshing of swimming beaches</li> <li>• Commercial fishing – Estuary general (in estuaries)</li> <li>• Recreational fishing – Shore-based line and trap fishing</li> <li>• Recreational fishing – Boat-based line and trap fishing</li> <li>• Recreational fishing – Hand gathering</li> <li>• Oyster aquaculture (in estuaries)</li> <li>• Mining and extractive industries (in estuaries)</li> <li>• Commercial fishing - Ocean Trap and Line (in coastal and marine waters)</li> <li>• Estuary entrance modifications (in coastal and marine waters)</li> <li>• Shipping - Small commercial vessels (ferries, charter boats, commercial fishing, whale watching etc.) (in coastal and marine waters)</li> <li>• Commercial fishing – Ocean Haul (in coastal and marine waters)</li> <li>• Commercial fishing – Sea urchin and turban shells (in coastal and marine waters)</li> <li>• Charter activities – Charter whale and dolphin watching (in coastal and marine waters)</li> <li>• Recreation and tourism – Swimming, surfing, dog walking etc (in coastal and marine waters)</li> </ul>	<ul style="list-style-type: none"> <li>• Climate change (20 years)</li> <li>• Urban stormwater discharge</li> <li>• Litter, solid waste, marine debris and microplastics</li> <li>• Inadequate social and economic information</li> <li>• Anti-social behaviour and unsafe practices</li> <li>• Sediment contamination (toxicants in sediment; dioxins in Sydney Harbour, Cooks River)</li> <li>• Limited or lack of access infrastructure to the marine estate</li> <li>• Lack of compliance with regulations (by users) or lack of compliance effort (by agencies)</li> <li>• Inadequate, inefficient regulation, over-regulation (agencies)</li> <li>• Reductions in abundances of top and lower order trophic levels from commercial, recreational and charter fishing</li> <li>• Habitat (physical) disturbance (e.g. from foreshore development, commercial and recreational fishing methods, four wheel driving, and extractive industries (mining).</li> <li>• Loss of public access (either by private development or Government area closures)</li> <li>• Overcrowding/congestion</li> <li>• Wildlife disturbance (Shorebirds, Turtles, Whales) by dog walkers, 4WD, marine vessels, etc.</li> <li>• Lack of community awareness of the marine estate, associated threats and benefits, regulations and opportunities for participation</li> <li>• Agricultural diffuse source runoff</li> <li>• Pests/diseases</li> <li>• Modified hydrology/hydraulics and flow regime</li> <li>• Seafood contamination</li> <li>• Lack of or ineffective community engagement or participation in governance (lack of evidence; lack of political standing; casual users who may not have English as 1st language, too much/display of information)</li> <li>• Loss or decline of marine industries</li> </ul>	<ul style="list-style-type: none"> <li>• Urban stormwater discharge</li> <li>• Climate change stressors (sea level rise, altered storm/cyclone activity, flooding, climate and sea temperature rise, altered ocean currents and nutrient inputs)</li> <li>• Habitat (physical) disturbance</li> <li>• Agricultural diffuse source runoff (in estuaries)</li> </ul> <p><i>Please note that this column includes only those priority threats that are directly comparable between the environmental and social and economic TARAs. Other threats will overlap between the two TARA priority lists however they are not directly equivalent.</i></p>

Table 5-4 Ranked Priority Threats to inform management initiatives for the South Region

Ranked Priority Threats to Environmental Assets for the South Region	Ranked Priority Threats to Social and Economic Benefits for the South Region	Shared Priority Threats across Assets and Benefits for the South Region
<ul style="list-style-type: none"> <li>• Estuary entrance modifications</li> <li>• Agricultural diffuse source runoff (in estuaries)</li> <li>• Climate Change (20yrs)</li> <li>• Urban stormwater discharge</li> <li>• Clearing riparian and adjacent habitat including wetland drainage (in estuaries)</li> <li>• Recreation and tourism -Boating and boating infrastructure (in estuaries)</li> <li>• Navigation &amp; entrance management and modification, harbour maintenance, dredging etc. (in estuaries)</li> <li>• Stock grazing of riparian and marine vegetation (in estuaries)</li> <li>• Sewage effluent and septic runoff (in estuaries)</li> <li>• Modified Freshwater flows - Extraction, artificial barriers to riverine and estuarine flow (e.g. dams, weirs, waterway crossings, floodgates), urban drainage, impervious surfaces; flood mitigation (in estuaries)</li> <li>• Recreation and Tourism – four wheel driving (in estuaries)</li> <li>• Foreshore development</li> <li>• Commercial fishing – Estuary General</li> <li>• Oyster aquaculture (in estuaries)</li> <li>• Recreational fishing - Boat-based line and trap fishing</li> <li>• Commercial fishing - Ocean Haul</li> <li>• Shipping – Large commercial (in estuaries)</li> <li>• Recreational fishing – Shore-based line and trap fishing</li> <li>• Beach nourishment and grooming</li> <li>• Commercial fishing – Abalone (in coastal and marine waters)</li> <li>• Commercial fishing – Sea urchin and turban shells (in coastal and marine waters)</li> <li>• Recreational fishing - Hand Gathering (in coastal and marine waters)</li> <li>• Charter activities – Whale and dolphin watching (in coastal and marine waters)</li> <li>• Shipping - Small commercial vessels (ferries, charter boats, commercial fishing, whalewatching etc.) (in coastal and marine waters)</li> <li>• Commercial fishing - Ocean Trap and Line (in coastal and marine waters)</li> </ul>	<ul style="list-style-type: none"> <li>• Climate change (20 years)</li> <li>• Agricultural diffuse source runoff</li> <li>• Inadequate social and economic information</li> <li>• Urban stormwater discharge</li> <li>• Reductions in abundances of top and lower order trophic levels from commercial, recreational and charter fishing</li> <li>• Anti-social behaviour and unsafe practices</li> <li>• Lack of compliance with regulations (by users) or lack of compliance effort (by agencies)</li> <li>• Limited or lack of access infrastructure to the marine estate</li> <li>• Habitat (physical) disturbance (e.g. from foreshore development, commercial and recreational fishing methods, four wheel driving, and extractive industries (mining).</li> <li>• Inadequate, inefficient regulation, over-regulation (agencies)</li> <li>• Loss of public access (either by private development or Government area closures</li> <li>• Loss or decline of marine industries</li> <li>• Litter, solid waste, marine debris and microplastics</li> <li>• Wildlife disturbance (Shorebirds, Turtles, Whales) by dog walkers, 4WD, marine vessels, etc.</li> <li>• Lack of community awareness of the marine estate, associated threats and benefits, regulations and opportunities for participation</li> <li>• Overcrowding/congestion</li> <li>• Pests/diseases</li> <li>• Modified hydrology/hydraulics and flow regime</li> <li>• Lack of or ineffective community engagement or participation in governance (lack of evidence; lack of political standing; casual users who may not have English as 1st language, too much/display of information)</li> <li>• Seafood contamination</li> </ul>	<ul style="list-style-type: none"> <li>• Climate change stressors (sea level rise, altered storm/cyclone activity, flooding, climate and sea temperature rise, altered ocean currents and nutrient inputs)</li> <li>• Agricultural diffuse source runoff (in estuaries)</li> <li>• Urban stormwater discharge</li> <li>• Habitat (physical) disturbance</li> </ul> <p><i>Please note that this column includes only those priority threats that are directly comparable between the environmental and social and economic TARAs. Other threats will overlap between the two TARA priority lists however they are not directly equivalent.</i></p>



benefits to further change, and to determine if some assets or benefits were at some form of ecological and/or social and economic tipping point that needed specific consideration;

- **Dealing with uncertainty/absence of evidence** – review how the initial TARA outputs addressed threats that were identified as having highly inferred risks and/or a poor evidence base. This included consideration of both whether the risk levels were seen as too conservative or not conservative enough given the level of uncertainty or lack of data presented in the evidence.
- **Cumulative risks** - taking a more systems level approach, identify how cumulative impacts to assets and benefits were addressed by the initial TARA outputs and if detailed risk assessments might also be required if it was perceived the threat could interact or accumulate in a way that cannot be accurately evaluated on an individual threat vs. asset/benefit approach .
- **Future risks** – review how the initial TARA outputs sought to identify and assign risks to threats that were trending toward greater impact over time (i.e. climate change vulnerability or increasing use levels) or could change as a result to a change in management (for example a future decision to allow offshore mining) and how to address these matters in the current and future TARA assessments.

Key resolutions and outcomes of the evaluation workshop are outlined below, noting the overarching recommendation was that these points are further considered and addressed in the 5 - step decision making process by MEMA.

## 6.2 Outcomes of the Evaluation Process

### 6.2.1 Legacy Issues

With respect to legacy issues it was resolved that:

- Management needs to focus on assets and benefits that have reduced adaptive capacity or otherwise low resilience (highly vulnerable to threats)
- Based on the Environment TARA – priorities are water quality, fish assemblages, seagrass, saltmarsh, and estuaries generally; noting the estuaries are under greatest multiple threat from catchment runoff, coastal development pressure and are more finite compared to the open coast and marine waters
- That MEMA could consider a strategy of prioritisation of estuary management for the most threatened/least resilient systems and consideration of future plans to assess the resilience of the estuary to future threats as a key management objective
- Based on the Social and Economic TARA - tangible and intangible cultural heritage are issues that have a high degree of irreversibility if they are impacted, are poorly articulated and understood and should be a priority for management
- For other social and economic benefits it is important to continue to manage the environment assets in a sustainable way such that these benefits continue to flow from the marine estate to users.

## 6.2.2 Dealing with Uncertainty/Absence of Evidence

With respect to dealing with uncertainty and an absence of evidence for risk levels the following was resolved:

For risks identified in the Environmental TARA, it was acknowledged that there are several critical knowledge gaps in the context of:

- effects of fishing on trophic structure and community function
- vessel strikes (shipping and boating) on marine megafauna
- stock levels of non-target fish species
- water quality issues in the context of the connection between estuaries and coast and marine waters

It was agreed that these form critical data gaps for consideration in future steps of the 5-step decision making process.

For the threats identified in the Social and Economic TARA, it was resolved that

- Some information gaps identified in the HSB assessment were filled through new information available from the community survey and from additional research and studies that have been undertaken since the original TARA workshop in 2015
- Removal of the focus on the uses and activities (e.g. fishing as a threat) and identify the stressors (overcrowding, antisocial behaviour, access restriction) from those uses and activities that impact on the flow of benefits from the marine estate has provided a greater link to the evidence presented in the supporting documentation which is more closely linked to these stressors and brought the Social and Economic TARA in closer alignment with the approach to stressors in the Environmental TARA.
- Modification of the consequence scale for the Social and Economic TARA has allowed for consideration of risks through a 'community well-being' lens (considering the spatial effects, temporal effects and the number of parties affected by stressors - not just documenting a user conflict between two specific user groups).

The social and economic validation workshop with Agencies and experts was subsequently held in July 2016 and the following was discussed and agreed:

- Better articulation of the definitions of stressors for the social and economic TARA
- Revised likelihood and consequence tables (noting these documents had previously been sent to MEEKP for in-principle approval)
- Revisions to the risk levels and matrix were agreed by participants and confirmed out of session; with the evidence table (Appendix D) updated in accordance with the discussions.

### 6.2.3 Cumulative Risk

With respect to cumulative risk issues, MEEKP identified several priority threats that it viewed as being highly cumulative or additive in nature and should receive priority attention in the next phase of the 5-step decision making process.

These generally related to a more ecosystems-approach to management and included:

- Fisheries – in terms of management of fish stocks and potential impacts on trophic structure and function
- Estuaries – particularly in terms of receiving environment water quality as a whole (not seeking to manage in isolation diffuse agricultural, diffuse urban stormwater, point sources, microplastics, sediment contamination, etc.).
- Climate change – noting the imperative to move toward practical adaptation/resilience building actions that can be taken now rather than waiting for impact to occur

In the example of fisheries, it was noted that the environmental TARA considers individual fisheries separately and that combining all of the fishing activities would result in a priority cumulative risk.

### 6.2.4 Future Risks

With respect to future risk issues, it was resolved that a ‘watching brief’ be kept on the following issues in the marine estate (that are either expected to increase in severity or may arise as a result of increased demand or changes to current policy):

- Offshore sand extraction (noting the likely increase in demand for sand resources for beach nourishment and/or construction)
- Marine aquaculture (noting this is currently only at two locations and a Sustainable Aquaculture Strategy for Marine Waters is under development)
- The outbreak of existing or new invasive species
- Coastal population increases leading to new or increased use conflicts and/or the loss of critical social and economic benefits (particularly in estuaries)
- Climate change – sea level rise, acidification and ocean warming – noting a key gap is understanding the vulnerability (including adaptive capacity) of various environmental assets to climate change impacts at a more localised scale (Statewide or bioregional scale)
- Offshore or coastal wind farms

To review these future risk issues and to re-assess existing risk levels, it was recommended a five year check-up/review process of the TARA be undertaken from the date of finalisation and formal endorsement of the current process.

This would be done to both monitor ‘minimal’ and ‘low’ risk levels (to assess if consequence or likelihood levels had changed) as well as to evaluate the effectiveness of management measures to treat the ‘moderate’ and ‘high’ risks identified in the original TARA.

## 7 Conclusion and Next Steps

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As demonstrated by the Statewide TARA findings, many of social and economic benefits generated across the marine estate are closely linked and interdependent with the maintenance of environmental assets that are, in turn, affected by environmental stressors.

These stressors often result from multiple human uses and activities that are occurring both within and adjacent to the marine estate (for example, diffuse sources of water pollution flowing to estuaries from river catchments or reduced fish stocks as a result of fishing effort outside of State waters).

In framing future management options, a key objective of the Statewide TARA has been to identify those stressors that have the greatest risk of producing adverse effects on the flow of benefits from the marine estate.

The findings of the TARA also provide data on the likely magnitude and direction of change in benefits derived from the marine estate under existing management controls at both a Statewide scale and at a regional scale (North, Central and South).

However it should be recognised that the TARA and its outputs as outlined in this report is essentially tool for the prioritisation of threats for treatment that need to be further assessed in subsequent steps of the MEMA decision making process. In this context, assignment of a 'High' or 'Moderate' risk level as part of the TARA process is a trigger for further interrogation of the threat but will not necessarily lead to a change to current management or regulations. Likewise, rating as a 'Minimal' or 'Low' risk indicates the risk is currently acceptable but still needs to be considered and tracked over time – particularly where there is poor information or evidence related to the threat and its effect.

MEMA will review the outputs of this TARA and the outcomes and recommendations of the MEEKP risk evaluation process (as set out in Section 6 of this report) to further investigate how existing management controls apply to the assigned risks (Step 3) and to determine appropriate tolerance levels to the identified risks and develop treatment options (Step 4) as part of the 5-step process.

An opportunity for community input into the TARA process will occur, calling for and considering further evidence on threats that may have been overlooked during the preparation of this draft assessment. The results of the consultation may influence the risk attribution levels to some threats or the identification of priority threats. This information will be considered in the finalization of the TARAs and subsequent consideration of risk management strategies in the next stages of the process.

## Appendix A Consequence and Likelihood Statements

### Goals, Objectives, Consequences and Likelihoods for Statewide Social and Economic TARA

The goals and objectives have been designed to be consistent with the objects of the *Marine Estate Management Act 2014*, the requirements for threat and risk assessment in the Act and the vision for the marine estate outlined in MEMA's Principles Paper as outlined below. The statements about goals and objectives given below have been designed for threat and risk assessment purposes only and, while they are broadly consistent with related Government objectives as expressed in existing legislation and policy documents, they do not represent policy or management objective statements.

#### Objects of the *Marine Estate Management Act 2014*

The objects of this Act are as follows:

(a) to provide for the management of the marine estate of New South Wales consistent with the principles of ecologically sustainable development in a manner that:

(i) promotes a biologically diverse, healthy and productive marine estate, and

(ii) facilitates:

- economic opportunities for the people of New South Wales, including opportunities for regional communities, and
- the cultural, social and recreational use of the marine estate, and
- the maintenance of ecosystem integrity, and
- the use of the marine estate for scientific research and education,

(b) to promote the co-ordination of the exercise, by public authorities, of functions in relation to the marine estate,

(c) to provide for the declaration and management of a comprehensive system of marine parks and aquatic reserves.

#### Act requirements for the assessment of threats and risks to marine estate (section 20)

(2) The purpose of the threat and risk assessment is:

(a) to identify threats to the environmental, economic and social values of the marine estate, and

(b) to assess the risks associated with those identified threats, and

(c) to inform marine estate management decisions by prioritising those threats and risks according to the level of impact on the values derived from the marine estate.

#### Vision for the NSW marine estate (as stated in the MEMA Principles Paper (Nov, 2013))

Our vision is for a healthy coast and sea, managed for the greatest well-being of the community, now and into the future.

**1. Social consequence definitions - Statewide**

**Overall social goal:** Maintain and enhance social benefits and cultural uses derived from the NSW marine estate so as to enhance community wellbeing in NSW

**Social objective:** To provide for recreational, cultural and social uses of the marine estate

Consequence level	Consequence of impacts on social benefits
Insignificant	<p><b>No or barely discernible negative impacts</b> on the social benefits enjoyed by the NSW community are or will be evident <b>at a Statewide scale</b>,</p> <p>or</p> <p>minor impacts on:</p> <p>the social benefits derived in one region; or</p> <p>the social benefits across one sector or user group</p>
Minor	<p><b>Discernible and/or temporary negative impacts</b> on the social benefits enjoyed by the NSW community are or will be evident <b>at a Statewide scale</b>,</p> <p>or</p> <p>moderate impacts on:</p> <p>the social benefits derived in one region; or</p> <p>the social benefits across one sector or user group.</p>
Moderate	<p><b>Measurable and on-going negative impacts</b> on the social benefits enjoyed by the NSW community are or will be evident <b>at a Statewide scale</b>,</p> <p>or</p> <p>major impacts on:</p> <p>the social benefits derived in one region; or</p> <p>the social benefits across one sector or user group</p> <p>For example, conflict over resource access and use has a major impact on the social benefit of safety, health and wellbeing especially within the commercial fishing sector.</p>

Consequence level	Consequence of impacts on social benefits
Major	<p><b>Substantial measurable and ongoing negative impacts</b> on the social benefits enjoyed by the NSW community <b>are or will be evident</b> at a Statewide scale,</p> <p>or</p> <p><b>catastrophic impacts</b> on:</p> <p>the social benefits derived in one region; or</p> <p>the social benefits across one or more sector or user group</p> <p>For example, climate change stressors sea level rise and altered storm/cyclone activity has a catastrophic impact on the social benefit of socialising &amp; sense of community due to loss of beach amenity and foreshore areas.</p>
Catastrophic	<p><b>Significant on-going and/or permanent negative impacts</b> are or are almost certain to be evident on social benefits enjoyed by the NSW community that are widespread and affect a large proportion of the sectors and user groups (including the broader community),</p> <p>or</p> <p>where the long term social benefits provided by the NSW marine estate at a Statewide scale are endangered either permanently or irreversibly</p>

**2. Economic consequence definitions – Statewide**

**Overall economic goal:** Maintain and enhance the economic benefits derived from the NSW marine estate

**Economic objective:** To provide for economic values, uses and opportunities of the marine estate

Consequence level	Consequence of impacts on economic benefits
Insignificant	<p><b>No or barely discernible negative impacts</b> on economic benefits are or will be evident at a Statewide scale,</p> <p>or</p> <p>minor impacts on:</p> <p>the economic benefits derived in one region; or</p> <p>across one sector or user group</p>

Consequence level	Consequence of impacts on economic benefits
Minor	<p><b>Discernible and/or temporary negative impacts</b> on economic benefits are or will be evident <b>at a Statewide scale</b>,</p> <p>or</p> <p>moderate impacts on:</p> <p>the economic benefits derived in one region; or</p> <p>the economic benefits across one sector or user group.</p>
Moderate	<p><b>Measurable and on-going negative impacts</b> on economic benefits are or will be evident <b>at a Statewide scale</b>,</p> <p>or</p> <p>major impacts on:</p> <p>the economic benefits derived in one region; or</p> <p>the economic benefits across one sector or user group</p> <p>For example, overcrowding/congestion has a major impact on the economic benefit of individual enjoyment value (consumer surplus), in particular in the central region.</p>
Major	<p><b>Substantial measurable and ongoing negative impacts</b> on economic benefits are or will be evident at a Statewide scale,</p> <p>or</p> <p><b>catastrophic impacts</b> on:</p> <p>the economic benefits derived in one region; or</p> <p>the economic benefits across one sector or more or user group</p> <p>For example, water pollution has a catastrophic impact on the economic benefit of viability of businesses, with a range of businesses impacted; consumptive users (commercial fishers) and passive users (tourism operators, coastal cafes and shops) across the State.</p>
Catastrophic	<p><b>Significant on-going and/or permanent negative impacts</b> are, or are almost certain to occur that would terminate delivery of the majority of economic benefits expected to be derived from the NSW Marine Estate either permanently or irreversibly at a State wide scale</p>

**3. Likelihood definitions relevant to all objectives (social and economic) – Statewide TARA**

Likelihood level	Likelihood of impacts
Rare	Never reported for this situation, but still plausible within the timeframe (< 5%)
Unlikely	Uncommon, but has been known to occur elsewhere. Expected to occur here only in specific circumstances within the timeframe (5-30%)
Possible	Some clear evidence exists to suggest this is possible in this situation within the timeframe (30-50%)
Likely	Expected to occur in this situation within the timeframe (50-90%)
Almost certain	A very large certainty that this will occur in this situation within the timeframe (>90%)

## Goals, Objectives, Consequences and Likelihoods

### NSW Marine Estate Threat and Risk Assessment for the Environmental TARA

#### 1. Introduction

The risk management standard (AS/NZS ISO 31000:2009 (Risk management – principles and guidelines)) notes that risk assessment involves the consideration of the causes and sources of risk to achieving the objectives of the “organisation” and its stakeholders; in this case the objective is to enhance and conserve biodiversity for the Hawkesbury Shelf marine bioregion. It also includes a consideration of the magnitude of the potential consequences and the likelihood that those consequences will occur given current management controls.

The NSW Marine Estate Management Authority (MEMA) has developed environmental, social and economic risk goals, objectives and consequence and likelihood tables for use in the risk assessment phase for the bioregion's threat and risk assessment (TARA).

Definitions of 'insignificant', 'minor', 'moderate', 'major' and 'catastrophic' consequences referred to in the tables in Section 2 are given in relation to each objective. Definitions of 'rare', 'unlikely', 'possible', 'likely' and 'almost certain' likelihood levels are given in Section 3 and relate to all objectives. These definitions will ensure that consequence and likelihood terminology is used consistently and transparently when undertaking threat and risk assessments for the NSW marine estate at any scale.

The goals and objectives given below have been designed for threat and risk assessment purposes only and, while they are broadly consistent with related Government objectives as expressed in existing legislation and policy documents, they do not represent policy or management objective statements.

#### 2. Legislative and Policy Setting

The goals and objectives have been designed to be consistent with:

- the objects and requirements for threat and risk assessment (TARA) in the *Marine Estate Management Act 2014* (MEM Act)
- the objects of other relevant legislation relating to clean waters, biodiversity and coastal processes as outlined in Attachment 1.
- the vision for the marine estate outlined in MEMA's Principles Paper
- the purpose and objectives of the Hawkesbury Shelf Marine Bioregion project

#### TARA Requirements in MEM Act

The TARA requirements are outlined in the objects and in section 20 of the MEM Act. The objects of the MEM Act are:

- (a) to provide for the management of the marine estate of NSW consistent with the principles of ecologically sustainable development in a manner that:
- (i) promotes a biologically diverse, healthy and productive marine estate, and
  - (ii) facilitates:
    - economic opportunities for the people of New South Wales, including opportunities for regional communities, and
    - the cultural, social and recreational use of the marine estate, and
    - the maintenance of ecosystem integrity, and

- the use of the marine estate for scientific research and education,
- (b) to promote the co-ordination of the exercise, by public authorities, of functions in relation to the marine estate,
- (c) to provide for the declaration and management of a comprehensive system of marine parks and aquatic reserves.

The requirements for threat and risk assessment outlined in Section 20 of the MEM Act are:

- (a) to identify threats to the environmental, economic and social values of the marine estate, and
- (b) to assess the risks associated with those identified threats, and
- (c) to inform marine estate management decisions by prioritising those threats and risks according to the level of impact on the values derived from the marine estate.

### **Vision for the NSW marine estate**

The vision as stated in MEMA's Principles Paper (MEMA, 2013) is for *a healthy coast and sea, managed for the greatest well-being of the community, now and into the future.*

### 3. Risk goals, objectives and consequence and likelihood tables

#### 3.1 Environmental consequence definitions

**Environmental objective 1:** To maintain the quality of estuarine and marine waters to ensure maintenance of environmental processes

This objective is consistent with the objects of the *Protection of the Environment Operations Act 1997*

Consequence level	Consequence of impacts on clean waters
Insignificant	No measurable negative impacts on water quality are or will be possible against natural variations.
Minor	Barely measurable negative impacts on water quality outside of natural variation are or will be evident, and any impacts identified have not or will not substantially affect environmental processes.
Moderate	Measurable and on-going negative impacts on water quality are or will be evident in one or more locations. Nevertheless, the level, duration and/or the proportion of area affected have not or will not influence the overall recovery capacity, and the environmental processes in most of the affected location(s) are or will be maintained.
Major	Substantial measurable and on-going negative impacts on water quality are or will be evident in one or more locations, and the level, duration and/or the proportion of area is such that environmental processes are or will be adversely affected.
Catastrophic	Substantial measurable on-going negative impacts on water in one or more locations are or will be evident that are or will endanger environmental processes and their underlying ecological assets in the long-term.

**Environmental objective 2:** To conserve estuarine and marine habitats and biotic assemblages, and ensure their ecologically sustainable use.

This objective is consistent with the objects of the MEM Act and the *Fisheries Management Act 1994*

Consequence level	Consequence of impacts on environmental assets (habitats and biotic assemblages)
Insignificant	No measurable negative impacts on habitats and/or biotic assemblages are or will be evident against natural variations.
Minor	Barely measurable negative impacts on habitats and/or biotic assemblages are or will be evident compared to total habitat area or abundance of biota against natural variations.
Moderate	Measurable and on-going negative impacts on habitats and/or biotic assemblages are or will be evident in one or more locations. Nevertheless, both the level and the percentage of habitats and/or biotic assemblages affected have not or will not influence their overall recovery capacity, and a change in the overall trophic/community structure isn't and will not be evident.

Consequence level	Consequence of impacts on environmental assets (habitats and biotic assemblages)
Major	Substantial measurable and on-going negative impacts on habitats and/or biotic assemblages are or will be evident in one or more locations, and the proportion of habitats and/or biotic assemblages affected will influence the recovery capacity of the habitats and/or biotic assemblages, with some clear shifts in the overall trophic/community structure and function.
Catastrophic	The level of habitat and/or biotic assemblages negatively affected endangers their long-term survival, and will result in extreme changes to the region's trophic/community structure as well as the function of the remaining habitat and/or biotic assemblages.

**Environmental objective 3:** To conserve listed threatened and protected estuarine and marine species.

This objective is consistent with the objects of the *Fisheries Management Act 1994*

Consequence level	Consequence of impacts on threatened and protected species
Insignificant	No measurable negative impacts on threatened or protected species are or will be evident against natural variation.
Minor	Barely measurable negative impacts on threatened or protected species are or will be evident against natural variation. Nevertheless, there are either no substantial negative impacts or only extremely few mortalities within 5-10 years, and there is not and will not be a measurable effect on local population status of protected species or recovery of threatened species.
Moderate	Many individuals of a threatened or protected species are or will be measurably negatively affected. Nevertheless, no on-going impact on local dynamics or overall number of individuals is or will be evident, and the impact has not or will not significantly affect population status of protected species or recovery of already threatened species.
Major	Substantial measurable and on-going negative impacts that are or will affect the number of individuals of protected species and recovery of already threatened species.
Catastrophic	The ongoing level of mortality has or will generate significant additional declines to already threatened or protected species leading to potential local extinction in NSW.

### **3.2 Likelihood definitions relevant to all environmental objectives**

<b>Likelihood level</b>	<b>Likelihood of impacts</b>
Rare	Never reported for this situation, but still plausible within the timeframe (< 5%)
Unlikely	Uncommon, but has been known to occur elsewhere. Expected to occur here only in specific circumstances within the timeframe (5-30%)
Possible	Some clear evidence exists to suggest this is possible in this situation within the timeframe (30-50%)
Likely	Expected to occur in this situation within the timeframe (50-90%)
Almost certain	A very large certainty that this will occur in this situation within the timeframe (>90%)

## Appendix B Workshops

Workshop Date	Details
August 2015	Environmental Workshop HSB
August 2015	Social and Economic HSB and Statewide Workshop
Feb 2016	Environmental State Workshop
May 2016	MEEKP Evaluation Workshop
July 2016	Social and Economic additional workshop

## Appendix C Environmental Risk Matrices and Evidence





## Appendix C Environmental Risk Matrices and Evidence

## Statewide Risk Assessment – Estuaries

## Estuarine waters

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
Shipping	Large commercial vessels and port activities and industries (trade and cruise ships)	Central	moderate	major	possible	<b>Water pollution</b> - major impacts were considered possible due to the defined stressors, including contamination from oil spills and antifouling paints, and level of large shipping activity in the region. See section 6.1.1 for further details.	A	L: Main ports only: Sydney Harbour, Botany Bay and Port Kembla
		North South	low	minor	likely	<b>Water pollution</b> - consequence of pollution occurring is much reduced from contamination from oil spills and antifouling paints due to reduced number of ports and level of shipping activity. See section 6.1.1 for further details.	A	L: Clarence R, Jervis Bay, Twofold Bay
	Small commercial vessels (ferries, charter boats)	All	low	minor	likely	<b>Water pollution</b> – impacts considered minor resulting from the defined stressors, including contamination from oil spills and antifouling paints. It was considered likely that this level of impact would occur due to the amount of vessel activity in the identified estuaries. See section 6.1.1 for further details.	L	L: Many large estuaries, particularly Sydney Harbour, Hawkesbury, Hunter
Commercial fishing	Estuary prawn trawl	North	Low	minor	likely	<b>Water pollution</b> – due to sediment re-suspension, with impacts minor at a local scale. See section 6.1.2 for further details.	L	L: in estuaries where EPT trawl occurs
Aquaculture	Oyster aquaculture	North South	low	minor	likely	<b>Water pollution</b> – due to sediment re-suspension, with impacts minor at a local scale. See section 6.1.7 for further details.	A	L:
	Prawn farms	North	Low	minor	likely	<b>Water pollution</b> – due to sediment re-suspension, with impacts minor at a local scale. See section 6.1.7 for further	A	L

## Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						details.		
Recreation and tourism	Boating and boating infrastructure	All	moderate	moderate	likely	<b>Water pollution</b> – impacts considered moderate reflecting the level of impact of the defined stressors which include antifouling paints and fuel spills, and considered likely that this level of impact would occur due to the amount of vessel activity in the identified estuaries. See section 6.1.9 for further details.	A	L: marinas, mooring areas in larger estuaries
	Four wheel driving	All	low	minor	likely	<b>Water pollution</b> – physical disturbance, habitat impacts and toxicants likely to result in minor impacts, but under current management there is limited access to nearshore area for four wheel drives in estuaries. See section 6.1.9 for further details.	A	L: where the specific activity occurs
Dredging	Navigation & entrance management and modification, harbour maintenance etc.	All	moderate	moderate	likely	<b>Water pollution</b> – impacts due to sediment re-suspension from operations and dewatering in barges leading to turbidity and potential toxin release, with impacts moderate at a local scale. See section 6.1.10 for further details.	A	L: Many large estuaries
Modified freshwater flows	Extraction, artificial barriers to riverine and estuarine flow (e.g. dams, weirs, waterway crossings, floodgates)	All	moderate	moderate	likely	<b>Water pollution</b> – moderate impacts likely to occur from acid sulfate soils leaching and reducing pH. See section 6.1.12 for further details.	L	R: Numerous estuaries, especially in North & South regions
Mining and extractive industries	Oil, gas, minerals, sand, aggregate, underground coal	Central	low	moderate	possible	<b>Water pollution</b> - moderate impacts possible due to suspended sediments. See section 6.1.11 for further details.	L	L
Service infrastructure	Pipelines, cables, trenching and boring	Central	low	minor	likely	<b>Water pollution</b> - minor impacts likely due to suspended sediments. See section 6.1.13 for further details.	L	L: Botany Bay

## Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
<b>Land-based impacts</b>								
Landuse Intensification	Urban stormwater discharge	All	high	major	almost certain	<b>Water pollution, marine debris</b> – major impacts almost certain from combined stressors of toxic contaminants, nutrients, suspended sediments, marine debris (including microplastics). Nutrients are present as bioavailable dissolved inorganic forms. See section 6.2.1 for further details.	A	All estuaries with urban runoff
	Foreshore development	All	low	minor	almost certain	<b>Water pollution</b> - minor impacts almost certain from combined stressors of toxic contaminants, nutrients and suspended sediments. See section 6.2.1 for further details.	L	R: all estuaries where urban development occurs
	Beach nourishment and grooming	Central	low	minor	likely	<b>Water pollution</b> - local impacts on water quality based on sediment resuspension through beach berm modification, with minor impacts likely. See section 6.2.1 for further details.	L	L: Coastal lagoons
	Clearing riparian and adjacent habitat including wetland drainage	All	high	major	likely	<b>Water pollution</b> - clearing and draining leads to acid runoff and blackwater events after floods. Major impacts likely to occur, although impacts isolated to affected areas only. See section 6.2.1 for further details.	A	R: Many estuaries where clearing and drainage occurs
	Agricultural diffuse source runoff	All	high	major	almost certain	<b>Water pollution</b> - major impacts almost certain from combined stressors of nutrients, suspended sediments, and potentially toxic contaminants. See section 6.2.1 for further details.	A	R: Restricted to estuaries with agricultural catchments
	Stock grazing of riparian and marine vegetation	All	low	minor	likely	<b>Water pollution</b> – minor impacts considered likely from the water pollution resulting from trampling and grazing and	A	R: all estuaries where grazing occurs

## Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						nutrients via defecation. See section 6.2.1 for further details.		
Point Discharges	Industrial discharges	North South	low	minor	likely	<b>Water pollution</b> - minor impacts likely from combined stressors of nutrients, and potentially toxic contaminants at a highly localised scale. See section 6.2.2 for further details.	L	L: Restricted to very few locations
		Central	high	major	likely	<b>Water pollution</b> - moderate impacts likely from combined stressors of nutrients, suspended sediments and potentially toxic contaminants. See section 6.2.2 for further details.	A	L: Estuaries with industrial discharges and industrial landuse, e.g. Hunter, Lake Macquarie, Hawkesbury, Port Jackson, Port Kembla.
	Thermal discharges	Central	high	major	almost certain	<b>Thermal pollution</b> - major impacts almost certain from elevated water temperature and changing dissolved oxygen within the affected system. See section 6.2.2 for further details.	A	L: Lake Mac, Lake Illawarra
	Sewage effluent and septic runoff	North South	moderate	moderate	almost certain	<b>Water pollution, marine debris (microplastics)</b> - moderate impacts almost certain from combined stressors of nutrients and potentially toxic contaminants, with risk elevated from septic runoff compared to sewage discharge. See section 6.2.2 for further details.	A	L:
		Central	high	major	almost certain	<b>Water pollution, marine debris (microplastics)</b> - major impacts almost certain from combined stressors of nutrients, suspended sediments and toxic	A	L: Hunter River, Lake Macquarie, Tuggerah,

## Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						contaminants. See section 6.2.2 for further details.		Hawkes
Hydrologic Modifications	Estuary entrance modification	All	moderate	moderate	almost certain	<b>Changes in tidal flow and tidal prism</b> - moderate impacts almost certain to occur from changes in tidal height, residence times, and volumes of freshwater inflowing impacts salinity and inundation. Secondary impacts on water quality. See section 6.2.3 for further details.	A	R
<b>Climate change</b>	<b>20 years</b>							
	Altered ocean currents and nutrient inputs	North	low	minor	likely	<b>Nutrient changes</b> - minor impacts on water quality. See section 6.3.1 for further details.	L	R: Drowned river valleys
	Altered storm/cyclone activity	All	low	moderate	possible	<b>Physical disturbance</b> - intensity of storms will result in re-suspending sediments. See section 6.2.2 for further details.	L	R: Drowned river valleys
	Flooding, storm surge, inundation	All	low	moderate	possible	<b>Physical disturbance</b> - vegetation death causes decreasing water quality (limited to coastal lagoons). See section 6.2.2 for further details.	A	R: Coastal lagoons and wave dominated
<b>Climate change</b>	<b>50 years</b>							
	Altered ocean currents and nutrient inputs	North	moderate	moderate	likely	<b>Nutrient changes</b> - moderate effects on water quality likely due to changing nutrient inputs. See section 6.2.2 for further details.	L	R: Drowned river valleys
	Climate and sea temp. rise	North	moderate	moderate	likely	<b>Elevated temperatures</b> - moderate effects on water quality due to increased temperatures. See section 6.2.2 for further details.	L	R: Drowned river valleys
		Central South	low	minor	likely	<b>Elevated temperatures</b> - limited water quality effects, mainly in drowned river	I	R: Drowned river valleys

Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						valleys. See section 6.2.2 for further details.		
	Ocean acidification	All	low	minor	likely	<b>Increased acidity</b> - limited water quality effects, mainly in drowned river valleys Limited water quality effects. See section 6.2.2 for further details.	I	R: Drowned river valleys
	Altered storm/cyclone activity	All	moderate	moderate	likely	<b>Physical disturbance</b> - intensity of storms re-suspending sediments and increasing catchment runoff. See section 6.2.2 for further details.	I	R: Drowned river valleys
	Flooding, storm surge, inundation	All	moderate	moderate	likely	<b>Physical disturbance</b> - intensity of storms re suspending sediments. See section 6.2.2 for further details.	I	R: Coastal lagoons and wave dominated

## Appendix C Environmental Risk Matrices and Evidence

## Saltmarsh

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
Shipping	Large commercial vessels and port activities and industries (trade and cruise ships)	Central	moderate	major	possible	<b>Water pollution</b> - considered possible that major impacts could occur due to potential oil spills, the low resilience of the habitat, and the level of this activity in the identified ports. See section 6.1.1 for further details.	A	L: Main ports only, but particularly Botany Bay and Hunter River
	Small commercial vessels (ferries, charter boats)	All	low	moderate	possible	<b>Water pollution</b> - considered possible that moderate impacts could occur due to potential oil spills, the low resilience of the habitat, and the level of this activity in the estuaries. See section 6.1.1 for further details.	A	L: Many large estuaries, particularly Hunter, Hawkesbury, Sydney Harbour, Port Stephens, Clarence River, Richmond River,
Commercial fishing	Estuary general	North	Low	minor	likely	<b>Physical disturbance</b> –minor impacts are likely due to activities associated with fishing. See section 6.1.2 for further details	L	L
Aquaculture	Oyster aquaculture	All	low	minor	likely	<b>Physical disturbance</b> - impact considered minor reflecting the level of activity at specific abandoned sites, and restricted to highly localised areas in estuaries where aquaculture occurs. See section 6.1.7 for further details	L	L:
Recreation and tourism	Four wheel driving	All	moderate	major	possible	<b>Physical disturbance</b> - extensive physical destruction and soil compaction possible, but under current management there is limited access to saltmarsh area for four wheel drives, and limited saltmarsh where there is access,	A	L: Stockton-Hunter, and in other regions, particularly coastal lagoons

## Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						although some illegal activity. Major impacts possible in localised areas. See section 6.1.9 for further details.		
Dredging	Navigation & entrance management and modification, harbour maintenance etc.	All	low	minor	likely	<b>Water pollution</b> - considered likely that minor impacts could occur due to sediment re-suspension from operations and dewatering in barges leading to turbidity and potential release of toxic contaminants. See section 6.1.10 for further details.	L	L: Most large estuaries, particularly Hunter River
Modified freshwater flows	Extraction, artificial barriers to riverine and estuarine flow (e.g. dams, weirs, waterway crossings, floodgates), urban drainage, impervious surfaces	All	high	major	likely	<b>Changes to tidal flow and patterns</b> – major impacts likely through changed water table and inundation regimes results in very broad overall impacts. See section 6.1.12 for further details.	A	L: All estuaries (where present)
Mining and extractive industries	Oil, gas, minerals, sand, aggregate, underground coal	Central	low	minor	likely	<b>Physical disturbance</b> - minor impacts considered possible due to physical disturbance. See section 6.1.11 for further details.	L	L: Limited coastal examples
Service infrastructure	Pipelines, cables, trenching and boring	Central	moderate	moderate	likely	<b>Physical disturbance, sedimentation and water pollution</b> – moderate impacts likely, but pulsed impacts at time of construction and mostly highly localised. See section 6.1.13 for further details.	L	R: Highly modified estuaries urban, industrial)
<b>Land-based impacts</b>								
Landuse Intensification	Urban stormwater discharge	All	moderate	moderate	likely	<b>Water pollution</b> – moderate impacts likely due to increased nutrients, contaminants and sediments and reduced salinities which impact biota in saltmarsh. See section 6.2.1 for further details.	A	R: All estuaries (where present)

Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
	Foreshore development	All	moderate	major	possible	<b>Physical disturbance</b> – major impacts due to direct habitat removal and destruction in some areas. Development of foreshore historically meant removing/infilling of saltmarsh. Possible under current management. See section 6.2.1 for further details.	A	L: all estuaries (where present)
	Clearing riparian and adjacent habitat including wetland drainage	North Central	high	major	likely	<b>Physical disturbance, changes to tidal flow velocity and patterns</b> – major impacts likely due to damage to habitat during removal and clearing, altering water tables and connectivity. Removal/clearing of adjacent habitats under current management is still likely, especially in rural catchments. See section 6.2.1 for further details.	A	L: all estuaries where clearing and drainage occurs
		South	moderate	major	possible	<b>Physical disturbance, changes to tidal flow velocity and patterns</b> – major impacts possible due to damage to habitat during removal and clearing, altering water tables and connectivity. Removal/clearing of adjacent habitats under current management is still possible, especially in rural catchments. See section 6.2.1 for further details.	A	L: all estuaries where clearing and drainage occurs
	Agricultural diffuse source runoff	All	moderate	moderate	likely	<b>Water pollution</b> – moderate impacts likely due to elevated nutrients, sediments and potential contaminants. Surface water carries nutrients and is likely to enter saltmarshes via overland flow. See section 6.2.1 for further details.	L	R: All estuaries where agricultural activities occur
	Stock grazing of riparian and marine vegetation	All	High	major	almost certain	<b>Physical disturbance, water pollution</b> – major impacts considered likely from the physical disturbance from trampling and grazing and nutrients via defecation. See	A	R all estuaries where grazing occurs

## Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						section 6.2.1 for further details.		
Point Discharges	Industrial discharges	Central	low	moderate	possible	<b>Water pollution</b> – moderate impacts possible due to elevated nutrients and sediments. Increased nutrient loads and contaminant concentrations negatively impact biota. Only possible under current management. See section 6.2.2 for further details.	L	L: estuaries where discharges occur
	Sewage effluent and septic runoff	Central	low	major	unlikely	<b>Water pollution</b> – major impacts from elevated nutrients and sediments, and lowered salinity would affect biota, but considered unlikely under current management. See section 6.2.2 for further details.	L	R: all estuaries where discharge occurs
Hydrologic Modifications	Estuary entrance modifications	All	high	major	likely	<b>Changes in tidal flow and patterns</b> – major impacts likely due to changes in estuary water from estuarine/brackish to more marine. Results in increased frequency of inundation and mangrove encroachment. Likely in all modified estuaries. See section 6.2.3 for further details.	A	All estuaries (where present)
<b>Climate change</b>	<b>20 years</b> – See section 6.3.1 for further details on climate change							
	Sea level rise	All	high	major	almost certain	<b>Physical disturbance</b> – habitat almost certain to be inundated, limited chances to expand range.	A	R
	Flooding, storm surge, inundation	All	low	moderate	possible	<b>Physical disturbance</b> - increased nutrient and sediment runoff may be significant, with moderate impacts possible.	I	R
<b>Climate change</b>	<b>50 years</b>							
	Climate and sea temperature rise	All	high	major	likely	<b>Elevated temperatures</b> - experimental studies show response and expected change	I	R

Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						is greater than thresholds. Resilient systems		
	Ocean acidification	All	high	major	likely	<b>Increased acidity</b> - experimental studies show response and expected pH change is greater than thresholds.	I	R
	Altered storm/cyclone activity	All	moderate	major	likely	<b>Physical disturbance</b> - tolerant of abiotic stress, but increased nutrient and sediment runoff may be significant.	I	R
	Sea level rise	All	high	major	almost certain	<b>Physical disturbance</b> - habitat will be inundated, limited chances to expand range, with major impacts almost certain.	L	R
	Flooding, storm surge, inundation	All	moderate	moderate	likely	<b>Physical disturbance</b> - increased nutrient and sediment runoff may be significant, with moderate impacts likely.	I	R

## Appendix C Environmental Risk Matrices and Evidence

## Mangroves

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
Shipping	Large commercial vessels and port activities and industries (trade and cruise ships)	Central	moderate	major	possible	<b>Water pollution</b> - major impacts were considered possible due to potential oil spills, the low resilience of the habitat, and the level of this activity in the identified ports. See section 6.1.1 for further details.	A	L: Main ports only, but particularly Botany Bay and Hunter River
	Small commercial vessels (ferries, charter boats)	Central	high	major	almost certain	<b>Physical disturbance</b> - major impacts were considered almost certain due to physical disturbance from specific vessel traffic which undermines mangroves and causes them to fall and level of vessel traffic at highly localised scale. See section 6.1.1 for further details.	A	L: Upper Parramatta River only
		North South	low	minor	likely	<b>Physical disturbance</b> –minor impacts were considered likely due to physical disturbance from specific vessel traffic which disturbs mangroves and associated biota. See section 6.1.1 for further details.	A	L:
Commercial fishing	Estuary general	North	Low	minor	likely	<b>Physical disturbance</b> –minor impacts are likely due to activities associated with the fishery. See section 6.1.2 for further details.	L	R
Recreational fishing	Shore-based line and trap fishing	All	low	minor	likely	<b>Physical disturbance</b> –minor impacts are likely due to activities. See section 6.1.4 for further details.	L	R
	Boat-based line and trap fishing	All	low	minor	likely	<b>Physical disturbance</b> - minor impacts due to physical disturbance from level of vessel traffic at localised scale. See section 6.1.4 for further details.	L	L
Aquaculture	Oyster aquaculture	All	low	minor	likely	<b>Physical disturbance</b> - impact considered minor reflecting the level of	A	L

Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						activity at specific abandoned sites, and restricted to highly localised areas in estuaries where aquaculture occurs. See section 6.1.7 for further details.		
Recreation and tourism	Boating and infrastructure	North Central	low	minor	likely	<b>Physical disturbance, water pollution</b> – minor impacts were considered likely reflecting the low level of the defined stressors from the activity (e.g. fuel spills, physical disturbance) and the moderate resilience of the habitat to these impacts. See section 6.1.9 for further details.	L	R: Most large estuaries, particularly Hunter River Hawkesbury River, Georges River, Lake Macquarie and Port Hacking
Modified freshwater flows	Extraction, artificial barriers to riverine and estuarine flow (e.g. dams, weirs, waterway crossings, floodgates), urban drainage, impervious surfaces	North	high	major	likely	<b>Changes to tidal flow and patterns</b> – major impacts likely through changed water table and inundation regimes results in prevention of inundation by floodgates and very broad overall impacts. Extent of impacts of reduced freshwater inflows and connectivity to floodplains limited. See section 6.1.12 for further details.	L	R
		Central	moderate	moderate	likely	<b>Changes to tidal flow and patterns</b> – moderate impacts likely through changed water table and inundation regimes results in prevention of inundation by floodgates and very broad overall impacts. Extent of impacts of reduced freshwater inflows and connectivity to floodplains limited. See section 6.1.12 for further details.	A	R
		South	low	moderate	possible	<b>Changes to tidal flow and patterns</b> – moderate impacts only possible in this region through changed water table and	A	L

## Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						inundation regimes which results in prevention of inundation by floodgates and very broad overall impacts. See section 6.1.12 for further details.		
Mining and extractive industries	Oil, gas, minerals, sand, aggregate, coal mining	Central	Low	minor	likely	<b>Physical disturbance</b> – only minor impacts considered likely. See section 6.1.11 for further details.	L	L
Service infrastructure	Pipelines, cables, trenching and boring	Central	moderate	moderate	likely	<b>Physical disturbance, water pollution</b> – moderate impacts likely, but pulsed impacts at time of construction and mostly highly localised. See section 6.1.13 for further details.	A	R: most estuaries
<b>Land-based impacts</b>								
Landuse Intensification	Urban stormwater discharge	All	low	moderate	possible	<b>Water pollution</b> – moderate impacts considered possible due to increased nutrients, contaminants and sediments and reduced salinities which impact biota in mangroves. See section 6.2.1 for further details.	L	R: Estuaries with mangroves near urban areas
	Foreshore development	North South	low	minor	likely	<b>Physical disturbance</b> – minor impacts likely due to direct habitat removal and destruction in some areas. Low levels of development of foreshore historically in these regions. Possible under current management. See section 6.2.1 for further details.	A	L: Estuaries with mangroves near urban areas
		Central	moderate	major	possible	<b>Physical disturbance</b> – major impacts possible due to direct habitat removal and destruction in some areas. Development of foreshore historically meant removing/infilling of mangroves. Possible under current management. See section 6.2.1 for further details.	L	R: Estuaries with mangroves near urban areas

## Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
	Clearing riparian and adjacent habitat including wetland drainage	North Central	moderate	major	likely	<b>Physical disturbance, changes to tidal flow velocity and patterns</b> – major impacts possible due to damage to habitat during removal and clearing, altering water tables and connectivity. Removal/clearing of adjacent habitats under current management is still likely, especially in rural catchments. See section 6.2.1 for further details.	L	R: Estuaries with mangroves
		South	low	moderate	possible	<b>Physical disturbance, changes to tidal flow velocity and patterns</b> – moderate impacts considered only possible in this region due to damage to habitat during removal and clearing, altering water tables and connectivity. Removal/clearing of adjacent habitats under current management is still likely, especially in rural catchments. See section 6.2.1 for further details.	L	R: Estuaries with mangroves
	Agricultural diffuse source runoff	All	moderate	moderate	likely	<b>Water pollution</b> – moderate impacts likely due to elevated nutrients, sediments and potential contaminants. Surface water carries nutrients and is likely to enter mangroves via overland flow. See section 6.2.1 for further details.	L	R: All estuaries where agricultural activities occur.
	Stock grazing of riparian and marine vegetation	All	high	Major	likely	<b>Physical disturbance, water pollution</b> – major impacts considered likely from the physical disturbance from trampling and grazing and nutrient inputs from defecation. See section 6.2.1 for further details.	A	R all estuaries where grazing occurs
Point Discharges	Industrial discharges	Central	moderate	major	possible	<b>Water pollution</b> – major impacts considered possible due to elevated nutrients and sediments. Increased	L	L: estuaries where discharges

## Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
	Sewage effluent and septic runoff	All	low	moderate	possible	<b>Water pollution, marine debris (Microplastics)</b> – moderate impacts from elevated nutrients, sediments and contaminants, and lowered salinity would affect biota. Sewage runoff carries microplastics, with moderate impacts possible. See section 6.2.2 for further details.	L	L: Hunter, Brisbane, Hawkesbury,
Hydrologic Modifications	Estuary entrance modifications	All	moderate	major	possible	<b>Changes in tidal flow and patterns</b> – major impacts possible due to changes in estuary water from estuarine/brackish to more marine. Results in increased frequency of inundation. Ongoing management allows openings and other modifications. See section 6.2.3 for further details.	L	R: All except drowned river valleys
<b>Climate change</b>	<b>20 year</b> - See section 6.3.1 for further details on climate change							
	Sea level rise	All	moderate	moderate	almost certain	<b>Physical disturbance</b> – increased water levels will result in landward expansion, but may not be able to expand in some estuaries.	A	L
<b>Climate change</b>	<b>50 year</b>							
	Climate and sea temperature rise	All	moderate	moderate	likely	<b>Elevated temperatures</b> - resilient systems, though some moderate effects likely.	I	R
	Ocean acidification	All	high	major	likely	<b>Increased acidity</b> - major impact on molluscs and other calcifying organisms likely.	I	R
	Altered storm/cyclone activity	All	low	minor	likely	<b>Physical disturbance</b> -tolerant to abiotic stress and like sheltered locations, so only minor impacts likely.	L	R
	Sea level rise	All	moderate	moderate	almost certain	<b>Physical disturbance</b> - may not be able to expand in some estuaries, and hence moderate impacts are almost certain to	A	R

Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						occur.		
	Flooding, storm surge, inundation	All	low	minor	likely	<b>Physical disturbance</b> - tolerant to abiotic stress and like sheltered locations, so only minor impacts likely.	L	R

## Appendix C Environmental Risk Matrices and Evidence

## Seagrass

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
Shipping	Large commercial vessels and associated port activities and industries (trade ships, cruise ships)	Central	moderate	major	possible	<b>Water pollution, physical disturbance</b> - major impacts were considered possible due to potential oil spills and physical disturbance, the moderate resilience of the habitat, and the level of this activity in the identified ports. See section 6.1.1 for further details.	L	L: Main ports only, but particularly Botany Bay and Sydney Harbour
		South	low	major	unlikely	<b>Water pollution, physical disturbance</b> - major impacts were considered unlikely due to low risk of oil spill and physical disturbance reflecting the level of this activity in several local areas. See section 6.1.1 for further details.	L	L: Jervis Bay, Twofold Bay
	Small commercial vessels (ferries, charter boats)	All	low	moderate	possible	<b>Water pollution, physical disturbance</b> - moderate impacts were considered possible due to physical disturbance and oil spills from vessel traffic. See section 6.1.1 for further details.	L	L: Several large estuaries, particularly Botany Bay, Sydney Harbour, Hawkesbury
Commercial fishing	Estuary General	All	low	minor	likely	<b>Physical disturbance</b> –minor impacts were considered likely to occur from this activity at a local scale under current management arrangements. See section 6.1.2 for further details.	L	L: estuaries where commercial fishing allowed only
	Estuary Prawn Trawl	North Central	low	minor	likely	<b>Physical disturbance, water pollution</b> –minor impacts from physical disturbance and sediment res-suspension were considered likely to occur from this activity at a local scale under current management arrangements, and only at	L	L: Hawkesbury only

## Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						a local scale. See section 6.1.2 for further details.		
Charter fishing	Line fishing	All	low	minor	likely	<b>Physical disturbance</b> –minor impacts were considered likely to occur from this activity at a local scale, principally related to anchor damage on this habitat at a local scale. See section 6.1.3 for further details.	L	L
Recreational fishing	Shore-based line and trap fishing	All	low	minor	likely	<b>Physical disturbance</b> - minor impacts due to physical disturbance at localised scale. See section 6.1.4 for further details.	L	R
	Boat-based line and trap fishing	All	low	moderate	possible	<b>Physical disturbance</b> - moderate impacts due to physical disturbance from level of vessel anchoring and scouring at localised scale. It was considered possible that this level of impact would occur from this activity under current management arrangements. See section 6.1.4 for further details.	A	R
	Hand gathering	All	low	moderate	possible	<b>Physical disturbance</b> - moderate impacts considered possible due to physical disturbance principally from impacts associated with prawning and nipper collecting at localised scale. See section 6.1.4 for further details.	L	L: South: Tabourie, Wallagoot Lake and other estuaries
Aquaculture	Oyster aquaculture	All	moderate	moderate	likely	<b>Physical disturbance</b> - moderate impact considered likely reflecting the level of activity at specific abandoned sites, and restricted to highly localised areas in estuaries where aquaculture occurs. Physical disturbance resulting from propellers, sediment re-suspension, and shading from boats/structures resulting in	A	L – Central: principally in Brisbane Waters. North : principally Port Stephens and Wallis Lake. South: estuaries

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						light limitation. Low resilience of components of the habitat to these impacts (i.e. <i>Posidonia</i> ). See section 6.1.7 for further details.		where activity occurs
Recreation and tourism	Boating and boating infrastructure	All	high	major	almost certain	<b>Physical disturbance, water pollution</b> – major impacts were considered almost certain reflecting the level of the defined stressors from the activity (physical disturbance resulting from propellers, anchoring, moorings, sediment re-suspension and shading from boats/jetties resulting in light limitation, fuel spills), and the low resilience of the habitat to these impacts. See section 6.1.9 for further details.	A	R: all estuaries where recreational boating and related infrastructure occurs
Dredging	Navigation & entrance management and modification, harbour maintenance etc.	All	moderate	major	possible	<b>Physical disturbance, water pollution</b> – major impacts were considered possible reflecting the level of the defined stressors from the activity (physical disturbance, sediment re-suspension), and the low resilience of the habitat to these impacts.	L	L: All estuaries with dredging
Modified freshwater flows	Extraction, artificial barriers to riverine and estuarine flow (e.g. dams, weirs, waterway crossings, floodgates)	All	low	minor	likely	<b>Changes to tidal flow and patterns</b> – only minor impacts likely through changed water table and inundation regimes and broad overall impacts. See section 6.1.12 for further details.	L	R
Mining and extractive industries	Oil, gas, minerals, sand, aggregate, underground coal	Central	moderate	moderate	likely	<b>Physical disturbance</b> – moderate impacts considered likely through subsidence which affects seagrass viability at depth. See section 6.1.11 for further details.	L	L: Lake Macquarie, Tuggerah
Service infrastructure	Pipelines, cables, trenching and boring	Central	moderate	moderate	likely	<b>Physical disturbance, sedimentation and water pollution</b> – moderate impacts	L	R: Botany Bay, Lake Macquarie,

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						likely, but pulsed impacts at time of construction and mostly highly localised. Removal of <i>Posidonia</i> leads to damage. See section 6.1.13 for further details.		Port Jackson, Port Hacking
<b>Land-based impacts</b>								
Landuse Intensification	Urban stormwater discharge	North South	moderate	moderate	likely	<b>Water pollution</b> – moderate impacts considered likely due to increased nutrients, contaminants and sediments and reduced salinities which impact seagrass and associated biota. See section 6.2.1 for further details.	A	R
		Central	high	major	almost certain	<b>Water pollution</b> – major impacts considered almost certain due to high levels of urban areas resulting in increased nutrients, contaminants and sediments and reduced salinities which impact seagrass and associated biota. See section 6.2.1 for further details.	A	R: All estuaries and some coastal lagoons
	Foreshore development	All	moderate	moderate	likely	<b>Physical disturbance, changes to tidal flow velocity and patterns</b> – moderate impacts likely due to direct habitat removal and destruction in some areas. Development of foreshore historically meant removing/ infilling of some seagrass areas. See section 6.2.1 for further details.	A	R: All estuaries where nearshore development (including moorings, marinas, jetties), in particular Lake Mac, Bot Bay,
	Beach nourishment and grooming	North South	low	moderate	possible	<b>Physical disturbance</b> – moderate impacts only possible due to direct removal of seagrass wrack from living beds which has potential to impact living seagrass and associated biota. Impacts occur at a local scale. See section 6.2.1 for further details.	A	R: most estuaries
		Central	moderate	moderate	likely	<b>Physical disturbance</b> – moderate impacts likely due to direct removal of seagrass	A	R: most estuaries

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						wrack from living beds which has potential to impact living seagrass and associated biota. Impacts occur at a local scale. See section 6.2.1 for further details.		
	Clearing riparian and adjacent habitat including wetland drainage	North South	Moderate	moderate	likely	<b>Physical disturbance, changes to tidal flow velocity and patterns</b> – major impacts possible due to damage to habitat during removal and clearing, altering water tables and connectivity. Removal/clearing of adjacent habitats under current management is still likely, especially in rural catchments. See section 6.2.1 for further details.	A	R
		Central	Low	moderate	possible	<b>Physical disturbance, changes to tidal flow velocity and patterns</b> – moderate impacts possible due to damage to habitat during removal and clearing, altering water tables and connectivity. Removal/clearing of adjacent habitats under current management is still likely, especially in rural catchments. See section 6.2.1 for further details.	L	Estuaries with seagrass
	Agricultural diffuse source runoff	North South	High	major	almost certain	<b>Water pollution, sedimentation</b> – major impacts almost certain due to elevated nutrients, sediments, potential contaminants and turbidity, and sedimentation. See section 6.2.1 for further details.	A	R
		Central	moderate	moderate	almost certain	<b>Water pollution, sedimentation</b> – moderate impacts almost certain due to elevated nutrients, sediments, potential contaminants and turbidity, and sedimentation. See section 6.2.1 for further details.	A	R: Estuaries with seagrass and agriculture catchment, e.g. Hawkesbury, Hunter, Tuggerah, Lake Macquarie.
	Stock grazing of riparian and marine	All	High	Major	likely	<b>Physical disturbance, water pollution, sedimentation</b> – major impacts considered	A	R: all estuaries where grazing

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
	vegetation					likely from the physical disturbance from trampling and due to elevated nutrients, sediment / turbidity caused by stock grazing on adjacent riparian or marine vegetation. See section 6.2.1 for further details.		occurs
Point Discharges	Industrial discharges	Central	low	moderate	possible	<b>Water pollution</b> – moderate impacts considered possible due to elevated nutrients and sediments. Increased contaminant concentrations negatively impact biota. Only possible under current management. See section 6.2.2 for further details.	A	R: Estuaries with seagrass and either current or historical industrial discharges, e.g. Port Jackson, Lake Mac, Brisbane water, Botany Bay, Illawarra, coastal lagoons
	Thermal discharges	Central	high	major	almost certain	<b>Thermal pollution</b> - major impacts considered almost certain with <i>Zostera</i> killed by elevated water temperatures. Species richness impacts, associated biota impacts, but limited to local impacts. On-going discharges exist. See section 6.2.2 for further details.	A	L: Lake Mac, Port Jackson, Lake Illawarra
	Sewage effluent and septic runoff	All	moderate	major	possible	<b>Water pollution, microplastics</b> – major impacts from elevated nutrients, sediments and contaminants affect biota. Sewage runoff carries microplastics. Occurs primarily as overflows, with major impacts possible. See section 6.2.2 for further details.	L, I	R: All estuaries
Hydrologic Modifications	Estuary entrance modifications	All	high	major	likely	<b>Changes in tidal flow and patterns, changes to tidal prism</b> – major impacts likely due to changes in estuary water from estuarine/brackish to more marine. Results in increased frequency of inundation. Ongoing management allows openings and	A	R: Lake Mac, Tuggerah, Brisbane Waters, Botany Bay, Hacking, Illawarra, coastal lagoons and other

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						other modifications. See section 6.2.3 for further details.		regional estuaries.
<b>Climate change</b>	<b>20 Years</b> - See section 6.3.1 for further details on climate change							
	Ocean acidification	All	low	moderate	possible	<b>Increased acidity</b> - seagrass and associated organisms sensitive to pH changes. Large changes unlikely in time frame.	L	R
	Altered storm/cyclones	All	low	moderate	possible	<b>Physical disturbance</b> - sensitive to decreased salinity ( <i>Zostera</i> ), and wave action. However, large changes unlikely in time frame.	L	R
	Sea level rise	All	low	minor	almost certain	<b>Physical disturbance</b> - lower limit is determined by water depth and turbidity. Large changes unlikely in time frame.	A	R
	Flooding, storm surge, inundation	All	low	moderate	possible	<b>Physical disturbance</b> - increased turbidity, decreased water depth. Large changes unlikely in time frame.	L	R
<b>Climate change</b>	<b>50 Years</b>							
	Climate and sea temp rise	All	moderate	moderate	likely	<b>Elevated temperatures</b> - seagrass species likely to be sensitive to increases in temp. Moderate impacts likely in time frame.	I	R
	Ocean acidification	All	high	major	likely	<b>Increased acidity</b> - seagrass and associated organisms sensitive to pH changes. Major changes likely in time frame.	I	R
	Altered storm/cyclones	All	moderate	moderate	likely	<b>Physical disturbance</b> - sensitive to decreased salinity ( <i>Zostera</i> ) and increased wave action. Moderate impacts likely.	I	R
	Sea level rise	All	low	minor	likely	<b>Physical disturbance</b> - lower limit is determined by water depth and turbidity. Minor changes likely in time frame.	A	R
	Flooding, storm surge,	All	moderate	moderate	likely	<b>Physical disturbance</b> - increased turbidity,	L	R

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
	inundation					with sensitivity to decreased salinity ( <i>Zostera</i> ) and increased wave action. Moderate impacts likely in time frame.		

## Appendix C Environmental Risk Matrices and Evidence

## Beaches and mudflats

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
Shipping	Large commercial vessels and associated port activities and industries (trade ships, cruise ships)	Central	moderate	major	possible	<b>Water pollution, physical disturbance</b> - major impacts were considered possible due to potential oil spills and physical disturbance, the moderate resilience of the habitat, and the level of this activity in the identified ports. See section 6.1.1 for further details.	L	L: Main ports only
		South	low	minor	likely	<b>Water pollution, physical disturbance</b> - minor impacts were considered likely due to potential oil spills and physical disturbance, the moderate resilience of the habitat, and the level of this activity in the identified areas. See section 6.1.1 for further details.	L	L: principally Twofold Bay and Jervis Bay
	Small commercial vessels (ferries, charter boats)	Central	moderate	moderate	almost certain	<b>Physical disturbance</b> – moderate impact reflecting the impact of the physical disturbance from specific vessel traffic which results in erosion and community composition change from vessel wake. It was considered almost certain that this level of impact would occur from this activity at this local scale. See section 6.1.1 for further details.	A	L: Upper Parramatta River
		North South	low	minor	likely	<b>Physical disturbance</b> –minor impacts were considered possible due to physical disturbance and oil spills from vessel traffic. See section 6.1.1 for further details.	L	R
Commercial fishing	Estuary General	Central	low	moderate	possible	<b>Physical disturbance</b> - moderate impacts possible at local scale. See section 6.1.2 for further details.	I	L: Port Hacking

## Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
Recreational fishing	Shore-based line and trap fishing	All	low	minor	likely	<b>Physical disturbance</b> - minor impacts were considered possible due to trampling at a local scale. See section 6.1.4 for further details.	L	L
	Hand gathering	North Central	moderate	moderate	likely	<b>Physical disturbance</b> – moderate impacts were considered likely at a local scale from trampling during bait gathering, particularly of nippers. See section 6.1.4 for further details.	L	L
		South	low	moderate	possible	<b>Physical disturbance</b> –minor impacts were considered possible due to trampling at a local scale during bait gathering, particularly of nippers. See section 6.1.4 for further details.	L	L
Aquaculture	Oyster aquaculture	All	low	moderate	possible	<b>Physical disturbance</b> - impact was considered moderate reflecting the level of physical disturbance at specific sites. It was considered possible that this level of impact would occur from this activity due to the amount of activity in the identified estuaries. See section 6.1.7 for further details.	A	L: in estuaries where oyster aquaculture occurs.
Recreation and tourism	Boating and boating infrastructure	Central	high	major	almost certain	<b>Water pollution, physical disturbance, bank erosion, antifouling</b> - major impacts were considered from vessel traffic from defined stressors from the activity (e.g. physical disturbance, bank erosion, antifouling, fuel spills) and the moderate resilience of the habitat to these impacts. It was considered almost certain that this level of impact would occur from this activity at this local scale. See section 6.1.9 for further details.	A	L: Higher impacts in Hawkesbury, Georges, Lake Macquarie, Hunter River

## Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
		North South	moderate	moderate	likely	<b>Water pollution, physical disturbance, antifouling</b> - moderate impacts were considered from vessel traffic from defined stressors from the activity (e.g. physical disturbance, bank erosion, antifouling, fuel spills) and the moderate resilience of the habitat to these impacts. It was considered likely that this level of impact would occur from this activity at this local scale. See section 6.1.9 for further details.	A	R
	Four wheel driving	All	moderate	major	possible	<b>Physical disturbance</b> - impact was considered major, and this reflects the level of activity at a local level and low abundance and overall life-history and ecological characteristics of the species that are impacted from physical compaction and disturbance, and which have relatively moderate–low resilience. There is limited access to beach and mudflat areas for four wheel drives, although some illegal activity. It was considered possible that this level of impact would occur, but only at a local scale where the activity occurs. See section 6.1.9 for further details.	L	L
Dredging	Navigation & entrance management and modification, harbour maintenance etc.	All	moderate	moderate	likely	<b>Water pollution</b> – moderate impacts were considered likely due to sediment re-suspension from operations and dewatering in barges leading to turbidity and potential release of toxic contaminants. Also some physical disturbance as entrance dredging of wave dominated estuaries and artificial	L	L: Most large estuaries, particularly Hunter River and Botany Bay

## Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						opening of coastal lagoons changes habitats, exposes beaches and mudflats. See section 6.1.10 for further details.		
Modified freshwater flows	Extraction, artificial barriers to riverine and estuarine flow (e.g. dams, weirs, floodgates)	All	low	minor	likely	<b>Changes to tidal flow and patterns</b> – minor impacts were considered likely through changed water table and inundation regimes results in very broad overall impacts. See section 6.1.12 for further details.	L	R
Mining and extractive industries	Oil, gas, minerals, sand, aggregate, underground coal	Central	low	moderate	possible	<b>Physical disturbance</b> - moderate impacts considered possible at a local scale. See section 6.1.11 for further details.	L	L
Service infrastructure	Pipelines, cables, trenching and boring	Central	low	moderate	possible	<b>Physical disturbance, sedimentation and water pollution</b> – moderate impacts likely, but pulsed impacts at time of construction and mostly highly localised. See section 6.1.13 for further details.	L	L: Highly modified estuaries
<b>Land-based impacts</b>								
Land-use Intensification	Urban stormwater discharge	Central	high	major	almost certain	<b>Water pollution</b> – major impacts due to increased nutrients, contaminants and sediments and reduced salinities which impact biota. This level of impacts was considered almost certain to occur at a local scale. See section 6.2.1 for further details.	A	R: All estuaries with sandy/muddy shorelines
		North South	moderate	moderate	likely	<b>Water pollution</b> – moderate impacts likely due to increased nutrients, contaminants and sediments and reduced salinities which impact biota at a local scale. See section 6.2.1 for further details.	A	L
	Foreshore development	Central	high	major	almost certain	<b>Physical disturbance</b> – major impacts due to changed wave patterns damage habitat and alter grain size. Development of	A	R: all estuaries with sandy/muddy shorelines

Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						foreshore historically meant removing/infilling of habitat. Impacts almost certain under current management. See section 6.2.1 for further details.		
		North South	moderate	moderate	likely	<b>Physical disturbance</b> – moderate impacts were considered likely at a local scale due to changed wave patterns damage habitat and alter grain size. Impacts almost certain under current management. See section 6.2.1 for further details.	A	L: estuaries with developed foreshores
	Beach nourishment and grooming	All	moderate	moderate	likely	<b>Physical disturbance</b> - moderate impacts were considered likely at a local scale due to deposition of sediment on estuary beaches changing habitat structure. See section 6.2.1 for further details.	I,L	R (Central):: Tuggerah, Brisbane Water, Hawkes, Pitt, Port Jackson, Botany Bay, Hacking, Kembla, Illawarra, coastal lagoons. L: (North and South where activity occurs).
	Clearing riparian and adjacent habitat including wetland drainage	North	moderate	moderate	likely	<b>Changes to tidal flow velocity and patterns</b> – moderate impacts were considered likely due to altering water tables and connectivity. Removal/clearing of adjacent habitats under current management is still likely, especially in rural catchments. See section 6.2.1 for further details.	L	L
		Central South	low	minor	likely	<b>Changes to tidal flow velocity and patterns</b> – only minor impacts were considered likely due to altering water tables and connectivity. Removal/clearing of adjacent habitats under current management is still likely, especially in rural catchments. See section 6.2.1 for further details.	I	L: Estuaries with flats

## Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
	Agricultural diffuse source runoff	All	moderate	moderate	almost certain	<b>Water pollution</b> – moderate impacts due to elevated nutrients, sediments and potential contaminants. This level of impacts almost certain to occur. See section 6.2.1 for further details.	A	R: Estuaries with agriculture catchments
Point Discharges	Industrial discharges	Central	moderate	moderate	almost certain	<b>Water pollution</b> – moderate impacts possible due to elevated nutrients and sediments. Increased nutrient loads and contaminant concentrations negatively impact biota. This level of impact almost certain, with contribution from legacy pollution. See section 6.2.2 for further details.	L	Estuaries with industrial discharges and landuse, e.g. Hunter, Hawkes, Botany, Lake Mac.
	Thermal discharges	Central	low	minor	almost certain	<b>Thermal pollution</b> - minor impacts were considered almost certain due to elevated water temperatures. Associated biota impacts, but limited to local areas. On-going discharges exist. See section 6.2.2 for further details.	A	Lake Mac, Illawarra, Port Jackson
	Sewage effluent and septic runoff	North South	moderate	moderate	likely	<b>Water pollution</b> – moderate impacts from elevated nutrients, sediments and contaminants affect biota. Occurs primarily from septic runoff, although some local scale sewage, with moderate impacts likely in estuaries with high levels of septic. See section 6.2.2 for further details.	A	R
		Central	low	moderate	possible	<b>Water pollution</b> – moderate impacts from elevated nutrients, sediments and contaminants affect biota, Sewage runoff carries microplastics. Occurs primarily as overflows, with major impacts unlikely to occur. See section 6.2.2 for further details.	A	L: Lake Macquarie, Hawkesbury, Hunter,
Hydrologic Modifications	Estuary entrance modifications	All	moderate	moderate	almost certain	<b>Changes in tidal flow and patterns, changes to tidal prism</b> – moderate impacts	L	R: Hunter, Tuggerah, Illawarra

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						considered almost certain due to changes in estuary water from estuarine/brackish to more marine. Results in increased frequency of inundation. Ongoing management allows openings and other modifications. Tidal prism is impacted, changes water quality, impacts habitat and altered current dynamics modify beach characteristics. See section 6.2.3 for further details.		
<b>Climate change</b>	<b>20 Years</b> - See section 6.3.1 for further details on climate change							
	Climate and sea temp. rise	All	low	moderate	possible	<b>Elevated temperatures</b> - species resilient to increases in maximum temp. Altering key species thresholds.	L	R
	Ocean acidification	All	low	moderate	possible	<b>Increased acidity</b> - molluscs sensitive to pH changes. Bivalves and calcifying organisms are most vulnerable.	I	R
	Sea level rise	All	low	minor	likely	<b>Physical disturbance</b> - some impact if intertidal flats become submerged.	A	R
	Flooding, storm surge, inundation	All	low	minor	likely	<b>Physical disturbance</b> - likely to have higher levels of disturbance, particularly in conjunction with higher sea levels, with minor impacts likely to occur.	I	R
<b>Climate change</b>	<b>50 Years</b>							
	Climate and sea temp. rise	All	moderate	moderate	likely	<b>Elevated temperatures</b> - temperature increases expected to be greater with more effect on beach biota, and moderate impacts likely.	I	R
	Ocean acidification	All	high	major	likely	<b>Increased acidity</b> - larger pH changes may affect sensitive organisms such as echinoderms and molluscs, with major impacts likely.	L	R

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
	Altered storm/cyclone activity	All	low	minor	likely	<b>Physical disturbance</b> -beaches with limited capacity to move due to infrastructure etc., so minor impacts are likely.	I	R
	Sea level rise	All	low	minor	likely	<b>Physical disturbance</b> - some impact if intertidal flats become submerged, with minor impacts likely.	A	R
	Flooding, storm surge, inundation	All	low	minor	likely	<b>Physical disturbance</b> - likely to have higher levels of disturbance, particularly in conjunction with higher sea levels, with minor impacts likely to occur.	I	R

## Appendix C Environmental Risk Matrices and Evidence

## Subtidal (Shallow) soft sediments

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
Shipping	Large commercial vessels and associated port activities and industries (trade ships, cruise ships)	Central	low	moderate	possible	<b>Water pollution, physical disturbance</b> - moderate impacts were considered possible due to potential oil spills and physical disturbance, including sediment resuspension and the moderate resilience of the habitat, and the level of this activity in the identified ports. See section 6.1.1 for further details.	L	L: Main ports only: Sydney Harbour, Botany Bay and Port Kembla
	Small commercial vessels (ferries, charter boats)	Central	moderate	moderate	likely	<b>Water pollution, physical disturbance</b> - moderate impacts were considered likely due to potential oil spills and physical disturbance, including sediment resuspension and the moderate resilience of the habitat, and the level of this activity in the identified areas. See section 6.1.1 for further details.	L	L: principally Sydney Harbour, Hawkesbury
		North South	low	minor	likely	<b>Water pollution, physical disturbance</b> - minor impacts were considered possible due to potential oil spills and physical disturbance, including sediment resuspension and the level of this activity in the identified areas. See section 6.1.1 for further details.	L	L: principally in estuaries where commercial fishing occurs
Commercial fishing	Estuary General	All	low	moderate	possible	<b>Physical disturbance</b> - moderate impacts were considered possible due to physical disturbance, including sediment resuspension and the moderate resilience of the habitat, and the level of this activity. See section 6.1.2 for further details.	L	L: In estuaries where commercial fishing occurs
	Estuary Prawn Trawl	North	Low	minor	likely	<b>Physical disturbance</b> –minor impacts	L	L: North:

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
		Central				were considered likely due to physical disturbance, including sediment resuspension and the moderate resilience of the habitat, and the level of this activity. See section 6.1.2 for further details.		Clarence River and Lake Wooloweyah only. Central: Hunter and Hawkesbury
Recreational fishing	Shore-based line and trap fishing	All	low	minor	likely	<b>Physical disturbance</b> - minor impacts were considered likely at a local scale. See section 6.1.4 for further details.	L	R
	Boat-based line and trap fishing	All	low	minor	likely	<b>Physical disturbance</b> - minor impacts were considered likely at a local scale. See section 6.1.4 for further details.	L	R – Central, L – North, south
	Fish stocking	South	low	minor	likely	<b>Physical disturbance</b> –minor impacts were considered likely at a local scale. See section 6.1.4 for further details.	L	L
Recreation and tourism	Boating and boating infrastructure	Central	high	major	likely	<b>Water pollution, physical disturbance, antifouling</b> - major impacts were considered likely from vessel traffic from defined stressors from the activity (e.g. anchoring, moorings, antifouling, fuel spills) and the moderate resilience of the habitat to these impact, but low resilience of some components (e.g. sponges). See section 6.1.9 for further details.	A	R: All estuaries, but particularly Lake Macquarie, Hawkesbury River, Sydney Harbour, Port Hacking
		North South	moderate	moderate	likely	<b>Water pollution, physical disturbance, antifouling</b> - major impacts were considered from vessel traffic from defined stressors from the activity (e.g. anchoring, moorings, antifouling, fuel spills) and the moderate resilience of the habitat to these impact, but low resilience of some components (e.g. soft corals and sponges). It was considered likely that this level of impact would occur from this	L	R – Most estuaries

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						activity at this local scale. See section 6.1.9 for further details.		
Dredging	Navigation & entrance management, modification and maintenance etc.	All	high	major	likely	<b>Water pollution, physical disturbance</b> – major impacts were considered likely due to sediment re-suspension from operations and dewatering in barges leading to turbidity and potential release of toxic contaminants. Physical disturbances and removal in generally small areas for discrete projects such as jetties, marinas. Likely to occur at a local scale. See section 6.1.10 for further details.	A	L: Wherever dredging occurs
Mining and extractive industries	Oil, gas, minerals, sand, aggregate, underground coal	Central	low	minor	likely	<b>Physical disturbance</b> – minor impacts considered likely at a local scale. See section 6.1.11 for further details.	L	L
Service infrastructure	Pipelines, cables, trenching and boring	Central	low	minor	likely	<b>Physical disturbance, sedimentation and water pollution</b> – moderate impacts likely, but pulsed impacts at time of construction and mostly highly localised. See section 6.1.13 for further details.	A	L: Modified estuaries only
<b>Land-based impacts</b>								
Landuse Intensification	Urban stormwater discharge	Central	high	major	likely	<b>Water pollution</b> – major impacts due to increased nutrients, contaminants and sediments and reduced salinities which impact biota. This level of impacts was considered likely to occur at a local scale. See section 6.2.1 for further details.	A	R: All estuaries in urban areas
		North South	moderate	moderate	likely	<b>Water pollution</b> – moderate impacts likely due to increased nutrients, contaminants and sediments and reduced salinities which impact biota at a local scale. See section 6.2.1 for further details.	A	L

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
	Foreshore development	Central	high	major	likely	<b>Physical disturbance</b> – major impacts due to changed wave patterns damage habitat and alter grain size. Development of foreshore historically meant removing/infilling of habitat. Impacts likely under current management. See section 6.2.1 for further details.	A	L: All estuaries with urban development
		North South	low	minor	likely	<b>Physical disturbance</b> – only minor impacts were considered likely at a local scale due to changed wave patterns damage habitat and alter grain size. Impacts almost certain under current management. See section 6.2.1 for further details.	A	L
	Beach nourishment and grooming	All	low	moderate	possible	<b>Physical disturbance</b> - moderate impacts were considered possible at a local scale due to deposition of sediment in estuary changing habitat structure. See section 6.2.1 for further details.	A	R: all estuaries with urban development
	Clearing riparian and adjacent habitat including wetland drainage	North South	moderate	moderate	likely	<b>Changes to tidal flow velocity and patterns</b> – moderate impacts were considered likely due to altering water tables and connectivity, with impacts local, especially in rural catchments. See section 6.2.1 for further details.	A	L
		Central	low	moderate	possible	<b>Changes to tidal flow velocity and patterns</b> – moderate impacts were considered likely due to altering water tables and connectivity, with impacts local, especially in rural catchments. See section 6.2.1 for further details.	I	All estuaries with developed shorelines
	Agricultural diffuse source runoff	North South	high	major	likely	<b>Water pollution</b> – moderate impacts due to elevated nutrients, sediments and potential contaminants. This level of impacts almost certain to occur. See section 6.2.1 for further	A	R

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						details.		
		Central	moderate	major	possible	Enriches natural habitats in systems with nutrients, organic carbon from agricultural catchments. Agricultural runoff delivers nutrient enriched sediment, with major impacts considered possible. See section 6.2.1 for further details.	A	R: Hawkesbury, Hunter, Macquarie, Tuggerah
Point Discharges	Industrial discharges	Central	moderate	major	possible	<b>Water pollution</b> – major impacts were considered possible due to elevated nutrients and sediments. Increased nutrient loads and contaminant concentrations negatively impact biota. Some contribution from legacy pollution. See section 6.2.2 for further details.	A	L: Sydney Harbour, Hunter, Port Kembla
	Thermal discharges	Central	low	moderate	possible	<b>Thermal pollution</b> – moderate impacts considered possible on associated biota, but limited to local areas. On-going discharges exist. See section 6.2.2 for further details.	A	L: Macquarie, Illawarra
	Sewage effluent and septic runoff	All	moderate	major	possible	<b>Water pollution</b> – major impacts from elevated nutrients, sediments and contaminants affect biota. Occurs primarily from septic runoff, although some local scale sewage, with moderate impacts likely in estuaries with high levels of septic. See section 6.2.2 for further details.	I	Hawkesbury Coastal Lagoons,
Hydrologic Modifications	Estuary entrance modification	All	moderate	moderate	almost certain	<b>Changes in tidal flow and patterns, changes to tidal prism</b> – moderate impacts considered almost certain due to changes in estuary water from estuarine/brackish to more marine. Results in increased frequency of inundation. Ongoing management allows openings and other modifications. Tidal prism is impacted, changes water quality,	A	L: Estuaries where dredging occurs, where shoreline development occurs

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						impacts habitat and alters currents. See section 6.2.3 for further details.		
<b>Climate change</b>	<b>50 Years</b> - See section 6.3.1 for further details on climate change							
	Climate and sea temp rise	All	low	minor	likely	<b>Elevated temperatures</b> - temperature increases expected to be greater with more effect on soft sediment biota, with minor impacts likely.	I	R
	Ocean acidification	All	high	major	likely	<b>Increased acidity</b> - larger pH changes may affect sensitive organisms such as echinoderms and molluscs, with major impacts likely.	I	R
	Sea level rise	All	low	minor	almost certain	<b>Physical disturbance</b> - some shallow soft sediment habitat may be lost due to changes in adjacent nearshore beach morphology, hence minor impacts are almost certain.	A	R

## Appendix C Environmental Risk Matrices and Evidence

## Rocky shores

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
Shipping	Large commercial vessels and associated port activities and industries (trade ships, cruise ships)	Central	moderate	major	possible	<b>Water pollution, physical disturbance</b> - major impacts were considered possible due to potential oil spills, the low resilience of the habitat to these impacts and the level of this activity in the identified ports. See section 6.1.1 for further details.	L	L: Main ports only
		South	low	minor	likely	<b>Water pollution, physical disturbance</b> - minor impacts were considered likely due to potential oil spills, and the level of this activity in the ports. See section 6.1.1 for further details.	L	L: Main port areas only
	Small commercial vessels (ferries, charter boats)	Central South	low	moderate	possible	<b>Water pollution, physical disturbance</b> - moderate impacts were considered possible due to potential oil spills and physical disturbance, the low resilience of the habitat, and the level of this activity in the identified areas. See section 6.1.1 for further details.	L	L: Several large estuaries, particularly Botany Bay, Sydney Harbour, Hawkesbury River
Recreational fishing	Shore-based line and trap fishing	All	low	minor	likely	<b>Physical disturbance, marine debris</b> - minor impacts were considered likely due to trampling at a local scale. See section 6.1.4 for further details.	L	R
	Hand gathering	Central South	low	moderate	possible	<b>Physical disturbance</b> – moderate impacts were considered possible at a local scale from trampling during bait gathering. See section 6.1.4 for further details.	L	R
Aquaculture	Oyster aquaculture	All	low	minor	likely	<b>Physical disturbance</b> - impact was considered only minor reflecting the level of physical disturbance at specific sites. It	A	L

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						was considered likely that this level of impact would occur from this activity due to the amount of activity in the estuaries where aquaculture occurs. See section 6.1.7 for further details.		
Recreation and tourism	Boating and boating infrastructure	Central	moderate	moderate	likely	<b>Water pollution, physical disturbance</b> - moderate impacts were considered likely from vessel traffic from defined stressors from the activity (e.g., physical disturbance through infrastructure, fuel spills) and the low resilience of components of the habitat to these impacts. See section 6.1.9 for further details.	L	R: All estuaries, but particularly Lake Macquarie, Hawkesbury River, Sydney Harbour, Port Hacking
		North South	low	minor	likely	<b>Water pollution, physical disturbance</b> - minor impacts were considered likely from vessel traffic from defined stressors from the activity (e.g., physical disturbance through infrastructure, fuel spills). See section 6.1.9 for further details.	L	R: All estuaries where boating and related infrastructure occurs
Modified freshwater flows	Extraction, artificial barriers to riverine and estuarine flow (e.g. dams, floodgates)	All	low	minor	likely	<b>Changes to tidal flow and patterns</b> – minor impacts were considered likely through changed water table and inundation regimes results in broad impacts. See section 6.1.12 for further details.	L	R
Mining and extractive industries	Oil, gas, minerals, sand, aggregate, underground coal	Central	low	minor	likely	<b>Physical disturbance</b> - minor impacts considered likely at a local scale. None present, but minor impacts likely over timeframe. See section 6.1.11 for further details.	L	L
<b>Land-based impacts</b>								

## Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
Landuse Intensification	Urban stormwater discharge	Central	high	major	likely	<b>Water pollution</b> – moderate impacts due to increased nutrients, contaminants and sediments and reduced salinities which impact biota. This level of impact was considered almost certain to occur. See section 6.2.1 for further details.	I	L: Limited to estuaries with sizeable rocky shore habitats.
		North South	low	minor	likely	<b>Water pollution</b> – minor impacts due to increased nutrients, contaminants and sediments and reduced salinities which impact biota. This level of impact was considered likely to occur. See section 6.2.1 for further details.	I	L: Limited to estuaries with sizeable rocky shore habitats.
	Foreshore development	Central	moderate	moderate	likely	<b>Physical disturbance</b> – moderate impacts were at a local scale as development on rocky shores always results in habitat alteration. Limited current management due to land tenures, so this level of impact is likely. See section 6.2.1 for further details.	L	L: Limited to estuaries with sizeable rocky shore habitats where development has occurred
	Clearing riparian and adjacent habitat including wetland drainage	Central	low	minor	likely	<b>Changes to tidal flow velocity and patterns</b> – minor impacts were considered likely due to altering water tables and connectivity. Removal/clearing of adjacent habitats under current management is still likely, especially in rural catchments. See section 6.2.1 for further details.	L	R
	Agricultural diffuse source runoff	Central	low	moderate	possible	<b>Water pollution</b> – moderate impacts due to elevated nutrients, sediments and potential contaminants. This level of impact was considered possible to occur. See section 6.2.1 for further details.	I	L: Hunter, Hawkes, Macquarie, Illawarra
Point Discharges	Industrial discharges	Central	low	major	unlikely	<b>Water pollution</b> – major impacts due to increased nutrient loads and contaminant concentrations negatively impact biota. Considered unlikely under current	I	L: All with industrial inputs

## Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						management. See section 6.2.2 for further details.		
	Thermal discharges	Central	low	minor	likely	<b>Thermal pollution</b> –minor impacts were considered likely due to elevated water temperatures and associated biota impacts. See section 6.2.2 for further details.	L	L: Macquarie, Illawarra
	Sewage effluent and septic runoff	Central South	low	moderate	possible	<b>Water pollution</b> – moderate impacts from elevated nutrients, sediments and contaminants affect biota. Occurs primarily from septic runoff, although some local scale sewage, with moderate impacts possible in estuaries with high levels of septic. See section 6.2.2 for further details.	I	L: Limited to estuaries where sewer overflows discharge over rocky shores, e.g. Lake Macquarie
Hydrologic Modifications	Estuary entrance modifications	All	low	minor	likely	<b>Changes in tidal flow and patterns, changes to tidal prism</b> –minor impacts considered likely due to changes in estuary water from estuarine/brackish to more marine. Results in increased frequency of inundation. Ongoing management allows openings and other modifications. Tidal prism is impacted, changes water quality. See section 6.2.3 for further details.	L	R
<b>Climate change</b>	<b>20 years</b> - See section 6.3.1 for further details on climate change							
	Ocean acidification	All	low	moderate	possible	<b>Increased acidity</b> - bivalves and calcifying organisms are most vulnerable.	I	R
	Sea level rise	All	low	minor	likely	<b>Physical disturbance</b> - assumes most organisms can move up the shore, but minor impacts likely.	A	R
<b>Climate change</b>	<b>50 years</b>							
	Climate and sea temperature rise	All	low	minor	likely	<b>Elevated temperatures</b> - temperature increases expected to be greater with more effect on rocky shore biota, and minor	L	R

Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						impacts likely.		
	Ocean acidification	All	high	major	likely	<b>Increased acidity</b> -larger pH changes may affect sensitive organisms such as echinoderms and molluscs, with major impacts likely.	L	R
	Altered storm/cyclone activity	All	low	minor	likely	<b>Physical disturbance</b> - rocky shore biota with limited capacity to move due to infrastructure etc., so minor impacts are possible.	I	R
	Sea level rise	All	low	minor	almost certain	<b>Physical disturbance</b> - sea level rise could change depths over rocky reefs in estuaries.	L	R
	Flooding, storm surge, inundation	All	low	minor	likely	<b>Physical disturbance</b> - likely to have higher levels of disturbance, particularly in conjunction with higher sea levels, with minor impacts likely to occur.	I	R

## Appendix C Environmental Risk Matrices and Evidence

## Subtidal reefs

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
Shipping	Large commercial vessels and associated port activities and industries (trade ships, cruise ships)	Central South	low	minor	likely	<b>Water pollution, physical disturbance</b> –minor impacts were considered likely due to potential oil spills and physical disturbance, including sediment resuspension and the moderate resilience of the habitat, and the level of this activity in the identified ports. See section 6.1.1 for further details.	L	L: Main ports only, but particularly Botany Bay and Sydney Harbour, and Jervis Bay and Twofold Bay
	Small commercial vessels (ferries, charter boats)	Central South	low	minor	likely	<b>Water pollution, physical disturbance</b> –minor impacts were considered likely due to potential oil spills and physical disturbance, including sediment resuspension and the moderate resilience of the habitat, and the level of this activity in the identified areas. See section 6.1.1 for further details.	L	L: Several large estuaries, particularly Sydney Harbour and Hawkesbury River
Recreational fishing	Shore-based line and trap fishing	All	low	minor	likely	<b>Marine debris</b> - minor impacts were considered likely due to marine debris at a local scale. See section 6.1.4 for further details.	L	L
	Boat-based line and trap fishing	All	low	minor	likely	<b>Physical disturbance, marine debris</b> - minor impacts were considered likely due to anchoring and marine debris at a local scale. See section 6.1.4 for further details.	L	R
Charter fishing	Line fishing	Central South	low	minor	likely	<b>Physical disturbance</b> –minor impacts were considered likely to occur from this activity at a local scale, principally related to anchor damage on this habitat at a local scale. See section 6.1.3 for further details.	L	L

## Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
Recreation and tourism	Boating and boating infrastructure	Central	moderate	moderate	likely	<b>Water pollution, physical disturbance</b> - moderate impacts were considered likely from vessel traffic from defined stressors from the activity (e.g. physical disturbance through infrastructure and anchoring, and contamination from fuel spills) and the moderate resilience of components of the habitat to these impacts. See section 6.1.9 for further details.	I	L: Several large estuaries, particularly Sydney Harbour and Hawkesbury River
		North South	low	minor	likely	<b>Water pollution, physical disturbance</b> –minor impacts were considered likely from vessel traffic from defined stressors from the activity (e.g., physical disturbance through infrastructure, fuel spills) and the moderate resilience of components of the habitat to these impacts. See section 6.1.9 for further details.	A	L
	Snorkelling and diving and other passive recreational use	North South	low	minor	likely	<b>Physical disturbance</b> –minor impacts were considered likely from physical disturbance and the moderate resilience of components of the habitat to these impacts. See section 6.1.9 for further details.	L	L
Dredging	Navigation & entrance management and modification, harbour maintenance etc.	All	low	minor	likely	<b>Water pollution, physical disturbance</b> –minor impacts were considered likely due to sediment re-suspension from operations and dewatering in barges leading to turbidity and potential release of toxic contaminants. Physical disturbances and removal in generally small areas for discrete projects such as jetties, marinas. Likely to occur at a local	A	L: Wherever dredging occurs

Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						scale. See section 6.1.10 for further details.		
Modified freshwater flows	Extraction, artificial barriers to riverine and estuarine flow (e.g. dams, weirs, floodgates)	All	low	minor	likely	<b>Changes to tidal flow and patterns</b> – only impacts were considered likely through changed water table and inundation regimes. See section 6.1.12 for further details.	L	R
Mining and extractive industries	Oil, gas, minerals, sand, aggregate, coal	Central	low	minor	likely	<b>Physical disturbance</b> - minor impacts considered likely at a local scale. None present, but minor impacts likely over timeframe. See section 6.1.11 for further details.	L	L
<b>Land-based impacts</b>								
Landuse Intensification	Urban stormwater discharge	Central	high	major	possible	<b>Water pollution</b> – major impacts due to increased nutrients, contaminants and sediments and reduced salinities which impact biota. This level of impact was considered to be possible. See section 6.2.1 for further details.	L	L: Port Hacking, Lake Macquarie, Hawkesbury, Pittwater, Port Jackson
		North South	low	minor	likely	<b>Water pollution</b> –minor impacts considered likely due to increased nutrients, contaminants and sediments and reduced salinities which impact biota. See section 6.2.1 for further details.	L	L:
	Clearing riparian and adjacent habitat including wetland drainage	North South	low	minor	likely	<b>Changes to tidal flow velocity and patterns</b> –minor impacts were considered likely due to altering water tables and connectivity. Removal/clearing of adjacent habitats under current management is still likely, especially in rural catchments. See section 6.2.1 for further details.	L	L:

## Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
	Agricultural diffuse source runoff	All	low	moderate	possible	<b>Water pollution</b> – moderate impacts due to elevated nutrients, sediments and potential contaminants. This level of impact was considered possible to occur. See section 6.2.1 for further details.	L	R: Estuaries with agriculture in catchment
Point Discharges	Thermal discharges	Central	low	minor	likely	<b>Thermal pollution</b> – minor impacts were considered likely due to elevated water temperatures and associated biota impacts. See section 6.2.2 for further details.	L	L:
	Sewage effluent and septic runoff	All	low	moderate	possible	<b>Water pollution</b> – moderate impacts from elevated nutrients, sediments and contaminants affect biota. Occurs primarily from septic runoff, although some local scale sewage, with moderate impacts possible in estuaries with high levels of septic. See section 6.2.2 for further details.	L	L
Hydrologic Modifications	Estuary entrance modification	All	low	minor	likely	<b>Changes in tidal flow and patterns, changes to tidal prism</b> – only minor impacts considered likely due to changes in estuary water from estuarine/brackish to more marine. Results in increased frequency of inundation. Ongoing management allows openings and other modifications. Tidal prism is impacted, changes water quality. See section 6.2.3 for further details.	L	L
<b>Climate change</b>	<b>20 Years</b> - See section 6.3.1 for further details on climate change							
	Climate and sea temp rise	All	low	minor	likely	<b>Elevated temperatures</b> - temperature increases expected to be greater with more effect on rocky shore biota, and minor impacts likely.	L	R

Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
<b>Climate change</b>	<b>50 Years</b> - See section 6.3.1 for further details on climate change							
	Altered ocean currents and nutrient inputs	All	low	minor	likely	<b>Nutrient changes</b> - changes to primary production associated with increased intensity of the EAC. This could lead to changes in upwelling regimes and either increases or decreases in nutrient concentrations and ratios, with minor impacts likely.	L	R
	Climate and sea temp rise	All	moderate	moderate	likely	<b>Elevated temperatures</b> - temperature increases expected to be greater with more effect on rocky shore biota, and moderate impacts likely.	L	R
	Ocean acidification	All	high	major	likely	<b>Increased acidity</b> - larger pH changes may affect sensitive organisms such as echinoderms and molluscs, with major impacts likely.	I	R
	Sea level rise	All	low	minor	almost certain	<b>Physical disturbance</b> - sea level rise could change depths over rocky reefs in estuaries, with minor impacts almost certain.	L	R
	Altered storm/cyclones	All	moderate	moderate	likely	<b>Physical disturbance</b> - sensitive to disturbance and increased wave action. Moderate impacts likely in time frame.	I	R

## Appendix C Environmental Risk Matrices and Evidence

## Planktonic assemblages

Resource use	Activity	Region	Risk level	Conseq	Likelihood	Key stressors	Confidence A: adequate L: limited I: inferred	Spatial extent L: local R: regional
Shipping	Large commercial vessels and associated port activities and industries (trade ships, cruise ships)	Central	low	moderate	possible	<b>Antifouling paints, water pollution</b> - moderate impacts were considered possible due to the defined stressors, including oil spills, and level of large shipping activity in the region. See section 6.1.1 for further details.	A	L: Main ports only: Sydney Harbour, Botany Bay and Port Kembla
	Small commercial vessels (ferries, charter boats)	Central	low	moderate	possible	<b>Water pollution, physical disturbance</b> - moderate impacts were considered possible due to oil spill and physical disturbance reflecting the level of this activity in several local areas. See section 6.1.1 for further details.	A	L: Main estuaries where small commercial vessels occur.
Recreation and tourism	Boating and boating infrastructure	All	low	minor	likely	<b>Antifouling paints and oil spills</b> –minor impacts considered likely due to stressors, including oil spills from boating activity and moored vessels. See section 6.1.9 for further details.	A	L: Localised - marinas
Dredging	Navigation & entrance management and modif. and maintenance	All	moderate	moderate	likely	<b>Water pollution</b> – moderate impacts likely due to sediment re-suspension from operations and dewatering in barges leading to turbidity and potential toxin release, with impacts at a local scale. See section 6.1.10 for further details.	A	L: Wherever dredging occurs
Modified freshwater flows	Extraction, artificial barriers to riverine and estuarine flow (e.g. dams, weirs, waterway crossings)	All	moderate	moderate	possible	<b>Water pollution</b> – moderate impacts considered possible to occur from acid sulfate soils leaching and reducing pH. See section 6.1.12 for further details.	L	L: Hunter, Clarence, Richmond
Mining and extractive industries	Oil, gas, minerals, sand, aggregate, underground coal	Central	low	minor	likely	<b>Water pollution</b> - moderate impacts possible due to suspended sediments, but none at present. See section 6.1.11 for further details.	L	L

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
<b>Land-based impacts</b>								
Landuse Intensification	Urban stormwater discharge	North South	moderate	moderate	likely	<b>Water pollution, marine debris, microplastics</b> – moderate impacts likely from combined stressors of toxic contaminants, nutrients, suspended sediments, marine debris and microplastics. Nutrients are present as bioavailable dissolved inorganic forms. See section 6.2.1 for further details.	A	R
		Central	high	moderate	almost certain	<b>Water pollution, marine debris (including microplastics)</b> – moderate impacts almost certain from combined stressors of toxic contaminants, nutrients, suspended sediments, marine debris and microplastics. Nutrients are present as bioavailable dissolved inorganic forms. See section 6.2.1 for further details.	A	R: All estuaries
	Clearing riparian and adjacent habitat including wetland drainage	All	moderate	moderate	likely	<b>Water pollution</b> – moderate impacts considered likely from clearing and draining which leads to acid runoff and blackwater events after floods. Moderate impacts likely to occur, although local impacts isolated to affected areas only. See section 6.2.1 for further details.	A	Hunter, Hawkes, Port Jackson, Botany Bay, Lake Illawarra, Coastal lagoons
	Agricultural diffuse source runoff	North South	high	moderate	almost certain	<b>Water pollution</b> - moderate impacts almost certain from combined stressors of nutrients, suspended sediments, and potentially toxic contaminants. See section 6.2.1 for further details.	A	R: all estuaries with agriculture in catchment
Central		moderate	moderate	likely	<b>Water pollution</b> - moderate impacts considered likely from combined stressors of nutrients, suspended sediments, and potentially toxic contaminants. See section	A	Restricted to estuaries with agricultural catchments. E.g.	

## Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						6.2.1 for further details.		Hawkes, Hunter, Tuggerah, Macquarie.
	Stock grazing of riparian and marine vegetation	All	low	minor	likely	<b>Water pollution</b> – minor impacts considered likely from the water pollution resulting from trampling and grazing and nutrients via defecation. See section 6.2.1 for further details.	A	R: all estuaries where grazing occurs
Point Discharges	Industrial discharges	Central	moderate	moderate	likely	<b>Water pollution</b> - minor impacts likely from combined stressors of nutrients, and potentially toxic contaminants and a highly localised scale. See section 6.2.2 for further details.	A	L: Estuaries with industrial discharges and industrial landuse, e.g. Hunter, Lake Macquarie, Hawkes, Port Jackson, Port Kembla.
	Thermal discharges	Central	high	major	likely	<b>Thermal pollution</b> - major impacts likely from elevated water temperature and changing dissolved oxygen within the affected system. See section 6.2.2 for further details.	A	L: Lake Mac, Tugg, Lake Illawarra
	Sewage effluent and septic runoff	All	moderate	moderate	likely	<b>Water pollution</b> - moderate impacts likely from combined stressors of nutrients, suspended sediments, and potentially toxic contaminants, with risk elevated from septic runoff compared to sewage discharge. See section 6.2.2 for further details.	A	R: Hunter River, Lake Mac, Tuggerah, Hawkes
Hydrologic Modifications	Estuary entrance modification	All	moderate	moderate	almost certain	<b>Changes in tidal flow and tidal prism</b> - moderate impacts almost certain to occur from changes in tidal height, residence times, and volumes of freshwater inflowing impacts salinity and inundation. Secondary impacts on water quality. See section 6.2.3	A	R: Lake Mac, Hawkes, Hunter, Tuggerah, Lake Illawarra, coastal lagoons

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						for further details.		
<b>Climate change</b>	<b>20 Years</b> - See section 6.3.1 for further details on climate change							
	Ocean acidification	All	moderate	moderate	likely	<b>Increased acidity</b> - only small pH changes in short time frame, with colicophores, pteropods are vulnerable. Moderate impacts likely.	I	R
	Altered ocean currents and nutrient inputs	North	low	minor	likely	<b>Nutrient changes</b> - changes to primary production associated with increased intensity of the EAC. This could lead to changes in upwelling regimes and either increases or decreases in nutrient concentrations and ratios, with minor impacts likely.	I	R
<b>Climate change</b>	<b>50 Years</b>							
Climate change	Altered ocean currents & nutrient inputs	All	moderate	moderate	likely	<b>Nutrient changes</b> - changes to primary production associated with increased intensity of the EAC. This could lead to changes in upwelling regimes and either increases or decreases in nutrient concentrations and ratios, with moderate impacts likely.	I	R
	Climate and sea temperature rise	All	low	moderate	possible	<b>Elevated temperatures</b> - larger temperature increases affect biota, with moderate impacts possible.	I	R
	Ocean acidification	All	high	major	likely	<b>Increased acidity</b> - larger pH changes will occur, with calcifying organisms vulnerable, and major impacts likely.	I	R

Appendix C Environmental Risk Matrices and Evidence

Fish assemblages

Resource use	Activity	Region	Risk level	Conseq	Likelihood	Key stressors	Confidence A: adequate L: limited I: inferred	Spatial extent L: local R: regional
Commercial fishing	Estuary General (EG)	North	High But contested by DPI to moderate	major	likely	<p><b>Reduction in abundances of species and trophic levels</b> – approx. 65% of recent statewide landings taken from this region, dominated by three species which makes up approx. 60% of landings, are primarily commercially taken in the EG fishery, resulting in a major consequence arising from harvest that is likely to occur. Overall, recent landings are dominated by five fully fished and five uncertain/undefined species in the top ten, and have intermediate or higher risk as defined in the EG Environmental Impact Study (EIS).</p> <p>Fully fished:</p> <ul style="list-style-type: none"> <li>• Sea mullet (Intermediate)</li> <li>• Luderick (Intermediate)</li> <li>• Yellowfin bream (Intermediate)</li> <li>• School prawn (Intermediate)</li> <li>• Sand whiting (Intermediate)</li> </ul> <p>Uncertain/undefined:</p> <ul style="list-style-type: none"> <li>• Giant mud crab (Intermediate)</li> <li>• Blue swimmer crab (Intermediate)</li> <li>• Dusky flathead (Intermediate)</li> <li>• River eels (Intermediate)</li> <li>• Catfish (Intermediate)</li> </ul> <p><b>Bycatch</b> – risks from bycatch of fish assemblages associated with the EG fishery is considered to be moderate as</p>	L	R: in large number of estuaries in the region, but risk will vary depending on estuary characteristics and fishing pressure.

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						negative impacts on bycatch assemblages are evident, however, the level of impact has not influenced their overall recovery capacity, and a change in the overall trophic / community structure is not evident in most of the estuaries. See section 6.1.2 for further details.		
		Central	moderate	moderate	likely	<p><b>Reduction in abundances of species and trophic levels</b> – approx. 27% of recent statewide landings taken from this region, dominated by five species which makes up approx. 80% of landings, are primarily commercially taken in the EG fishery, resulting in a moderate consequence arising from harvest that is likely to occur. Overall, recent landings are dominated by five fully fished and five uncertain/ undefined species in the top ten, and have intermediate or higher risk as defined in the EG EIS.</p> <p>Fully fished:</p> <ul style="list-style-type: none"> <li>• Sea mullet (Intermediate)</li> <li>• Luderick (Intermediate)</li> <li>• Yellowfin bream (Intermediate)</li> <li>• School prawn (Intermediate)</li> <li>• Sand whiting (Intermediate)</li> </ul> <p>Uncertain/undefined:</p> <ul style="list-style-type: none"> <li>• Common silverbidy (Intermediate)</li> <li>• Blue swimmer crab (Intermediate)</li> <li>• Dusky flathead (Intermediate)</li> <li>• River eels (Intermediate)</li> </ul>	L	L: In estuaries where commercial fishing occurs

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						<ul style="list-style-type: none"> <li>Whitebait (Unknown)</li> </ul> <p>In addition, Mulloway is a key secondary species in the EG fishery and identified as recruitment overfished (H). Harvest of nippers in Port Hacking was also identified as a low level of impact, although their undefined status identifies that the effect of harvest of these species, particularly at a local scale is unknown. <b>Bycatch</b> – risks from bycatch of fish assemblages associated with the EG fishery is considered to be moderate as negative impacts on bycatch assemblages are evident, however, the level of impact has not influenced their overall recovery capacity, and a change in the overall trophic / community structure is not evident in most of the estuaries. See section 6.1.2 for further details</p>		
		South	High But contested by DPI to moderate	major	likely	<p><b>Reduction in abundances of species and trophic levels</b> – harvest in this region is considerably lower at approx. 8% of recent statewide landings, and principally from one estuary dominated by three species which makes up approx. 60% of landings, and are primarily commercially taken in the EG fishery, resulting in a major consequence arising from harvest that is likely to occur.. Overall, recent landings are dominated by one overfished, five fully fished and four uncertain/ undefined species in the</p>	L	R – estuaries where EG fishery occurs

Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						<p>top ten, and have intermediate or higher risk as defined in the EG EIS.</p> <p><b>Recruitment overfished:</b></p> <ul style="list-style-type: none"> <li>• Mulloway (Intermediate)</li> </ul> <p><b>Fully fished:</b></p> <ul style="list-style-type: none"> <li>• Luderick (Intermediate)</li> <li>• Yellowfin bream (Intermediate)</li> <li>• School prawn (Intermediate)</li> <li>• Sand whiting (Intermediate)</li> <li>• Sea mullet (Intermediate)</li> </ul> <p><b>Uncertain/undefined:</b></p> <ul style="list-style-type: none"> <li>• Common silverbidy (Intermediate)</li> <li>• Cockles (Intermediate)</li> <li>• Dusky flathead (Intermediate)</li> <li>• River eels (Intermediate)</li> </ul> <p><b>Bycatch</b> – risks from bycatch of fish assemblages associated with the EG fishery is considered to be moderate as negative impacts on bycatch assemblages are evident, however, the level of impact has not influenced their overall recovery capacity, and a change in the overall trophic / community structure is not evident in most of the estuaries. See section 6.1.2 for further details</p>		
	Estuary Prawn Trawl (EPT)	North	Moderate	moderate	likely	<b>Reduction in abundances of species and trophic levels</b> – approx. 40% of recent statewide landings taken from this region, dominated by school prawns	L	L: Clarence River and Lake Wolloweyah

Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
			moderate			which makes up approx. 80% of landings, which is identified as fully fished and has high overall risk defined in the EPT EIS, resulting in a moderate consequence arising from harvest that is likely to occur. In addition, Eastern king prawns is caught in small numbers in the EPT fishery (growth overfished, H). <b>Bycatch</b> – risks from bycatch of fish assemblages associated with the EPT fishery is considered to be moderate as negative impacts on bycatch assemblages are evident, however, the level of impact has not influenced their overall recovery capacity, and a change in the overall trophic / community structure is not evident in the estuaries fished. The moderate impact was considered 'likely' to occur from this activity due to the amount of fishing effort within the Clarence		
		Central	moderate	moderate	likely	<b>Reduction in abundances of species and trophic levels</b> – approx. 60% of recent statewide landings taken from this region, dominated by school prawns which makes up approx. 98% of landings, is identified as fully fished and has high overall risk defined in the EPT EIS. In addition, Eastern king prawns are caught in small numbers in the EPT fishery (growth overfished, H). <b>Bycatch</b> – risks from bycatch of harvested assemblages associated with the EPT fishery is considered to be moderate as negative	L	L: Hunter and Hawkesbury estuaries.

Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						impacts on bycatch assemblages are evident, however, the level of impact has not influenced their overall recovery capacity, and a change in the overall trophic / community structure is not evident in the estuaries fished. The moderate impact was considered 'likely' to occur from this activity due to the amount of fishing effort within the Hunter and Hawkesbury estuaries. See section 6.1.2 for further details.		
Charter fishing	Line fishing	Central	low	minor	likely	<b>Reduction in abundances of species and trophic levels</b> – Higher amount of harvest and bycatch from this region resulting in minor impacts that are considered likely to occur	L	L
Recreational fishing	Shore-based line and trap fishing	All	Moderate	moderate	likely	<b>Reduction in abundances of species and trophic levels</b> - the impact on harvested assemblages as a result of shore-based recreational fishing relates to approx. even levels of recent statewide landings taken from each region, dominated by several species which makes up a majority of the landings, and several that are either overfished, growth overfished or fully fished and/or have either moderate-high to low resilience.  Overfished • Mulloway  Growth overfished • Silver trevally	L	R

Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						<p>Fully fished:</p> <ul style="list-style-type: none"> <li>• Yellowfin bream</li> <li>• Luderick</li> <li>• Sand whiting</li> </ul> <p><b>Bycatch</b> – risks from bycatch of assemblages associated with the recreational shore-based fishery is considered to be moderate as negative impacts on bycatch assemblages are evident, however, the level of impact has not influenced their overall recovery capacity, and a change in the overall trophic/community structure is not evident in most of the estuaries. It was considered 'likely' that this level of impact would occur from this activity reflecting the impact of the defined stressors from the activity against background variations and life history characteristics of harvested species which have characteristics of high resilience, and due to the amount of shore-based fishing effort in the estuaries in the regions. See section 6.1.4 for further details</p>		
	Boat-based line and trap fishing	All	Moderate	moderate	likely	<b>Reduction in abundances of species and trophic levels</b> - the impact on harvested assemblages as a result of boat-based recreational fishing relates to approx. even levels of recent statewide landings taken from each region, dominated by several species which makes up a majority of the landings, or are either overfished, growth overfished	L	R

Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						<p>or fully fished and/or have either moderate or low resilience.</p> <p>Overfished:</p> <ul style="list-style-type: none"> <li>• Mulloway</li> </ul> <p>Growth overfished:</p> <ul style="list-style-type: none"> <li>• Snapper</li> <li>Silver trevally</li> </ul> <p>Fully fished:</p> <ul style="list-style-type: none"> <li>• Yellowfin bream</li> <li>• Luderick</li> <li>• Sand whiting</li> <li>• Tiger flathead</li> </ul> <p><b>Bycatch</b> – risks from bycatch of assemblages associated with the recreational shore-based fishery is considered to be moderate as negative impacts on bycatch assemblages are expected, however, the level of impact has not influenced their overall recovery capacity, and a change in the overall trophic/community structure is not evident in most of the estuaries. It was considered likely that this level of impact would occur from this activity reflecting the impact of the defined stressors from the activity against background variations and life history characteristics of many harvested species. See section 6.1.4 for further details.</p>		

## Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
	Spearfishing	All	low	minor	likely	<b>Reduction in abundances of species and trophic levels</b> - the impact on harvested assemblages as a result of spearfishing was considered minor reflecting the impact of the defined stressors from the activity against background variations and life history characteristics of harvested species which have characteristics of high resilience. It was considered likely that this level of impact would occur from this activity, but at the local scale. See section 6.1.4 for further details.	L	L
	Hand gathering	North Central	Moderate	moderate	likely	<b>Reduction in abundances of species and trophic levels</b> – moderate impacts were considered likely due to high levels of harvest of nippers at local scale. In addition, recreational harvest of school prawns occurs in a number of estuaries. See section 6.1.4 for further details.	L	L: restricted to specific locations where harvest of nippers occurs at a high level such as Tweed River, Port Hacking, as well as school prawns in selected estuaries
		South	low	moderate	possible	<b>Reduction in abundances of species and trophic levels</b> – moderate impacts were considered possible due to level of harvest of nippers at local scale. See section 6.1.4 for further details.	L	L

## Appendix C Environmental Risk Matrices and Evidence

## Threatened and protected species (macrophytes, fish and shark)

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
Shipping	Large commercial vessels and associated port activities and industries (trade ships, cruise ships)	Central	moderate	major	possible	<b>Water pollution</b> - major impact on <i>Posidonia</i> and saltmarsh was considered possible reflecting the level of impact of defined stressors from the activity, principally oil spills, and the low resilience of the habitat to these impacts. See section 6.1.1 for further details.	L	L: Main ports only, but particularly Botany Bay and Sydney Harbour
		North South	low	major	unlikely	<b>Water pollution, physical disturbance</b> - major impacts were considered unlikely due to lower risk of oil spill and physical disturbance reflecting the level of this activity in several local areas. See section 6.1.1 for further details.	L	L: Jervis Bay, Twofold Bay, Yamba
	Small commercial vessels (ferries, charter boats)	Central	low	moderate	possible	<b>Water pollution, physical disturbance</b> - moderate impact on <i>Posidonia</i> and saltmarsh was considered possible reflecting the level of impact of defined stressors from the activity, principally oil spills, and the low resilience of the habitat to these impacts. It was considered possible that this level of impact would occur from this activity due to the amount of vessel activity in the identified areas. See section 6.1.1 for further details.	A	L: Many large estuaries, particularly Hawkesbury, Hunter, Sydney Harbour
Commercial fishing	Estuary General	North South	moderate	moderate	likely	<b>Physical disturbance, incidental catch of species of conservation concern</b> — moderate impacts considered likely related to impacts on <i>Posidonia</i> and saltmarsh and associated protected species (e.g. sygnathids). See section 6.1.2 for further details.	R	R
		Central	low	minor	likely	<b>Physical disturbance, incidental catch</b>	L	L: In estuaries

## Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						<b>of species of conservation concern</b> — only minor impacts considered likely related to impacts on <i>Posidonia</i> and saltmarsh and associated protected species (e.g. sygnathids). See section 6.1.2 for further details.		where commercial fishing occurs
	Estuary Prawn Trawl	North Central	low	minor	likely	<b>Incidental catch of species of conservation concern</b> — only minor impacts considered likely related to impacts on protected species (e.g. sygnathids). See section 6.1.2 for further details.	L	L: Hawkesbury estuary, Clarence
Charter fishing	Line fishing	All	low	minor	likely	<b>Physical disturbance</b> – only minor impacts considered likely related to impacts on <i>Posidonia</i> and saltmarsh through physical disturbance. See section 6.1.3 for further details.	L	L
Recreational fishing	Shore-based line and trap fishing	All	low	minor	likely	<b>Physical disturbance</b> –minor impacts considered likely related to impacts on <i>Posidonia</i> and saltmarsh through physical disturbance. See section 6.1.4 for further details.	L	R
	Boat-based line and trap fishing	All	low	minor	likely	<b>Physical disturbance</b> –minor impacts considered likely related to impacts on <i>Posidonia</i> through physical disturbance. See section 6.1.4 for further details.	L	R
Aquaculture	Oyster aquaculture	All	moderate	moderate	likely	<b>Physical disturbance</b> – moderate impacts considered likely related to impacts on <i>Posidonia</i> and saltmarsh through physical disturbance. See section 6.1.7 for further details.	L	R
Recreation and tourism	Boating and boating infrastructure	All	high	major	likely	<b>Physical disturbance, water pollution</b> –major impacts on <i>Posidonia</i> as a result of boating and infrastructure was	A	R: All estuaries, but particularly Lake Macquarie,

## Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						considered 'major' reflecting the level of defined stressors from the activity (e.g. physical disturbance resulting from propellers, anchoring, moorings, sediment resuspension and shading from boats/jetties resulting in light limitation) and the low resilience of components of the habitat to these impacts. It was considered likely that this level of impact would occur from this activity at the local scale. See section 6.1.9 for further details.		Hawkesbury River, Sydney Harbour, Port Hacking
	Four wheel driving	All	moderate	major	possible	<b>Physical disturbance</b> - extensive physical destruction and soil compaction possible, but under current management there is limited access to saltmarsh area for four wheel drives, and limited saltmarsh where there is access, although some illegal activity. Major impacts possible in localised areas. See section 6.1.9 for further details.	L	L
Dredging	Navigation & entrance management, modification and maintenance etc.	All	moderate	major	possible	<b>Water pollution, physical disturbance</b> - major impacts could occur due to sediment re-suspension from operations and dewatering in barges leading to turbidity and potential release of toxic contaminants. Physical disturbances and removal in generally small areas for discrete projects such as jetties, marinas. It was considered 'possible' that this level of impact would occur from this activity due to the amount of dredging activity in the identified estuaries. See section 6.1.10 for further details.	L	L: All estuaries where dredging occurs

## Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
Modified freshwater flows	Extraction, artificial barriers to riverine and estuarine flow (e.g. dams, weirs, waterway crossings, floodgates)	All	high	major	likely	<b>Changes to tidal flow and patterns</b> – major impacts on saltmarsh likely through changed water table and inundation regimes results in very broad overall impacts. See section 6.1.12 for further details.	L	R: Hunter, Hawkesbury, coastal lagoons
Mining and extractive industries	Oil, gas, minerals, sand, aggregate, underground coal	Central	moderate	moderate	likely	<b>Physical disturbance</b> - major impacts considered possible from subsidence as it affects seagrass viability at depth. Coal mines still mine under seagrass beds, with moderate impacts likely. See section 6.1.11 for further details.	L	L
Service infrastructure	Pipelines, cables, trenching and boring	Central	moderate	moderate	likely	<b>Physical disturbance, sedimentation and water pollution</b> – moderate impacts likely, but pulsed impacts at time of construction and mostly highly localised. See section 6.1.13 for further details.	L	L
<b>Land-based impacts</b>								
Landuse Intensification	Urban stormwater discharge	Central	high	major	almost certain	<b>Water pollution</b> – major impacts on <i>Posidonia</i> and saltmarsh almost certain due to increased nutrients, contaminants and sediments and reduced salinities which impact biota in saltmarsh. See section 6.2.1 for further details.	A	L: All estuaries where <i>Posidonia</i> present
		North South	moderate	moderate	likely	<b>Water pollution</b> – moderate impacts on <i>Posidonia</i> and saltmarsh likely due to increased nutrients, contaminants and sediments and reduced salinities which impact biota in saltmarsh. See section 6.2.1 for further details.	A	R: All estuaries (where present)
	Foreshore development	All	moderate	major	possible	<b>Physical disturbance</b> – major impacts due to direct habitat removal and destruction of saltmarsh in some areas. Development of	A	R: All estuaries (where present)

Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						foreshore historically meant removing/infilling of saltmarsh. Possible under current management. See section 6.2.1 for further details.		
	Clearing riparian and adjacent habitat including wetland drainage	North Central	high	major	likely	<b>Physical disturbance, changes to tidal flow velocity and patterns</b> – major impacts on saltmarsh likely due to damage to habitat during removal and clearing, altering water tables and connectivity. Removal/clearing of adjacent habitats under current management is still likely, especially in rural catchments. See section 6.2.1 for further details.	A	R: All estuaries
		South	moderate	major	possible	<b>Physical disturbance, changes to tidal flow velocity and patterns</b> – major impacts on saltmarsh possible due to damage to habitat during removal and clearing, altering water tables and connectivity. Removal/clearing of adjacent habitats under current management is still possible, especially in rural catchments. See section 6.2.1 for further details.	A	L: all estuaries where clearing and drainage occurs
	Agricultural diffuse source runoff	North South	high	major	almost certain	<b>Water pollution, sedimentation</b> – major impacts on <i>Posidonia</i> almost certain due to elevated nutrients, sediments, potential contaminants and turbidity, and sedimentation. See section 6.2.1 for further details.	A	Estuaries with <i>Posidonia</i> and agriculture catchment, e.g. Hawkes, Hunter, Tuggerah, Macquarie.
		Central	moderate	moderate	almost certain	<b>Water pollution, sedimentation</b> – moderate impacts on <i>Posidonia</i> and saltmarsh almost certain due to elevated nutrients, sediments, potential contaminants and turbidity, and sedimentation. See section 6.2.1 for further details.	A	R: Estuaries with seagrass and agriculture catchment, e.g. Hawkesbury, Hunter, Tuggerah,

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
								Lake Macquarie.
	Stock grazing of riparian and marine vegetation	All	High	Major	likely	<b>Physical disturbance</b> – major impacts considered likely on saltmarsh from the physical disturbance from trampling and grazing. See section 6.2.1 for further details.	A	R all estuaries where grazing occurs
Point Discharges	Industrial discharges	Central	low	moderate	possible	<b>Water pollution</b> – moderate impacts on <i>Posidonia</i> and saltmarsh considered possible due to elevated nutrients and sediments. Increased contaminant concentrations negatively impact biota. Only possible under current management. See section 6.2.2 for further details.	A	L: Estuaries with seagrass and either current or historical industrial discharges, e.g. Port Jackson, Lake Mac, Bris Water, Botany Bay, Illawarra, coastal lagoons
	Sewage effluent and septic runoff	All	moderate	major	possible	<b>Water pollution, microplastics</b> – major impacts from elevated nutrients, sediments and contaminants which affect biota, Sewage runoff carries microplastics. Occurs primarily as overflows, with major impacts possible. See section 6.2.2 for further details.	L, I	All estuaries
Hydrologic Modifications	Estuary entrance modification	All	high	major	likely	<b>Changes in tidal flow and patterns, changes to tidal prism</b> – major impacts likely on <i>Posidonia</i> and saltmarsh due to changes in estuary water from estuarine/brackish to more marine. Results in increased frequency of inundation. Ongoing management allows openings and other modifications. Mangrove encroachment into saltmarsh areas. Likely in all modified estuaries. See section 6.2.3 for further details.	A	All estuaries (where present)

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
<b>Climate change</b>	<b>20 years</b> - See section 6.3.1 for further details on climate change							
	Sea level rise	All	high	major	almost certain	<b>Physical disturbance</b> - saltmarsh likely to be inundated and limited chances to expand range. High chance of sea level rise with major impacts on saltmarsh almost certain.	L	R
	Flooding, storm surge, tsunami, inundation	All	low	minor	likely	<b>Physical disturbance</b> - increased turbidity, and changes to salinities likely to impact <i>Posidonia</i> and saltmarsh. Wave action. Minor impacts likely in time frame.	I	R
<b>Climate change</b>	<b>50 years</b>							
	Climate and sea temperature rise	All	high	major	likely	<b>Elevated temperatures</b> - likely impacts to be major on saltmarsh.	I	R
	Ocean acidification	All	high	major	likely	<b>Increased acidity</b> - <i>Posidonia</i> likely to be sensitive to pH changes. Major impacts likely in time frame.	I	R
	Altered storm/cyclone activity	All	moderate	moderate	likely	<b>Physical disturbance</b> - tolerant of abiotic stress. Increased nutrient and sediment runoff may be significant, with moderate impacts likely.	I	R
	Sea level rise	All	high	major	almost certain	<b>Physical disturbance</b> - saltmarsh likely to be inundated and limited chances to expand range. High chance of sea level rise, with major impacts almost certain.	L	R
	Flooding, storm surge, inundation	All	moderate	moderate	likely	<b>Physical disturbance</b> - increased nutrient and sediment runoff may be significant, with moderate impacts likely.	I	R

## Appendix C Environmental Risk Matrices and Evidence

## Threatened and protected marine mammals, reptiles and birds

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
Shipping	Large commercial vessels and associated port activities and industries (trade ships, cruise ships)	Central South	moderate	major	likely	<b>Wildlife disturbance</b> - the impacts as a result of large commercial vessels was considered major reflecting the impact of the defined stressor from the activity. It was considered likely that this level of impact would occur from this activity due to the increasing whale abundance together with increasing shipping significantly increase risk of vessel strike especially on entering and leaving major ports during whale migration season. In particular, naïve calves and species that must remain on the surface following feeding dives are particularly vulnerable. Recovering populations of Southern Right Whale (especially those on the south coast of NSW) that nurse in shallow bays and estuaries have low resilience to vessel strike, and wildlife disturbance which cause subsequent change behaviour. The impact of noise on marine mammals and reptiles is well documented in the literature but poorly researched within the regions. See section 6.1.1 for further details.	A	L: Main ports and coastal shipping routes to 3nm
	Small commercial vessels (ferries, charter boats)	North South	Low	Minor	likely	See section 6.1.1 for further details.	L	L
		Central	moderate	moderate	likely	<b>Wildlife disturbance</b> - the impacts as a result of small commercial vessels was considered moderate reflecting the impact of the defined stressor from the activity and the population status. It was considered likely that this level of impact	A	L: Many large estuaries, particularly Sydney Harbour, Hawkesbury,

Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
			moderate			would occur from this activity due to the increasing whale abundance together with increasing small vessel activity that significantly increase risk of vessel strike during whale migration season. In particular, naïve calves and species that must remain on the surface following feeding dives are particularly vulnerable. Recovering populations of Southern Right Whale (especially those of the south coast of NSW) that nurse in shallow bays and estuaries have low resilience to vessel strike, and wildlife disturbance which cause subsequent change behaviour. The impact of noise on marine mammals is well documented in the literature but poorly researched within the regions. See section 6.1.1 for further details.		Hunter, rivers and coastal lakes
Commercial fishing	Estuary General	North Central	moderate	moderate	likely	<b>Wildlife disturbance, catch of species of conservation concern</b> - the impacts of the estuary general fishery was considered 'moderate' reflecting the impact of the defined stressor from the activity. It was considered likely that this level of impact would occur from this activity as NPWS receives reports of entanglements of shorebirds, marine mammals, and turtles in estuaries in the two regions. These data are reported to the Elements database and through Taronga Zoo's case register, though an understanding of the true scale of estuarine entanglements is limited by	L	All estuaries where the activity occurs

## Appendix C Environmental Risk Matrices and Evidence

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						lack of data and most likely under-reported. Ingestion of baited hooks etc may be extensive. See section 6.1.2 for further details.		
		South	low	minor	likely	See section 6.1.2 for further details.	L	L
	Estuary Prawn Trawl	North Central	low	minor	likely	<b>Wildlife disturbance, catch of species of conservation concern</b> - the impacts of the estuary prawn trawl fishery was considered moderate reflecting the impact of the defined stressor from the activity. It was considered likely that this level of impact would occur from this activity as interactions are known to occur between prawn trawl fishery and seabirds, marine turtles and marine mammals in other location, (e.g. South Australia, Northern Territory). Local data is scant and therefore the risk is inferred to occur in these regions. Also, bycatch reporting not a requirement. See section 6.1.2 for further details.	I	L: Hunter, Hawkesbury Clarence
Charter fishing	Line fishing	Central	low	minor	likely	<b>Wildlife disturbance</b> - the impacts of charter fishing was considered 'minor' reflecting the impact of the defined stressor from the activity Seabird entanglements are common in estuaries, with species such as the Australian pelican. Data in the bioregion is insufficient to assess full impact, but this level of impact is likely. See section 6.1.3 for further details.	L	Lake Macquarie, Hawkesbury, Pittwater, Port Jackson, Botany, Pt Hacking. All estuaries where activity occurs
Recreational fishing	Shore-based line and trap fishing	North Central	moderate	moderate	likely	<b>Wildlife disturbance, catch of species of conservation concern</b> - The impacts	L	R

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						of shore-based recreational fishing was considered 'moderate' reflecting the impact of the defined stressors from the activity, and the population status of the species. The major stressor here is wildlife disturbance. Activities that contribute to this are physical disturbance of shorebirds, seabirds and marine mammals; acoustic disturbance from vessels; ingestion and entanglement in recreational fishing gear including crab traps. Interactions with marine mammals and reptiles in the central region are likely to occur due to high level of recreational fishing. See section 6.1.4 for further details.		
		South	low	minor	likely	Less activity across the landscape in the south, however, disturbance to beach nesting species such as Oystercatchers, and Hooded Plover remains an issue see section on wildlife disturbance. See section 6.1.4 for further details.	L	R
	Boat-based line and trap fishing	North Central	moderate	moderate	likely	The impacts of boat-based recreational fishing was considered 'moderate' reflecting the impact of the defined stressors from the activity (wildlife disturbance, marine debris, incidental bycatch), and the population status of the species. In particular, turtles caught in crab pots reported to NPWS – high mortalities of turtles documented from recreational crab pots and fish traps e.g. witches hat traps in NSW also applies in this bioregion where these methods are	L	R

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						permitted. Entangled seals and seals caught on lures reported to NPWS. Discarded fishing gear and debris from rec fishers poses a threat to turtles and seabirds through ingestion and entanglement. This is likely given the high level of rec fishing that occurs in this bioregion. The NPWS marine incident database holds records of turtle mortality from marine debris ingestion. Interactions with marine mammals and reptiles are likely to occur in this bioregion due to high level of boat-based recreational fishing. See section 6.1.4 for further details.		
		South	low	minor	likely	Less activity than in the other regions. See section 6.1.4 for further details.	L	R
	Hand gathering	North	Low	minor	likely	Impacts on shorebirds considered to be minor.	L	L
Charter activities	Whale and dolphin watching	North	moderate	moderate	likely	High levels of whale tourism in the region. Adequate research on impacts e.g. noise, disturbance, displacement, stress, reduced fitness, behavioural change. Concerns related to the long-term impact of dolphin watching activities especially in Port Stephens stem from a review of impacts on these populations. See section 6.1.6 for further details.	A	L: All estuaries where activity occurs
		South	low	Minor	likely	High levels of whale tourism in the region. Adequate research on impacts e.g. noise, disturbance, displacement, stress, reduced fitness, behavioural change. Concerns related to the long-term impact of dolphin watching activities	L	L

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						especially in Jervis Bay and Twofold Bay stem from a review of impacts on these populations. See section 6.1.6 for further details.		
Aquaculture	Oyster aquaculture	All	low	minor	likely	Increased vessel strike for marine turtles, disturbance of shorebirds at roost and feeding sites from boats and human interaction. See section 6.1.7 for further details.	I	L: All estuaries where activity occurs
	Mussel farms	South	Low	minor	likely	Increased vessel strike for marine turtles, disturbance of birds, but impacts considered to be minor. See section 6.1.7 for further details.	L	L
Recreation and tourism	Boating and boating infrastructure	All	moderate	moderate	likely	Increasing whale and marine turtle abundance together with increasing recreational vessel usage significantly increase risk of vessel strike especially on entering and leaving major ports during whale migration season, and within estuaries and coastal lakes. Naïve calves and species that tend to remain on the surface (marine turtles) are particularly vulnerable. Recovering populations of Southern Right Whale that nurse in shallow bays and estuaries and listed marine turtle species have low resilience to vessel strike, and disturbance from vessels which cause subsequent change behaviour, potentially reducing fitness of the population. The impact of noise and disturbance on marine wildlife is well documented in the literature but poorly researched within the bioregion. Disturbance of seals at major	A	L: all

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						haulout or colony sites, shorebirds at major roost and feeding sites may impact on breeding success and reduce migration capacity. Development of infrastructure including marinas will have consequences for marine fauna including noise and increased negative human/wildlife interaction. See section 6.1.9 for further details.		
	Swimming, passive use and walking	All	low	minor	likely	See section 6.1.9 for further details.	L	R
	Four wheel driving	All	moderate	major	possible	Damage to nesting and foraging habitat for shorebirds, damage to nesting habitat for turtles. Disturbance of highly endangered shorebirds at roost and feeding sites may impact on breeding success and reduce migration capacity. See section 6.1.9 for further details.	L	L: Hunter, Coastal lagoons
Dredging	Navigation & entrance management, modification and maintenance	All	low	moderate	possible	Noise impacts on cetaceans from dredging within estuaries and estuary mouth. The impact of noise and disturbance on marine wildlife is well documented in the literature but poorly researched within the bioregion data inadequate to make a clear assessment of the threat. See section 6.1.10 for further details.	I	L: Ports/Estuaries
Modified freshwater flows	Extraction, artificial barriers to riverine and estuarine flow (e.g. dams, weirs, waterway crossings, floodgates)	All	low	minor	likely	See section 6.1.12 for further details.	A	L: Hunter

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
Mining and extractive industries	Oil, gas, minerals, sand, aggregate, underground coal	All	low	minor	likely	Noise impacts on cetaceans from offshore developments a high threat. Vessel strike and dredging possible source of threats. No data to make clear assessment of threat. See section 6.1.11 for further details.	L	L
Service infrastructure	Pipelines, cables, trenching and boring	All	low	moderate	possible	Noise impacts on cetaceans from offshore developments a high threat. Vessel strike, trenching and boring. No data to make clear assessment of threat. Very limited. See section 6.1.13 for further details.	L	L: Large estuaries
<b>Land-based impacts</b>								
Landuse Intensification	Urban stormwater discharge	North South	low	Minor	likely	See section 6.2.1 for further details.	A	L
		Central	high	major	likely	Evidence of microplastics, marine debris and other contaminants impacting marine fauna. Some data from necropsies by Taronga Zoo in bioregion on ingestion of debris in threatened species. See section 6.2.1 for further details.	L	R
	Foreshore development	North South	low	minor	likely	See section 6.2.1 for further details.	L	L
		Central	high	major	almost certain	Impacts high on nesting shorebirds and turtles from permanent loss of near shore habitat. See section 6.2.1 for further details.	A	R
	Beach nourishment and grooming	Central	moderate	moderate	almost certain	Impacts high on nesting shorebirds. Impacts on foraging shorebirds. Number of beaches this occurs on fairly low. Threat would need to be reassessed if this changes. See section 6.2.1 for further details.	L	Port Jackson, Tuggerah, Lake Macquarie and wherever the activity occurs

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
	Clearing riparian and adjacent habitat including wetland drainage	North South	moderate	moderate	likely	See section 6.2.1 for further details.	L	R
		Central	high	major	likely	Loss of wetlands and habitat for migratory shorebirds likely to lead to local extinctions and additional declines to already threatened species. See section 6.2.1 for further details.	A	R
	Agricultural diffuse source runoff	All	low	minor	likely	Over the past 20 years artificial chemicals and substances such as pesticides are suspected of causing about 8% of fish kills in NSW (DPI website). However, fish kills are not the only result of exposure to toxic substances. See section 6.2.1 for further details.	I	L: Hunter, Hawkesbury
Point Discharges	Industrial discharges	Central	moderate	moderate	likely	Top predators in the food chain such as birds of prey are at risk from exposure to dioxins through bioaccumulation of dioxins in their food. Poor breeding success in some species such as white-bellied Sea Eagles has been linked to high concentrations of environmental pollutants containing organochlorine compounds, including dioxins. See section 6.2.2 for further details.	L	L
	Thermal discharges	Central	low	minor	likely	Turtles seek heated water and often getting caught in inlet canals of power stations. NPWS currently working with power authorities to reduce information gap. See section 6.2.2 for further details.	I	Lake Macquarie,
	Sewage effluent and septic runoff	North South	low	minor	likely	See section 6.2.2 for further details.	L	L
		Central	moderate	moderate	likely	<b>Water pollution</b> - Evidence of disease and pharmaceuticals transmission from land based sources e.g. toxoplasmosis in dolphins. See section 6.2.2 for further	L	L: All estuaries with urban development

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<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
						details.		
Hydrologic Modifications	Estuary entrance modifications.	All	moderate	moderate	likely	<b>Water pollution</b> - dredging from developments likely to impact coastal marine species. Artificial opening of intermittent estuaries has been shown to affect abundance and diversity of meiofauna. Though little data is available from NSW these infaunal impacts are likely to affect higher trophic level species especially migratory shorebirds. See section 6.2.3 for further details.	L	L: Wave dominated and coastal lagoons
<b>Climate change</b>	<b>20 years</b> - See section 6.3.1 for further details on climate change							
	Climate and sea temperature rise	All	low	minor	likely	<b>Elevated temperatures</b> - higher sea temp likely to change distribution and abundance of marine turtles further into the regions. Changes in temp likely to impact turtles nesting success and change the sex composition of population preliminary data being collected by NPWS. Changing climate triggers may impact whale migration and feeding behaviour in NSW waters. Changing dynamics of coastal wetlands likely to impact Ramsar Sites (shorebird protection sites) and internationally listed shorebird species.	L	L: Drowned valleys and wave dominated estuaries
	Ocean acidification	All	low	minor	likely	<b>Increased acidity</b> - indirect effects from loss of habitat, decreased food availability for marine fauna.	L	R
	Altered storm/cyclone activity	All	moderate	moderate	likely	<b>Physical disturbance</b> - beach deterioration will impact shorebirds and seabird foraging. Increased pollution and marine debris. Increased mortality of marine fauna after	L	R

Appendix C Environmental Risk Matrices and Evidence

						extreme weather events.		
	Sea level rise	All	high	major	likely	<b>Physical disturbance</b> - loss of habitat and nesting sites for shorebirds and turtles. Loss of shorebirds foraging habitat. Loss of intertidal foraging habitat including seagrass.	A	R
<b>Climate change</b>	<b>50 years</b>							
Climate change	Altered ocean currents & nutrient inputs	All	moderate	moderate	likely	<b>Nutrient changes</b> - changes to EAC likely to impact turtles and foraging whales and dolphins. Swimming against changes current likely to impact fitness of migrating species. Changes to nutrients and subsequent fish abundance likely to impact higher order predators (seabirds, marine mammals, turtles).	I	R
	Climate and sea temperature rise	All	high	major	likely	<b>Elevated temperatures</b> - sea temperature likely to change distribution and abundance of marine turtles further into bioregion. Changes in temp likely to impact turtles nesting success and change the sex composition of turtles. Temperature may impact migration of whales. Dynamics of coastal wetlands likely to change impacting shorebirds.	I	R
	Ocean acidification	All	high	major	likely	<b>Increased acidity</b> - indirect effects from loss of habitat, decreased food availability for marine fauna.	I	R
	Altered storm/cyclone activity	All	moderate	moderate	likely	<b>Physical disturbance</b> -beach deterioration will impact shorebirds and seabird foraging. Increased pollution and marine debris. Increased mortality of marine fauna after extreme weather events.	I	R
	Sea level rise	All	high	almost certain	likely	<b>Physical disturbance</b> - loss of habitat and nesting sites for shorebirds and turtles. Loss of shorebirds foraging habitat. Loss of intertidal foraging habitat including seagrass.	I	R
	Flooding, storm surge, inundation	All	moderate	moderate	likely	<b>Physical disturbance, wildlife disturbance</b> - increased disturbance to onshore feeding and roosting areas.	I	R

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## Appendix C Environmental Risk Matrices and Evidence

## Coastal and marine waters

## Coastal and marine waters

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
Shipping	Large commercial vessels and associated port activities and industries (trade ships, cruise ships)	Central	low	minor	likely	<b>Water pollution, marine debris</b> - moderate impacts were considered possible due to the defined stressors, including oil spills and debris, and high level of large shipping activity in the region. See section 8.1.1 for further details.	L	L: adjacent to major ports
	Small commercial vessels (ferries, charter boats, etc.)	All	low	minor	likely	<b>Water pollution, marine debris</b> – impacts considered minor resulting from the defined stressors, including oil spills. It was considered likely that this level of impact would occur due to the amount of vessel activity in the regions. See section 8.1.1 for further details.	L	N: L – adjacent to minor ports C: R – majority of coast S: L – adjacent to minor ports
Charter activities	Whale and dolphin watching	Central	low	minor	likely	<b>Water pollution, marine debris</b> – impacts considered minor resulting from the defined stressors, including oil spills. It was considered likely that this level of impact would occur due to the amount of vessel activity in the region. See section 8.1.5 for further details.	I	L
Service infrastructure	Pipelines, cables, trenching and boring	Central	low	minor	likely	<b>Water pollution</b> – impacts considered minor resulting from the defined stressor. It was considered likely that this level of impact would occur due to the amount of activity in the region. See section 8.1.12 for further details.	L	L
<b>Land-based impacts</b>								
Landuse intensification	Urban stormwater	All	low	minor	almost certain	<b>Water pollution</b> – only minor impacts considered almost certain resulting from the	A	L: All urban areas

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	discharge					defined stressors, reflecting the level of diffusion that occurs within close vicinity of discharges. See section 8.2.1 for further details.		
Point discharges	Industrial discharges	Central	low	moderate	possible	<b>Water pollution</b> – moderate impacts considered possible resulting from the defined stressors, reflecting the level of diffusion that occurs within close vicinity of discharges. Under current management large discharges should be unlikely, and localised to areas with industry. See section 8.2.2 for further details.	A	L: Localised industrial areas e.g. Port Kembla
	Sewage effluent and septic runoff	All	low	moderate	possible	<b>Water pollution</b> – moderate impacts considered possible resulting from the defined stressors, including nutrients, reflecting the level of diffusion that occurs within close vicinity of discharges. In localised areas as the deep ocean outfalls off Sydney discharge into deep water, assisting dilution. See section 8.2.1 for further details.	A	Localised (adjacent to local outfalls)
<b>Climate change</b>	<b>20 Yrs</b>					See section 8.3.1 for further details on all climate change threats.		
	Altered ocean currents and nutrient inputs	North	moderate	moderate	likely	<b>Nutrient changes</b> - increasing influence of warm, saline nutrient poor East Australian Current water in northern region will likely result in a moderate impact on water column characteristics.	A	R
		Central South	low	minor	likely	<b>Nutrient changes</b> - less influence of warm, saline nutrient poor East Australian Current water will likely result in a minor impact on water column characteristics.	A	R
	Altered storm/ cyclone activity	North	moderate	moderate	likely	<b>Physical disturbance</b> - increased intensity of storms likely to lead to increased occurrence of large event river run-off. This is likely to lead to moderate impacts on water quality on the open coast.	A	R: Most large estuaries
		Central South	low	moderate	possible	<b>Physical disturbance</b> - increased intensity of storms possible to lead to increased occurrence of large event river run-off. This will possibly lead to moderate impacts on water quality on the open coast.	L	R: mostly Hunter and Hawkesbury.

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Climate change	50 Yrs							
Climate change	Altered ocean currents & nutrient inputs	North	moderate	moderate	likely	<b>Nutrient changes</b> - expected strong influence of warm, saline nutrient poor East Australian Current water in both northern and central regions will likely result in a moderate impact on water column characteristics.	I	R
		Central						
		South	low	minor	likely	<b>Nutrient changes</b> - limited impacts of currents on oceanic water quality, with minor impacts likely.	I	R
	Climate and sea temperature rise	All	moderate	moderate	likely	<b>Elevated temperatures</b> - larger temperature increases expected to be synergistic with other effects, with moderate impacts likely.	I	R
	Ocean acidification	All	high	major	likely	<b>Increased acidity</b> - significant acidification expected within 50 years, experiments show potential effects in synergy with temperature, with major impacts likely.	I	R
	Altered storm/ cyclone activity	All	moderate	moderate	likely	<b>Physical disturbance</b> - increased river run off especially from Hunter and Hawkesbury. Increased intensity of storms may lead to increased occurrence of large event river run off especially from Hunter and Hawkesbury. This could lead to increased impacts on nearshore communities, with moderate impacts likely.	I	R
Flooding, storm surge, inundation	All	low	moderate	possible	<b>Physical disturbance</b> - likely to have higher levels of disturbance, particularly in conjunction with higher sea levels, with moderate impacts possible.	I	R	

## Appendix C Environmental Risk Matrices and Evidence

## Beaches

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
Shipping	Small commercial vessels (ferries, charter boats, etc.)	Central	Low	minor	likely	<b>Marine debris, water pollution</b> – only minor impacts were considered likely due to the defined stressors, including fuel spills, and high level of shipping activity in the region. See section 8.1.1 for further details.	L	R
Commercial fishing	Ocean Haul (OH)	North South	moderate	moderate	likely	<b>Physical disturbance, wildlife disturbance</b> - moderate impacts considered likely from defined stressors, but only at a local scale. See section 8.1.2 for further details.	L	L
Recreational fishing	Hand gathering	North	moderate	moderate	likely	<b>Physical disturbance, wildlife disturbance</b> - moderate impacts considered likely from defined stressors, but only at a local scale. See section 8.1.3 for further details.	L	L
		Central South	low	minor	likely	<b>Physical disturbance</b> – only minor impacts considered likely from trampling, but only at a local scale. See section 8.1.3 for further details.	L	L – at locations where pipis and beachworms are harvested
Recreation and Tourism	Swimming, surfing and dog walking	All	low	moderate	possible	<b>Physical disturbance, wildlife disturbance, marine debris</b> - moderate impacts considered possible from defined stressors, but only at a local scale. See section 8.1.8 for further details.	L	North: L – adjacent to major towns Central: R – majority of coast South: L – adjacent to major towns
	Four wheel driving	North Central	high	major	likely	<b>Physical disturbance</b> - impact was considered major, and this reflects the level of activity at a local level and low abundance and	A	L. Localised impacts on the few beaches that

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						overall life-history and ecological characteristics of the species that are impacted from physical compaction and disturbance, and which have relatively moderate–low resilience. There is limited access to beach areas for four wheel drives, although some illegal activity. It was considered possible that this level of impact would occur, but only at a local scale where the activity occurs. See section 8.1.8 for further details.		this activity is allowed. Only several beaches in central region, with many more on the north coast.
Service infrastructure	Pipelines, cables, trenching and boring	Central	Low	minor	likely	<b>Physical disturbance</b> – only minor impacts likely, but pulsed impacts at time of construction and mostly highly localised. See section 8.1.12 for further details.	L	L
<b>Land-based impacts</b>								
Landuse intensification	Urban stormwater discharge	All	moderate	moderate	likely	<b>Water pollution</b> – moderate impacts was considered likely to occur at a local scale due to increased nutrients, contaminants and sediments and reduced salinities which impact biota. See section 8.2.1 for further details.	L	L. Limited to some beaches near major urban areas.
	Foreshore development	North	moderate	moderate	likely	<b>Physical disturbance</b> – moderate impacts due to change to habitat extent and structure. Impacts considered likely under current management. See section 8.2.1 for further details.	I	L: Limited number of beaches where development has occurred
		South	moderate	moderate	likely			
			Central	high	major	likely	<b>Physical disturbance</b> – major impacts due to change to habitat extent and structure. Impacts considered likely under current management, although much of the impacts are legacy issues and new developments are likely to have less impacts. See section 8.2.1 for further details.	L
	Beach nourishment and grooming	All	moderate	moderate	almost certain	<b>Physical disturbance</b> - moderate impacts were considered almost certain at a local scale due to changed structure on beaches, including removal of biota and removal of organic material which disrupts foodwebs. See section 8.2.1 for further details.	I	North: L - beaches where grooming and nourishment occurs Central: L - nourishment occurring at

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								Cronulla and Narrabeen when nearby channels are dredged. Grooming at large number of beaches South: L - beaches where grooming and nourishment occurs
Clearing riparian and adjacent habitat including wetland drainage		North	low	minor	likely	<b>Physical disturbance</b> – only minor impacts were considered likely due to removal/clearing of adjacent habitats which under current management is still likely. See section 8.2.1 for further details.	L	L: clearance and drainage activity less
		South						
		Central	moderate	major	possible	<b>Physical disturbance</b> –major impacts were considered possible due to removal/clearing of adjacent habitats under current management is still likely Removal of vegetation adjacent to beaches for urban area development unlikely under current management, but large legacy issues exist. See section 8.2.1 for further details.	L	L: Large number of beaches where development occurs and drainage has occurred
Point discharges	Sewage effluent and septic runoff	Central	low	minor	likely	<b>Water pollution</b> - only minor impacts were considered likely due to nutrients and contaminants. Discharge from estuaries is dispersed and diluted in nearshore zone. See section 8.2.2 for further details.	A	
Hydrologic modifications	Estuary entrance modifications	All	high	major	almost certain	<b>Physical disturbance</b> – major impacts considered almost certain due to physical disturbance from dredging, mechanical openings, construction of walls etc changing natural habitat characteristics and sand movement. Most impacts are legacy issues and new developments are likely to have less impacts, although maintenance activities will have an ongoing impact on beach habitats. See section 8.2.3 for further details.	L	R: all beaches adjacent to estuaries where modifications have occurred

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Climate change	20 Years					See section 8.3.1 for further details on all climate change threats.		
	Altered storm / cyclone activity	All	low	moderate	possible	<b>Physical disturbance</b> - beaches with limited capacity to move due to sea walls etc., so moderate impacts are possible.	A	R
	Sea level rise	All	moderate	moderate	likely	<b>Physical disturbance</b> - some beaches may be lost due to their limited capacity to extend inland (local certain circumstances), hence moderate impacts are likely.	A	R
Climate change	50 Years							
	Climate and sea temp rise	All	moderate	moderate	likely	<b>Elevated temperatures</b> - temperature increases expected to be greater with more effect on beach biota, and moderate impacts likely.	L	R
	Ocean acidification	All	high	major	likely	<b>Increased acidity</b> - larger pH changes may affect sensitive organisms such as echinoderms and molluscs, with major impacts likely.	L	R
	Altered storm / cyclone activity	All	low	moderate	possible	<b>Physical disturbance</b> - beaches with limited capacity to move due to sea walls etc., so moderate impacts are possible.	L	R
	Sea level rise	All	high	major	likely	<b>Physical disturbance</b> - some beaches may be lost due to their limited capacity to extend inland in localised areas, with major impacts likely.	L	R
	Flooding, storm surge, inundation	All	high	major	likely	<b>Physical disturbance</b> - likely to have higher levels of disturbance, particularly in conjunction with higher sea levels, with major impacts expected to be likely.	L	R

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## Shallow soft sediments

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
Commercial fishing	Ocean trawl	North	low	minor	likely	<b>Physical disturbance</b> – only minor impacts were considered likely due to levels of effort in this habitat in this depth range in this region which indicates limited measureable impacts on benthic assemblages. See section 8.1.2 for further details.	A	R
Service infrastructure	Pipelines, cables, trenching and boring	Central	low	minor	Likely	<b>Physical disturbance</b> – only minor impacts likely, but pulsed impacts at time of construction and mostly highly localised. See section 8.1.12 for further details.	L	L
<b>Land-based impacts</b>								
Landuse intensification	Urban stormwater discharge	All	low	moderate	possible	<b>Water pollution</b> – moderate impacts was considered possible to occur at a local scale due to increased nutrients, contaminants and sediments and reduced salinities which impact biota. See section 8.2.1 for further details.	L	L: Large rivers that deposit pollutants into nearshore zone only, e.g. Port Jackson, Hunter, Tweed
	Beach nourishment and grooming	Central	low	minor	likely	<b>Physical disturbance</b> – only minor impacts were considered likely at a local scale due to changed structure on beaches which would have associated adjacent effects, including removal of biota and removal of organic material which disrupts foodwebs. See section 8.2.1 for further details.	L	L; groomed and nourished beaches only
	Clearing riparian and adjacent	Central	low	minor	likely	<b>Physical disturbance</b> – only minor impacts were considered likely due to removal/clearing of adjacent habitats under current	L	L

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	habitat including wetland drainage					management is still likely. See section 8.2.1 for further details.		
	Agricultural diffuse source runoff	All	low	minor	Likely	<b>Water pollution</b> - only minor impacts were considered likely due to contamination from sediments in agricultural runoff, which are discharged from estuaries and dispersed and diluted in nearshore zone. See section 8.2.1 for further details.	A	Larger rivers with agricultural catchments which carry pollutants to nearshore zone only, e.g. Hawkesbury, Hunter, Clarence, Tweed, Richmond
Point discharges	Industrial discharges	Central	low	minor	likely	<b>Water pollution</b> - only minor impacts were considered likely due to contamination from sediments in agricultural runoff. Discharge from estuaries is dispersed and diluted in nearshore zone. See section 8.2.2 for further details.	A	Localised, offshore of Port Kembla.
	Sewage effluent and septic runoff	All	low	minor	likely	<b>Water pollution</b> - only minor impacts were considered likely due to nutrients and contaminants. Discharge from estuaries is dispersed and diluted in nearshore zone. See section 8.2.2 for further details.	A	L: Confined to nearshore discharge points, e.g. Norah Head, Burwood, Wollongong
Hydrologic modifications	Estuary entrance modifications	All	low	minor	likely	<b>Physical disturbance</b> – only minor impacts were considered likely due to physical disturbance from dredging, mechanical openings, construction of walls etc changing natural habitat characteristics and sand movement. Most impacts are legacy issues and new developments are likely to have less impacts, although maintenance activities will have an ongoing impact. See section 8.2.3 for further details.	A	R: all beaches adjacent to estuaries where modifications have occurred
<b>Climate change</b>	<b>20 Years</b>					See section 8.3.1 for further details on all climate change threats.		
	Altered storm/ cyclone activity	All	low	minor	likely	<b>Physical disturbance</b> - disturbance of shallow soft sediments likely, but only minor impacts expected against background variation.	A	R

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Climate change	50 Years							
Climate and sea temperature rise	All	low	moderate	possible	<b>Elevated temperatures</b> - temperature increases expected to be greater with some effect on shallow soft sediment biota, and moderate impacts possible.	L	R	
Ocean acidification	All	high	major	likely	<b>Increased acidity</b> - larger pH changes may affect sensitive organisms such as echinoderms and molluscs, with major impacts likely.	L	R	
Altered storm/ cyclone activity	All	moderate	moderate	likely	<b>Physical disturbance</b> - disturbance of shallow soft sediments likely, with moderate impacts expected against background variation.	I	R	
Sea level rise	All	moderate	minor	likely	<b>Physical disturbance</b> - some shallow soft sediment habitat may be lost due to changes in adjacent nearshore beach morphology, hence minor impacts are likely.	A	R	
Flooding, storm surge, inundation	All	low	minor	possible	<b>Physical disturbance</b> - likely to have higher levels of disturbance, particularly in conjunction with higher sea levels, with moderate impacts expected to be possible.	L	R	

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## Deep soft sediments

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
Shipping	Large commercial vessels and associated port activities and industries	Central	high	major	likely	<b>Physical disturbance</b> – major impacts were considered likely due to levels of anchor chains at a highly localised scale in this region which is expected to result in measureable impacts on benthic assemblages. See section 8.1.1 for further details.	L	L: offshore of Hunter and Illawarra
Commercial fishing	Ocean Trap and Line (OTL)	All	low	minor	likely	<b>Physical disturbance</b> - only minor impacts were considered likely due to the defined stressors which are limited with the gear type used in this fishery, and habitat type that has moderate to high inherent capacity to respond to physical disturbances. See section 8.1.2 for further details.	A	R
	Ocean Trawl (OT)	All	moderate	moderate	likely	<b>Physical disturbance</b> – moderate impacts were considered likely due to the defined stressor levels impacting on assemblages associated with deep soft sediments. See section 8.1.2 for further details.	L	R
Aquaculture	Fish farming	North	low	minor	likely	<b>Water pollution</b> – nutrients, pathogens - only minor impacts were considered likely due to farm management and dilution in the coastal waters zone. See section 8.1.5 for further details.	L	L
Dredging	Navigation & entrance management and modification,	North South	low	minor	likely	<b>Physical disturbance</b> - only minor impacts were considered likely due to the defined stressors relating to sediment re-suspension and re-distribution, and habitat that has mod to high inherent capacity to respond to physical	A	L

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	harbour maintenance					disturbances. See section 8.1.9 for further details.		
		Central	moderate	moderate	likely	<b>Physical disturbance</b> - moderate impacts were considered likely due to sediment re-suspension and re-distribution - related to spoil dumping at a local scale, which are likely to contain contaminated sediments. See section 8.1.9 for further details.	A	L. Hunter, Illawarra and Sydney
<b>Land-based impacts</b>								
	Agricultural diffuse source runoff	All	low	minor	likely	<b>Water pollution</b> - only minor impacts were considered likely due to contamination from sediments in agricultural runoff, which are discharged from estuaries mostly during floods and dispersed and diluted in coastal waters zone. See section 8.2.1 for further details.	L	L. Offshore of larger rivers with agricultural catchments which discharge in floods e.g. Hawkesbury, Hunter, Clarence, Richmond
Point discharges	Industrial discharges	Central	low	minor	likely	<b>Water pollution</b> - only minor impacts were considered likely due to contamination from sediments in agricultural runoff. Discharge from estuaries is dispersed and diluted in nearshore zone. Sediment contamination - some impact on benthic biota in sediments is possible if from industrial pollutants reach deep sediments via dumped dredge spoil and are transported from estuaries to nearshore in local areas. See section 8.2.2 for further details.	A	L. Offshore from dredged ports with industrial inputs – Hunter, Sydney, Illawarra,
	Sewage effluent and septic runoff	Central	low	moderate	possible	<b>Water pollution</b> - moderate impacts were considered possible due to nutrients and contaminants discharged from deep water outfalls with localised impact in area surrounding discharge area. See section 8.2.2 for further details.	A	L: Confined to deep ocean outfalls
<b>Climate change</b>	<b>50 years</b>					See section 8.3.1 for further details on all climate change threats.		
	Climate and	All	low	moderate	possible	<b>Elevated temperatures</b> - greater temperature	A	R

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sea temperature rise					increases affect biota, but impacts to be minor in deep soft sediments		
Ocean acidification	All	high	major	likely	<b>Increased acidity</b> - oceanic organisms expected to be more sensitive to change, with major impacts likely to occur.	L	R
Altered storm/cyclone activity	All	moderate	moderate	likely	<b>Physical disturbance</b> - disturbance of deep soft sediments that is likely to result in moderate impacts	I	R
Sea level rise	All	low	minor	likely	<b>Physical disturbance</b> - water depth may potentially affect biota, but impacts to be minor in deep soft sediments	A	R

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## Rocky shores

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
Shipping	Large commercial vessels and associated port activities and industries	Central	low	minor	likely	<b>Water pollution, marine debris</b> – only minor impacts were considered likely due to the defined stressors, including oil spills, and high level of large shipping activity in the region. See section 8.1.1 for further details.	L	L
	Small commercial vessels (ferries, charter boats, etc.)	All	low	minor	likely	<b>Marine debris, water pollution</b> – only minor impacts were considered likely due to the defined stressors, including fuel spills, and high level of shipping activity in the regions. See section 8.1.1 for further details.	L	L
Recreational fishing	Shore-based line and trap fishing	All	low	minor	likely	<b>Physical disturbance, marine debris</b> - only minor impacts were considered likely due to trampling and marine debris at a local scale. See section 8.1.3 for further details.	L	L
	Hand gathering	All	low	minor	likely	<b>Physical disturbance</b> - only minor impacts were considered likely due to trampling at a local scale. See section 8.1.3 for further details.	L	R
Recreation and Tourism	Swimming, surfing and dog walking	All	low	moderate	possible	<b>Physical disturbance, wildlife disturbance, marine debris</b> - moderate impacts considered possible from defined stressors. See section 8.1.8 for further details.	L	North: L – adjacent to major towns Central: R – majority of coast South: L – adjacent to major towns
Service infrastructure	Pipelines, cables, trenching and boring	Central	low	minor	likely	<b>Physical disturbance</b> – only minor impacts likely, but pulsed impacts at time of construction and mostly highly localised. See section 8.1.12 for further details.	L	L

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Land-based impacts								
Landuse intensification	Urban stormwater discharge	Central	low	moderate	possible	<b>Water pollution</b> – moderate impacts was considered possible to occur at a local scale due to increased nutrients, contaminants and sediments and reduced salinities which impact biota and can result in local production of nuisance macroalgae. See section 8.2.1 for further details.	L	L: in very close proximity to outlets that cross rocky shores
	Foreshore development	Central	moderate	major	possible	<b>Physical disturbance</b> – major impacts due to change to habitat extent and structure. Impacts considered only possible, although much of the impacts are legacy issues and new developments are likely to have less impacts. See section 8.2.1 for further details.	L	L: All rocky shores where development has occurred/is occurring
Point discharges	Sewage effluent and septic runoff	Central	moderate	major	possible	<b>Water pollution</b> - major impacts were considered possible due to nutrients and contaminants occurring on rocky shores at a local scale. Also, discharge from estuaries is dispersed and diluted in nearshore zone. See section 8.2.2 for further details.	L	L: Only areas near STP discharges, e.g. Norah Head, Diamond Bay
		North South	low	minor	likely	<b>Water pollution</b> - only minor impacts were considered likely due to nutrients and contaminants. Discharge from estuaries is dispersed and diluted in nearshore zone. See section 8.2.2 for further details.	A	L
Hydrologic modifications	Estuary entrance modifications	North South	low	minor	likely	<b>Physical disturbance</b> – minor impacts considered likely due to physical disturbance from dredging, mechanical openings, construction of walls etc. Most impacts are legacy issues and new developments are likely to have less impacts. See section 8.2.3 for further details.	L	R: all rocky shores adjacent to beaches in the vicinity of estuaries where modifications have occurred
<b>Climate change</b>	<b>20 Years</b>					See section 8.3.1 for further details on all climate change threats.		
	Altered storm/ cyclone activity	All	low	moderate	possible	<b>Physical disturbance</b> - altered wave climate may affect organisms on rocky shore, with moderate impacts possible.	L	R
	Sea level rise	All	low	moderate	possible	<b>Physical disturbance</b> - some rocky shores may be lost due to their limited capacity to	L	R

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						extend inland (local certain circumstances), hence moderate impacts are likely.		
<b>Climate change</b>	<b>50 Years</b>							
	Ocean acidification	All	moderate	moderate	likely	<b>Increased acidity</b> - many calcifying organisms, but substantial natural variation may lead to resilience for some rocky shore biota, although moderate impacts likely.	L	R
	Altered storm/ cyclone activity	All	low	moderate	possible	<b>Physical disturbance</b> - altered wave climate may affect organisms on rocky shore, with moderate impacts possible.	L	R
	Sea level rise	All	moderate	moderate	likely	<b>Physical disturbance</b> - limited capacity for biota to move in most places. Shore platforms particularly vulnerable to modest increases in sea level, leading to displacement of habitat and biota, with moderate impacts likely.	L	R
	Flooding, storm surge, inundation	All	low	minor	likely	<b>Physical disturbance</b> - likely to have higher levels of disturbance, particularly in conjunction with higher sea levels, but impacts expected to be minor.	L	R

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## Shallow rocky reefs

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
Shipping	Large commercial vessels and associated port activities and industries	Central	low	minor	Likely	<b>Water pollution</b> – only minor impacts were considered likely due to the defined stressors, including oil spills, and high level of large shipping activity in the region. See section 8.1.1 for further details.	L	R
	Small commercial vessels (ferries, charter boats, etc.)	All	low	minor	likely	<b>Marine debris, water pollution</b> – only minor impacts were considered likely due to the defined stressors, including fuel spills, and high level of shipping activity in the regions. See section 8.1.1 for further details.	L	L
Commercial fishing	Ocean Trap and Line (OTL)	All	low	minor	likely	<b>Physical disturbance</b> - only minor impacts were considered likely due to physical disturbance from gear types. See section 8.1.2 for further details.	A	R
	Ocean Trawl (OT)	Central South	low	moderate	possible	<b>Physical disturbance</b> – moderate impacts were considered possible due to limited trawling on areas of very low profile cobble and bedrock reefs and large area of this habitat type in these regions and trawling focussed on fish assemblages. See section 8.1.2 for further details.	L	R
Charter fishing	Line fishing	All	low	minor	likely	<b>Physical disturbance</b> – only minor impacts were considered likely associated with anchoring on shallow reefs. See section 8.1.2 for further details.	L	L
Recreational fishing	Shore-based line and trap	All	low	minor	likely	<b>Marine debris</b> – only minor impacts were considered likely associated with marine	A	L

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	fishing					debris, principally lost fishing gear on shallow reefs at a local scale. See section 8.1.3 for further details.		
	Boat-based line and trap fishing	All	low	minor	likely	<b>Physical disturbance</b> – only minor impacts were considered likely associated with anchoring on shallow reefs. See section 8.1.3 for further details.	A	R
	Hand gathering	All	low	minor	likely	<b>Physical disturbance</b> – only minor impacts considered likely from trampling, but only at a local scale. See section 8.1.3 for further details.	L	L
Recreation and tourism	Boating and boating infrastructure	All	low	minor	likely	<b>Physical disturbance</b> – only minor impacts were considered likely associated with anchoring on shallow reefs. See section 8.1.8 for further details.	L	L
Service infrastructure	Pipelines, cables, trenching and boring	Central	low	minor	likely	<b>Physical disturbance</b> – only minor impacts likely, but pulsed impacts at time of construction and mostly highly localised. See section 8.1.12 for further details.	L	L
<b>Land-based impacts</b>								
Landuse intensification	Urban stormwater discharge	Central	moderate	moderate	likely	<b>Water pollution</b> – moderate impacts was considered likely to occur at a local scale due to increased nutrients, contaminants and sediments and reduced salinities which impact biota. See section 8.2.1 for further details.	L	L
		North South	low	minor	likely	<b>Water pollution</b> – only minor impacts were considered likely to occur at a local scale due to increased nutrients, contaminants and sediments and reduced salinities which impact biota. See section 8.2.1 for further details.	L	L
	Agricultural diffuse source runoff	All	low	minor	likely	<b>Water pollution</b> - only minor impacts were considered likely due to contamination from sediments in agricultural runoff, which are discharged from estuaries, principally during floods, and dispersed and diluted in nearshore zone. See section 8.2.1 for further details.	L	L: Offshore of main large estuaries with high discharge
Point discharges	Industrial discharges	Central	low	moderate	possible	<b>Water pollution</b> - only minor impacts were considered likely due to contamination from	L	L

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						sediments in agricultural runoff. Discharge from estuaries occurs principally during floods and is dispersed and diluted in nearshore zone. See section 8.2.2 for further details.		
	Sewage effluent and septic runoff	Central	moderate	moderate	likely	<b>Water pollution</b> - moderate impacts were considered likely due to nutrients and contaminants from point sources at a local scale. Discharge from estuaries, principally during floods, are also dispersed and diluted in nearshore zone. See section 8.2.1 for further details.	A	L
<b>Climate change</b>	<b>20 Years</b>					See section 8.3.1 for further details on all climate change threats.		
Climate change	Altered ocean currents & nutrient inputs	All	low	moderate	possible	<b>Nutrient changes</b> - reduction of nutrients may affect growth of habitat forming macro-algae on shallow reef habitat, with moderate impacts possible.	I	R
	Altered storm/cyclone activity	All	moderate	moderate	likely	<b>Physical disturbance</b> - storms can disturb kelp and associated biota on shallow reef habitat, with moderate impacts likely.	I	R
<b>Climate change</b>	<b>50 Years</b>							
Climate change	Altered ocean currents & nutrient inputs	All	moderate	moderate	likely	<b>Nutrient changes</b> - reduction of nutrients may affect growth of habitat forming macro-algae resulting in moderate impacts on shallow reef habitat.	I	R
	Climate and sea temp rise	All	moderate	moderate	likely	<b>Elevated temperatures</b> - increased temp and associated reduction of nutrients will affect growth of habitat forming macro-algae resulting in moderate impacts on shallow reef habitat.		R
	Ocean acidification	All	moderate	moderate	likely	<b>Increased acidity</b> - larger pH changes may affect sensitive organisms such as urchins and molluscs, with moderate impacts likely.	L	R
	Altered storm/cyclone activity	All	moderate	moderate	likely	<b>Physical disturbance</b> - storms can disturb kelp and associated biota on shallow reef habitat, with moderate impacts likely.	I	R
	Flooding, storm surge, inundation	All	low	minor	likely	<b>Physical disturbance</b> - likely to have higher levels of disturbance, particularly in conjunction with higher sea levels, but impacts	I	R

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					expected to be minor.		
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## Deep rocky reefs

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
Shipping	Large commercial vessels and associated port activities and industries	Central	moderate	major	possible	<b>Physical disturbance</b> – major impacts were considered possible due to levels of anchor chains at a highly localised scale in this region which is expected to result in measureable impacts on benthic assemblages. See section 8.1.1 for further details.	I	L: offshore of Hunter and Illawarra
Commercial fishing	Ocean Trap and Line (OTL)	All	low	minor	likely	<b>Physical disturbance</b> - only minor impacts were considered likely due to physical disturbance from gear types. See section 8.1.2 for further details.	A	R
	Ocean Trawl (OT)	Central South	low	moderate	possible	<b>Physical disturbance</b> – moderate impacts were considered possible due to limited trawling on areas of very low profile cobble and bedrock reefs and large area of this habitat type in these regions and trawling focussed on fish assemblages. See section 8.1.2 for further details.	L	R
<b>Recreation and tourism</b>	Boating and boating infrastructure	All	low	minor	likely	<b>Physical disturbance</b> – only minor impacts were considered likely associated with anchoring on deep reefs. See section 8.1.12 for further details.	L	R
<b>Land-based impacts</b>								
Landuse intensification	Agricultural diffuse source runoff	All	low	minor	likely	<b>Water pollution</b> - only minor impacts were considered likely due to contamination from sediments in agricultural runoff, which are discharged from estuaries, principally during floods, and dispersed and diluted in coastal waters. See section 8.2.1 for further details.	L	L: Offshore of main large estuaries with high discharge
Point discharges	Sewage effluent and	Central	moderate	moderate	likely	<b>Water pollution</b> - moderate impacts were considered likely due to nutrients and	A	L: Principally around Bondi and

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	septic runoff					contaminants from point sources at a local scale. Discharge from estuaries, principally during floods, are also dispersed and diluted in coastal waters. See section 8.2.2 for further details.		North Head outfalls
<b>Climate change</b>	<b>50 years</b>					See section 8.3.1 for further details on all climate change threats.		
	Ocean acidification	All	moderate	moderate	likely	<b>Increased acidity</b> - larger pH changes may affect sensitive organisms such as urchins and molluscs, with moderate impacts likely.	L	R

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## Planktonic assemblages

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
Shipping	Small commercial vessels (ferries, charter boats, etc)	Central	low	minor	likely	<b>Water pollution</b> – only minor impacts were considered likely due to the defined stressors, including fuel spills, and level of shipping activity in the region. See section 8.1.1 for further details.	L	L
Bait and aquarium trade	Imported baits and fish	All	low	moderate	possible		L	R
<b>Land-based impacts</b>								
Landuse intensification	Agricultural diffuse source runoff	All	low	minor	likely	<b>Water pollution</b> – only minor impacts considered likely from combined stressors of nutrients, suspended sediments, and potentially toxic contaminants, with dilution on the open coast from estuarine discharges, principally during flood events. See section 8.2.1 for further details.	L	L: Near large agricultural rivers, Hunter, Hawkesbury
Point discharges	Sewage effluent and septic runoff	All	low	minor	likely	<b>Water pollution</b> – only minor impacts considered likely from combined stressors of nutrients, suspended sediments, and potentially toxic contaminants, with dilution on the open coast from estuarine discharges, principally during flood events. See section 8.2.2 for further details.	A	L
<b>Climate change</b>	<b>20 Years</b>					See section 8.3.1 for further details on all climate change threats.		
Climate change	Altered ocean currents & nutrient inputs	All	moderate	moderate	likely	<b>Nutrient changes</b> - reduction of nutrients may result in changes in primary production, with moderate impacts likely.	L	R
	Ocean acidification	All	moderate	moderate	likely	<b>Increased acidity</b> - only small pH changes over this time frame, but colicophores,	I	R

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						pteropods are vulnerable, with moderate impacts likely.		
<b>Climate change</b>	<b>50 Years</b>							
Climate change	Altered ocean currents & nutrient inputs	All	moderate	moderate	likely	<b>Nutrient changes</b> - changes to primary production associated with increased intensity of the EAC. This could lead to changes in upwelling regimes and either increases or decreases in nutrient concentrations and ratios, with moderate impacts likely.	L	R
	Climate and sea temperature rise	All	low	moderate	possible	<b>Elevated temperatures</b> - larger temp increases affect biota, with moderate impacts possible.	A	R
	Ocean acidification	All	high	major	likely	<b>Increased acidity</b> - larger pH changes will occur, with coccolicophores, pteropods vulnerable, and major impacts likely.	I	R

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Fish assemblages

Resource use	Activity	Region	Risk level	Conseq	Likelihood	Key stressors	Confidence A: adequate L: limited I: inferred	Spatial extent L: local R: regional
Commercial fishing	Ocean Trap and Line (OTL)	North	moderate	moderate	likely	<p><b>Reduction in abundances of species and trophic levels</b> – approx. 40% of recent statewide landings are taken from this region, dominated by two growth overfished, four fully fished and four undefined species in top ten, and/or either moderate (M) or higher risk from OTL Environmental Impact Study (EIS).</p> <p>Growth -overfished</p> <ul style="list-style-type: none"> <li>• Snapper (MH)</li> <li>• Yellowtail kingfish (MH)</li> </ul> <p>Fully-fished</p> <ul style="list-style-type: none"> <li>• Australian bonito (MH)</li> <li>• Spotted mackerel (M)</li> <li>• Spanish mackerel (M)</li> <li>• Spanner crab (ML)</li> </ul> <p>Undefined/uncertain</p> <ul style="list-style-type: none"> <li>• Leatherjackets (H)</li> <li>• Whaler sharks (H)</li> <li>• Teraglin (MH)</li> <li>• Mackerel tuna (U)</li> </ul> <p>In addition, Mulloway is a key secondary species in the OTL fishery (overfished, H).</p> <p>Harvest was also considered to have only a moderate risk to the trophic structure of harvested assemblages as OTL have not or will not influence their overall recovery</p>	Limited (L)	Regional (R)

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				capacity, and a change in the overall trophic/community structure isn't and will not be evident. See section 8.1.2 for further details.		
Central	low	minor	likely	<p><b>Reduction in abundances of species and trophic levels</b> – approx. 15% of recent statewide landings taken from this region, dominated by three growth overfished, five fully fished and two undefined species in top ten, and/or either moderate (M) or higher risk from OTL EIS.</p> <p>Growth -overfished</p> <ul style="list-style-type: none"> <li>• Snapper (MH)</li> <li>• Yellowtail kingfish (MH)</li> <li>• Silver trevally (M)</li> </ul> <p>Fully-fished</p> <ul style="list-style-type: none"> <li>• Australian bonito (MH)</li> <li>• Tailor (U)</li> <li>• Sweep (M)</li> <li>• Yellowfin bream (L)</li> <li>• Yellowtail scad (U)</li> </ul> <p>Undefined/uncertain</p> <ul style="list-style-type: none"> <li>• Leatherjackets (H)</li> <li>• Wobbegong sharks (H)</li> </ul> <p>In addition, Mulloway is a key secondary species in the OTL fishery (overfished, H).</p> <p>Harvest was also considered to have only a moderate risk to the trophic structure of harvested assemblages as OTL have not or will not influence their overall recovery capacity, and a change in the overall trophic/community structure isn't and will not</p>	L	R

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					be evident. See section 8.1.2 for further details.		
	South	High  Contested by DPI as moderate	Major	Likely	<p><b>Reduction in abundances of species and trophic levels</b> – proportion of recent statewide landings taken from this region range from approx. 35% (2009/10) to 10% (2013/14), dominated by two growth overfished, two fully fished and five undefined species in top ten, and/or either moderate (M) or higher risk from OTL EIS, resulting in a major consequence arising from harvest that is likely to occur.</p> <p>Growth -overfished</p> <ul style="list-style-type: none"> <li>• Yellowtail kingfish (MH)</li> <li>• Snapper (MH)</li> </ul> <p>Fully-fished</p> <ul style="list-style-type: none"> <li>• Australian bonito (H)</li> <li>• Gummy shark (H)</li> </ul> <p>Undefined/uncertain</p> <ul style="list-style-type: none"> <li>• Leatherjackets (H)</li> <li>• Wobbegong sharks (H)</li> <li>• Southern maori wrasse (U)</li> <li>• Eastern red scorpionfish (U)</li> <li>• Whaler sharks (H)</li> </ul> <p>Harvest was also considered to contribute to a risk to the trophic structure of fish assemblages where OTL will influence their overall recovery capacity, and a change in the overall trophic/community structure will be evident. See section 8.1.2 for further details.</p>	L	R
Ocean Trawl (OT)	North	High	major	likely	<p><b>Reduction in abundances of species and trophic levels</b> – approx. 45% of recent landings taken from this region, dominated by</p>	L	R

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				<p>one growth overfished, five fully fished and three undefined species in top ten, and/or either moderate (M) or higher risk from OT EIS, resulting in a major consequence arising from harvest that is likely to occur.</p> <p>Growth overfished</p> <ul style="list-style-type: none"> <li>• Eastern king prawns (MH)</li> </ul> <p>Fully fished:</p> <ul style="list-style-type: none"> <li>• School prawn (MH)</li> <li>• Trawl whiting (not defined)</li> <li>• Yellowtail scad (L)</li> <li>• Tiger flathead (L)</li> <li>• Bluespotted flathead (U)</li> <li>• Bugs (I)</li> </ul> <p>Undefined:</p> <ul style="list-style-type: none"> <li>• Octopus (L)</li> <li>• Shovelnose rays (U)</li> <li>• Cuttlefish (I)</li> </ul> <p><b>Bycatch</b> – given level of trawl effort in this region on this habitat, levels of bycatch determined to result in high risk to considerable numbers of bycatch species with attributed intermediate-high and high risk levels in NSW published studies. See section 8.1.2 for further details.</p>			
	Central	Low	minor	likely	<p><b>Reduction in abundances of species and trophic levels</b> – approx. 10% of landings is taken from this region dominated by two growth overfished, four fully fished and three undefined species in top ten, and/or either moderate (M) or higher risk from the OT EIS</p>	A	R

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				<p>Growth overfished</p> <ul style="list-style-type: none"> <li>• Silver trevally (MH)</li> <li>• Eastern king prawns (MH)</li> </ul> <p>Fully fished:</p> <ul style="list-style-type: none"> <li>• Yellowtail scad (U)</li> <li>• Tiger flathead (L)</li> <li>• Bluespotted flathead (U)</li> <li>• Bugs (I)</li> </ul> <p>Undefined:</p> <ul style="list-style-type: none"> <li>• Leatherjackets (MH)</li> <li>• Shovelnose rays (U)</li> <li>• Cuttlefish (I)</li> </ul> <p><b>Bycatch</b> – given level of trawl effort in this region on this habitat, levels of bycatch determined to result in moderate risk to considerable numbers of bycatch species with attributed intermediate-high and high risk levels in NSW published studies. See section 8.1.2 for further details.</p>			
	South	Low	Minor	likely	<p><b>Reduction in abundances of species and trophic levels</b> – approx. 10% of landings taken from this region dominated by two growth overfished, three fully fished and four undefined species in top ten, and/or either moderate (M) or higher risk from OT EIS.</p> <p>Growth overfished</p> <ul style="list-style-type: none"> <li>• Silver trevally (MH)</li> <li>• Snapper (U)</li> </ul> <p>Fully fished:</p> <ul style="list-style-type: none"> <li>• Tiger flathead (L)</li> <li>• John dory (I)</li> <li>• School prawn (MH)</li> </ul>	A	R

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					<p>Undefined:</p> <ul style="list-style-type: none"> <li>Leatherjackets (MH)</li> <li>Angel sharks (H)</li> <li>Cuttlefish (I)</li> <li>Red gurnard/latchet (MH)</li> </ul> <p><b>Bycatch</b> – given level of trawl effort in this region on this habitat, levels of bycatch determined to result in moderate risk to considerable numbers of bycatch species with attributed intermediate-high and high risk levels in NSW published studies. See section 8.1.2 for further details.</p>		
Ocean Haul (OH)	North	<p>High</p> <p>Contested by DPI as moderate</p>	major	likely	<p><b>Reduction in abundances of species and trophic levels</b> – approx. 45% of statewide landings taken from this region, dominated by one overfished species, seven fully fished and two undefined/uncertain species in top ten with either moderate (M) or higher risk from OH EIS, resulting in a major consequence arising from harvest that is likely to occur.</p> <p>Overfished:</p> <ul style="list-style-type: none"> <li>Mulloway (M)</li> </ul> <p>Fully fished:</p> <ul style="list-style-type: none"> <li>Sea mullet</li> <li>Eastern sea garfish</li> <li>Eastern Australian salmon (H)</li> <li>Luderick (Int)</li> <li>Yellowfin bream</li> <li>Yellowtail scad</li> <li>Whitebait - sandy sprat</li> </ul> <p>Undefined/uncertain</p> <ul style="list-style-type: none"> <li>Australian sardine</li> <li>Frigate mackerel</li> </ul>	L	R

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				Harvest was considered to have a high risk to the trophic structure of fish assemblages as the level of OH effort and catch is likely to result in some clear shifts in the overall trophic/community structure and function. See section 8.1.2 for further details.			
	Central	moderate	moderate	likely	<p><b>Reduction in abundances of species and trophic levels</b> – approx. 15% of recent statewide landings taken from this region, dominated by six fully fished and two undefined/uncertain species in top ten with either moderate (M) or higher risk from OH EIS, resulting in a moderate consequence arising from harvest that is likely to occur.</p> <p>Fully fished:</p> <ul style="list-style-type: none"> <li>• Yellowtail scad (</li> <li>• Sea mullet</li> <li>• Eastern Australian salmon (H)</li> <li>• Sand whiting</li> <li>• Luderick (Int)</li> <li>• Eastern sea garfish (H)</li> <li>• Tailor</li> <li>• Eastern sea garfish</li> </ul> <p>Undefined/uncertain</p> <ul style="list-style-type: none"> <li>• Silver sweep (H)</li> <li>• Goldspot mullet</li> </ul> <p>In particular, the purse-seine fishery of silver sweep resulted in localised depletions in this region. Harvest was also considered to have only a moderate risk to the trophic structure of pelagic assemblages as OH has not or will not influence their overall recovery capacity, and a change in the overall trophic/community structure isn't and will not be evident. See</p>	L	R

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					section 8.1.2 for further details.			
		South	moderate	moderate	likely	<p><b>Reduction in abundances of species and trophic levels</b> – approx. 20% of recent statewide landings taken from this region (although this is variable), dominated by one growth overfished, six fully fished and two undefined/uncertain species in top ten with either moderate (M) or higher risk from OH EIS, resulting in a moderate consequence arising from harvest that is likely to occur.</p> <p>Growth overfished:</p> <ul style="list-style-type: none"> <li>• Silver trevally (M-H)</li> </ul> <p>Fully fished:</p> <ul style="list-style-type: none"> <li>• Eastern Australian salmon (H)</li> <li>• Yellowtail scad</li> <li>• Sea mullet (H)</li> <li>• Eastern sea garfish (H)</li> <li>• Luderick (Int)</li> <li>• Sand whiting</li> </ul> <p>Undefined/uncertain</p> <ul style="list-style-type: none"> <li>• Silver sweep (H)</li> <li>• Australian sardine (U)</li> </ul> <p>Harvest was also considered to have only a moderate risk to the trophic structure of pelagic assemblages as OTL have not or will not influence their overall recovery capacity, and a change in the overall trophic/community structure isn't and will not be evident. See section 8.1.2 for further details.</p>	L	R
	Sea urchin and turban shell	North	Low	minor	likely	<p><b>Reduction in abundances of species</b> - low levels of harvest in this region. See section 8.1.2 for further details.</p>	A	L
		Central	moderate	moderate	likely	<p><b>Reduction in abundances of species and</b></p>	A	L – fished on only

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					<b>trophic levels</b> - removal of the species that have life history characteristics that result in mod-low resilience, and fact that commercial catches of sea urchins and turban shell from the bioregion have averaged around <5% and 25% of the statewide catch respectively within the last 5 years. See section 8.1.2 for further details.		very few reefs	
	South	Moderate	Moderate	likely	<b>Reduction in abundances of species and trophic levels</b> - removal of the species that have life history characteristics that result in mod-low resilience, and fact that commercial catches of sea urchins and turban shell from the bioregion have averaged around <5% and 25% of the statewide catch respectively within the last 5 years. See section 8.1.2 for further details.	A	L	
Lobster	All	low	minor	likely	<b>Reduction in abundances of species and trophic levels, by-catch</b> - small levels of catch and effort from this fishery on this habitat inside 3 nm in these regions. See section 8.1.2 for further details.	A	R	
Abalone	North	Low	Minor	likely	<b>Reduction in abundances of species and trophic levels</b> - removal of the species that have life history characteristics that result in mod-low resilience, and fact that commercial catches of sea urchins and turban shell from the bioregion have averaged around <5% and 25% of the statewide catch respectively within the last 5 years. See section 8.1.2 for further details.	A	L	
	Central							
	South	Moderate	Moderate	likely	<b>Reduction in abundances of species and trophic levels</b> - removal of the species that have life history characteristics that result in mod-low resilience, and fact that commercial catches of abalone from the region make statewide catch respectively within the last 5 years. See section 8.1.2 for further details.	A	R	
Charter fishing	Line fishing	All	low	minor	likely	<b>Reduction in abundances of species and</b>	L	L – adjacent to

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						<p><b>trophic levels</b> - reflects the amount of charter fishing effort at a local scale adjacent to the major estuaries. Moderate to high resilience characteristics of the assemblages. By-catch also a likely stressors at low levels. See section 8.1.2 for further details.</p>		major estuaries
Recreational fishing	Shore-based line and trap fishing	All	Moderate	moderate	likely	<p><b>Reduction in abundances of species and trophic levels</b> – the impact on harvested assemblages as a result of shore-based recreational fishing relates to approx. even levels of recent statewide landings taken from each region, dominated by several species which makes up a majority of the landings, and several that are either overfished or fully fished and/or have either moderate-high to low resilience.</p> <p>Overfished</p> <ul style="list-style-type: none"> <li>• Mulloway</li> </ul> <p>Fully-fished</p> <ul style="list-style-type: none"> <li>• Sand flathead</li> <li>• Tiger flathead</li> </ul> <p>In addition, several species of sharks and rays are taken, most of which have low resilience.</p> <p><b>Bycatch</b> – risks from bycatch of assemblages associated with the recreational shore-based fishery is considered to be moderate as negative impacts on bycatch assemblages are evident, however, the level of impact has not influenced their overall recovery capacity, and a change in the overall trophic/community structure is not evident in most of the estuaries. It was considered 'likely' that this level of impact would occur from this activity reflecting the impact of the defined stressors from the activity against background variations and life history characteristics of harvested</p>	L	R

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					species which have characteristics of high resilience, and due to the amount of shore-based fishing effort in the in the regions, particularly adjacent to many estuaries. See section 8.1.3 for further details.		
Boat-based line and trap fishing	All	Moderate	moderate	likely	<p><b>Reduction in abundances of species and trophic levels</b> - the impact on harvested assemblages as a result of shore-based recreational fishing relates to approx. even levels of recent statewide landings taken from each region, dominated by several species which makes up a majority of the landings, and several that are either overfished, growth overfished or fully fished and/or have either moderate-high to low resilience.</p> <p>Overfished</p> <ul style="list-style-type: none"> <li>• Mulloway</li> </ul> <p>Growth overfished</p> <ul style="list-style-type: none"> <li>• Snapper</li> <li>• Silver trevally</li> </ul> <p>Fully fished:</p> <ul style="list-style-type: none"> <li>• Yellowfin bream</li> <li>• Luderick</li> <li>• Sand whiting</li> </ul> <p>In addition, several species of sharks and rays are taken, most of which has low resilience.</p> <p><b>Bycatch</b> – risks from bycatch of assemblages associated with the recreational shore-based fishery is considered to be moderate as negative impacts on bycatch assemblages are evident, however, the level of impact has not influenced their overall recovery capacity, and a change in the overall trophic/community structure is not evident in most of the estuaries. It was considered 'likely' that this</p>	L	R

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			moderate	moderate	likely	level of impact would occur from this activity reflecting the impact of the defined stressors from the activity against background variations and life history characteristics of harvested species which have characteristics of high resilience, and due to the amount of shore-based fishing effort in the regions, particularly adjacent to many estuaries. See section 8.1.3 for further details.		
	Hand gathering	All	moderate	moderate	likely	<b>Reduction in abundances of species and trophic levels</b> - moderate impacts considered likely reflecting the life-history characteristics of several of these reef associated harvested species (including lobster, crabs, abalone, whelks, octopus, sea urchins and cunjevoi) which indicates relatively moderate-low resilience. See section 8.1.3 for further details.	L	L
	Spearfishing	All	low	minor	likely	<b>Reduction in abundances of species and trophic levels</b> – only minor impacts considered likely reflecting the amount of fishing effort at a local scale and the life-history characteristics of several of these reef associated harvested species (including red morwong, rock cale, leatherjackets, girellids), which indicates relatively low resilience. See section 8.1.3 for further details.	L	R
Recreation and tourism	Shark meshing of swimming beaches	Central	low	minor	likely	<b>By-catch</b> - only minor impacts considered likely reflecting the amount by-catch, particularly of species with moderate to high resilience due to their life-history characteristics.	A	R: restricted to beaches where meshing occurs, but this is widespread throughout the bioregion

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## Threatened and protected fish and sharks

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
Commercial fishing	Ocean Trap and Line (OTL)	North	high	major	likely	<b>Incidental catch of species of conservation concern</b> - major impacts considered likely with higher bycatch of grey nurse sharks on north coast that will result in on-going negative impacts that will affect the recovery of the species. See section 8.1.2 for further details.	L	R
		Central	moderate	moderate	likely	<b>Incidental catch of species of conservation concern</b> - moderate impacts considered likely reflecting the fact that ocean trap and line catch and effort occurs in coastal waters in the bioregion, and interaction with white sharks and grey nurse sharks in coastal waters. Many individuals of a threatened or protected species are or will be measurably negatively affected. Nevertheless, no on-going impact on local dynamics or overall number of individuals is or will be evident, and the impact has not or will not significantly affect recovery of already threatened species. See section 8.1.2 for further details.	A	R
		South						
	Ocean Trawl (OT)	North	moderate	moderate	likely	<b>Incidental catch of species of conservation concern</b> - moderate impacts considered likely reflecting the fact that ocean trawl catch and effort occurs at a higher level in coastal waters of the regions, and interaction occurs with syngnathids and grey nurse sharks in coastal waters. See section 8.1.2 for further details.	L	R
		Central						
		South	low	minor	likely	<b>Incidental catch of species of conservation concern</b> - only minor impacts considered likely reflecting lower level in coastal waters of the region, and interaction occurs with syngnathids	L	R

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						and grey nurse sharks in coastal waters. See section 8.1.2 for further details.		
	Ocean Haul	All	low	minor	likely	<b>Incidental catch of species of conservation concern</b> – only minor impacts considered likely reflecting limited evidence to indicate that ocean haul activities impact on threatened and protected fish and sharks in all regions. See section 8.1.2 for further details.	L	L
Charter fishing	Line fishing	All	low	minor	likely	<b>Incidental catch of species of conservation concern</b> - only minor impacts considered likely reflecting limited evidence to indicate that charter line fishing activities impact on threatened and protected fish and sharks in all regions. See section 8.1.2 for further details.	L	R
Recreational fishing	Shore-based line and trap fishing	North	moderate	moderate	likely	<b>Incidental catch of species of conservation concern</b> - moderate impacts considered likely reflecting the amount of shore-based fishing effort on both beaches and rocky shores throughout the regions, and the likely interaction with grey nurse sharks, particularly juveniles. See section 8.1.3 for further details.	L	R
		Central						
		South	low	minor	likely	<b>Incidental catch of species of conservation concern</b> - only minor impacts considered likely reflecting the likely interaction with grey nurse sharks, particularly juveniles in this region. See section 8.1.3 for further details.	L	R
	Boat-based line and trap fishing	All	moderate	moderate	likely	<b>Incidental catch of species of conservation concern</b> - moderate impacts considered likely reflecting the amount of boat-based fishing effort throughout the regions, and the likely interaction with grey nurse sharks, particularly juveniles, and black cod. See section 8.1.3 for further details.	L	R
	Spearfishing and hand gathering	All	low	minor	likely	<b>Incidental catch of species of conservation concern</b> - impact was considered minor, and this level of impact was considered likely. This primarily reflects the fact that limited catch of grey nurse sharks and black cod in coastal waters is known to occur from this activity. See section 8.1.3 for further details.	L	L

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	Shark meshing of swimming beaches	Central	high	major	likely	<b>Incidental catch of species of conservation concern</b> - impact on threatened and protected sharks as a result of shark meshing of swimming beaches was considered major, and this level of impact was considered likely. This primarily reflects the fact that the activity is known to result in catch of white sharks and grey nurse sharks at levels that has resulted in it being identified as a key threatening process given the population status of these species. See section 8.1.8 for further details.	A	L
<b>Land-based impacts</b>								
Landuse intensification	Urban stormwater discharge	Central	low	minor	likely	<b>Physical disturbance</b> - impact on threatened and protected fish and sharks was considered minor, and this level of impact was considered likely, reflecting possible entanglement and ingestion of plastics. See section 8.2.1 for further details.	L	R
<b>Climate change</b>	<b>20 Years</b>					See section 8.3.1 for further details on all climate change threats.		
Climate change	Altered ocean currents & nutrient inputs	All	low	minor	likely	<b>Nutrient changes</b> - reduction of nutrients may result in changes in primary production, with minor impacts likely. See section 8.3.1 for further details.	L	R
	Ocean acidification	All	low	minor	likely	<b>Increased acidity</b> - only small pH changes over this time frame, with minor impacts likely. See section 8.3.1 for further details	I	R
<b>Climate change</b>	<b>50 Years</b>							
Climate change	Altered ocean currents & nutrient inputs	All	moderate	moderate	likely	<b>Nutrient changes</b> - changes to primary production associated with increased intensity of the EAC. This could lead to changes in upwelling regimes and either increases or decreases in nutrient concentrations and ratios, with moderate impacts likely. See section 8.3.1 for further details.	L	R
	Ocean acidification	All	moderate	moderate	likely	<b>Increased acidity</b> - acidity increases affect biota, with moderate impacts likely. See section 8.3.1 for further details	A	R

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## Appendix C Environmental Risk Matrices and Evidence

## Threatened and protected marine mammals, reptiles and birds

<u>Resource use</u>	<u>Activity</u>	<u>Region</u>	<u>Risk level</u>	<u>Conseq</u>	<u>Likelihood</u>	<u>Key stressors</u>	<u>Confidence</u> A: adequate L: limited I: inferred	<u>Spatial extent</u> L: local R: regional
Shipping	Large commercial vessels and associated port activities and industries	north	low	minor	likely	Limited vessel traffic. Risk localised off port of Yamba. See section 8.1.1 for further details.	L	L
		Central	high	major	likely	Increasing whale abundance together with increasing recreation and commercial shipping significantly increase risk of vessel strike especially on entering and leaving major ports during whale migration season. Naive calves and species that must remain on the surface following feeding dives (Sperm whale) are particularly vulnerable. Recovering populations of Southern Right Whale that nurse, enter and leave shallow bays and estuaries have low resilience to vessel strike, and wildlife disturbance which cause subsequent change behaviour. The impact of noise on marine mammals is well documented in the literature but poorly researched within the bioregion. Data show 10 year history of interactions. See section 8.1.1 for further details.	L	R: but most likely near major ports and shipping routes
		south	low	minor	likely	Limited vessel traffic. Risk localised off port of Eden. See section 8.1.1 for further details.	L	R
	Small commercial vessels (ferries,	north	moderate	moderate	likely	Physical disturbance – vessel strike, noise at a lower level. Impacts on humpbacks and marine turtles. See section 8.1.1 for further details.	L	R - Multiple ports, including offshore of Port Stephens,

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	charter boats, etc.)		moderate	moderate	likely			Port Mac, Coffs, Yamba, Richmond, Tweed
		central	moderate	moderate	likely	Increasing whale abundance together with increasing small commercial shipping significantly increase risk of vessel strike especially on entering and leaving major ports during whale migration season. Naïve calves and species that must remain on the surface following feeding dives are particularly vulnerable. Recovering populations of Southern Right Whale that nurse, enter and leave shallow bays and estuaries have low resilience to vessel strike, and wildlife disturbance which cause subsequent change behaviour. The impact of noise on marine mammals is well documented in the literature but poorly researched within the region. See section 8.1.1 for further details.	A	R: but most likely near major harbours
		south	moderate	moderate	likely	Physical disturbance – vessel strike, noise at lower level. Impacts on humpbacks and seals. See section 8.1.1 for further details.	L	R - Multiple ports, including offshore of Jervis Bay, Batemans Bay, Narooma, Eden
Commercial fishing	Ocean Trap and Line (OTL)	North  Central	moderate	moderate	likely	<b>Physical disturbance – entanglement</b> - the impact of OTL on threatened species is rated moderate because large whale entanglements occur regularly. The majority of entanglements are in line and trap gear, and are recorded in the NPWS marine incident database. These entanglements are the largest known anthropogenic threat to cetaceans recorded in the database. Accidental bycatch from entanglement in gear, and ingestion of baited hooks etc may be extensive across the state, but further research is required. <b>Marine debris</b> - seabird mortality reported to the Australian Bird and bat banding Scheme (ABBBS) as being recovered in fishing gear or 'human objects'/debris is relatively low. However, for	L	R: but most likely near major harbours

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					some species (such as Little penguin) it represented a major cause of mortality. See section 8.1.2 for further details.		
	South	Low	Minor	likely	Reduced effort and hence interactions. See section 8.1.2 for further details.	L	R
Ocean Trawl (OT)	North Central	moderate	moderate	likely	<b>Physical disturbance – entanglement</b> - interactions between trawl fishing and marine mammals and turtles is well documented internationally and nationally e.g. South Australia. There is no reason to suspect levels are lower in this region than elsewhere. Poor reporting on by-catch i.e. seals within the bioregion and elsewhere leads to under reporting. The threat is rated as likely to occur based on documented evidence from other regions, but there are uncertainties in these regions which influences the risk levels. The adoption by industry of turtle exclusion devices (TEDS) in the northern Australian commercial prawn trawl has had a significant impact on reducing the anthropogenic impact on this species. Turtle exclusion devices are not mandatory in NSW. See section 8.1.2 for further details.	I	R: but most likely near major harbours
	South		Minor	likely	Reduced effort and interactions. See section 8.1.2 for further details.	L	R
Ocean Haul (OH)	North	low	Moderate	possible	Bycatch of wildlife reported elsewhere. Likelihood is based on potential disturbance of nesting or roosting shorebirds/seabirds from noise and light caused by beach hauling activities with significance of impact dependant on species. See section 8.1.2 for further details.	I	R
Lobster	All	low	moderate	possible	Large whale entanglements in trap lines and floats occur regularly and increasingly, which poses a moderate threat to whales. The likelihood that this impact is derived from the Lobster fishery is rated as possible given the occurrence in Western Australia (Groom & Coughran 2014). In NSW coastal waters	A	R:

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						numbers very low and a moderate impact is only possible. See section 8.1.2 for further details.		
Charter fishing	Line fishing	All	low	moderate	likely	Incidental catch of seabirds on lines and entanglement from discarded gear is well documented from within estuaries outside the bioregion and are likely to occur similarly in the continental shelf of this bioregion. Literature suggests a capture rate of 0.36 (95% c.i.: 0.09 to 0.66) birds per 100 fisher hours. Data in the bioregion is insufficient to assess full impact. See section 8.1.4 for further details.	I	R:
Recreational fishing	Shore-based line and trap fishing	All	low	minor	likely	<b>Wildlife disturbance</b> – shorebirds including pied oyster catchers and sooty oyster catches. See section 8.1.3 for further details.	I	R
	Boat-based line and trap fishing	All	low	minor	likely	<b>Wildlife disturbance.</b> See section 8.1.3 for further details.	L	R: but most likely near major harbours
	Hand gathering	North South	low	minor	likely	See section 8.1.3 for further details.	L	L
Charter activities	Whale and dolphin watching	All	moderate	moderate	likely	<b>Wildlife disturbance</b> - the threat to cetaceans from whale and watching activities is rated as moderate. High levels of whale tourism in all regions. There is limited research on impacts e.g. noise, disturbance, displacement, stress, reduced fitness, behavioural change. See section 8.1.5 for further details.	L	R: but most likely near major harbours
Recreation and tourism	Swimming and surfing and passive use including dog walking	North South	low	minor	likely	<b>Physical disturbance, wildlife disturbance</b> - Interaction with some large whale species (common with SRWs) and potential infringement of approach distance regulations. Impacts resulting from interactions with shorebirds. See section 8.1.8 for further details.	I	R
		Central	moderate	moderate	likely	<b>Physical disturbance, wildlife disturbance</b> - Interaction with some large whale species and potential infringement of approach distance regulations. Impacts resulting from interactions	L	R

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						with shorebirds. See section 8.1.8 for further details.		
	Four wheel driving	North	high	major	likely	<b>Physical disturbance, wildlife disturbance</b> - Largely unregulated/permitted and generally restricted to certain beaches. Damage to nesting and foraging habitat for shorebirds, damage to nesting habitat for turtles. Disturbance of shorebirds at major roost and feeding sites may impact on breeding success and reduce migration capacity. See section 8.1.8 for further details.	A	L: restricted to relevant ocean beaches
		central	moderate	moderate	likely	<b>Physical disturbance, wildlife disturbance</b> - See section 8.1.8 for further details.	L	L: restricted to relevant ocean beaches
	Shark meshing of swimming beaches	Central	high	major	almost certain	Accidental entanglement of cetaceans and turtles. Managed under Joint Management Agreement reviewed 5-yearly. See section 8.1.8 for further details.	A	Illawarra to Newcastle
Dredging	Navigation & entrance management and modification, harbour maintenance etc.	all	low	moderate	possible	The impact of noise and disturbance on marine wildlife is well documented in the literature but poorly researched within the bioregion. Data are inadequate to make a clear assessment of the threat in this bioregion therefore it is rated as possible. See section 8.1.9 for further details.	I	R: but most likely near major harbours and estuaries
<b>Land-based impacts</b>								
Landuse intensification	Urban stormwater discharge	North South	low	minor	likely	Water pollution, marine debris - see section 8.2.1 for further details.	L	L
		Central	high	major	likely	Evidence of microplastics, marine debris and other contaminants impacting marine turtles, dolphins, seabirds. Some data from necropsies by Taronga Zoo in bioregion on ingestion of debris in threatened species. See section 8.2.1 for further details.	A	R: offshore of major urban centres
	Foreshore development	North south	low	minor	likely	See section 8.2.1 for further details.	L	L
Central		high	major	Almost certain	Impacts high on nesting shorebirds and turtles. Permanent loss of near shore habitat. Possible	A	R	

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						impacts on inshore dolphins. Again, legacy of existing development – unlikely to be replaced under current mgmt. settings. See section 8.2.1 for further details.		
	Beach nourishment and grooming	Central	moderate	moderate	Almost certain	Impacts high on nesting shorebirds and turtles. Impacts on foraging shorebirds. Number of beaches this occurs on fairly low. Threat would need to be reassessed if this changes. See section 8.2.1 for further details.	A	L
	Clearing riparian and adjacent habitat including wetland drainage	Central	high	major	likely	Loss of wetlands and habitat for migratory shorebirds likely to lead to local extinctions and additional declines to already threatened species. Activities that may lead directly to loss of wetland with existing management settings e.g. NSW Wetlands Policy, SEPP 14 coastal wetlands, zoning and land use controls, but threat may be from unauthorised activities/lack of compliance. See section 8.2.1 for further details.	A	L
Hydrologic modifications	Estuary entrance modifications	North South	low	minor	likely	<b>Wildlife disturbance</b> – minor impacts considered likely due to disturbance from dredging, mechanical openings, construction of walls etc. Most impacts are legacy issues and new developments are likely to have less impacts. See section 8.2.3 for further details.	L	R: all rocky shores adjacent to beaches in the vicinity of estuaries where modifications have occurred
<b>Climate change</b>	<b>20 years</b>					See section 8.3.1 for further details on all climate change threats.		
Climate change	Altered ocean currents & nutrient inputs	All	low	minor	likely	<b>Nutrient changes</b> - changes to EAC likely to impact turtles and foraging whales and dolphins. Swimming against changes current likely to impact fitness of migrating species. Changes to nutrients and subsequent fish abundance likely to impact higher order predators (seabirds, marine mammals, turtles	I	R
	Climate and sea temperature rise	All	low	minor	likely	<b>Elevated temperatures</b> - higher sea temp likely to change distribution and abundance of marine turtles further into bioregion (NPWS data showing increasing numbers and nesting). Changes in temp likely to impact	I	R

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					turtles nesting success and change the sex composition of population preliminary data being collected by NPWS. Changing climate triggers may impact whale migration and feeding behaviour in NSW waters. Changing dynamics of coastal wetlands likely to impact Ramsar Sites (shorebird protection sites) and internationally listed shorebird species.		
	Ocean acidification	All	low	minor	likely	Indirect effects from loss of habitat, decreased food availability for marine fauna	I R
	Altered storm/cyclone activity	All	moderate	moderate	likely	<b>Physical disturbance</b> - beach deterioration will impact shorebirds and seabird foraging. Increased pollution and marine debris. Increased mortality of marine fauna after extreme weather events	I R
	Sea level rise	All	high	major	likely	<b>Physical disturbance</b> - loss of habitat and nesting sites for shorebirds and turtles. Loss of shorebirds foraging habitat. Loss of intertidal foraging habitat including seagrass.	I R
	Flooding, storm surge, inundation	All	low	minor	likely	<b>Physical disturbance</b> - some loss of habitat and nesting sites for shorebirds and turtles. Loss of shorebirds foraging habitat. Impacts on intertidal foraging habitat, including seagrass.	I R
<b>Climate change</b>	<b>50 years</b>						
Climate change	Altered ocean currents & nutrient inputs	All	high	major	likely	<b>Nutrient changes</b> - changes to EAC likely to impact turtles and foraging whales and dolphins. Swimming against changes current likely to impact fitness of migrating species. Changes to nutrients and subsequent fish abundance likely to impact higher order predators (seabirds, marine mammals, turtles)	I R
	Climate and sea temperature rise	All	high	major	likely	<b>Elevated temperatures</b> - sea temp likely to change distribution and abundance of marine turtles further into bioregion. Changes in temp likely to impact turtles nesting success and change the sex composition of turtles. Temp may impact migration of whales. Dynamics of coastal wetlands likely to change impacting shorebirds	I R

Appendix C Environmental Risk Matrices and Evidence

Ocean acidification	All	High	major	likely	Indirect effects from loss of habitat, decreased food availability for marine fauna	I	R
Altered storm/cyclone activity	All	moderate	moderate	likely	<b>Physical disturbance</b> - beach deterioration will impact shorebirds and seabird foraging. Increased pollution and marine debris. Increased mortality of marine fauna after extreme weather events	I	R
Sea level rise	All	high	major	likely	<b>Physical disturbance, wildlife disturbance</b> - loss of habitat and nesting sites for shorebirds and turtles. Loss of shorebirds foraging habitat. Loss of intertidal foraging habitat, including seagrass.	L	R
Flooding, storm surge, inundation	All	high	major	likely	<b>Physical disturbance, wildlife disturbance</b> - Loss of habitat and nesting sites for shorebirds and turtles. Loss of shorebirds foraging habitat. Impacts on intertidal foraging habitat, including seagrass.	I	R



## Appendix D Social and Economic Risk Matrix and Evidence

## Social and Economic TARA - Statewide

Tier 1 benefits		Social benefits															Economic benefits											
		Participation						Enjoyment						Cultural heritage & use			Indirect values			Viability of businesses			Direct values					
Tier 2 benefits		Safety, health & wellbeing (including relaxation)			Socialising & sense of community			Enjoying the biodiversity & beauty of the marine estate (social intrinsic value)			Consumptive use (extracting)			Tangible Aboriginal cultural heritage (historic objects, places, items, and source of food)			Intangible Aboriginal heritage (traditions, practices, knowledge, spiritual values)			Intrinsic & bequest values (economic intrinsic value)			Employment & value of production			Individual enjoyment value (consumer surplus)		
Social and Economic Threats		North	Central	South	North	Central	South	North	Central	South	North	Central	South	North	Central	South	North	Central	South	North	Central	South	North	Central	South	North	Central	South
Tier 1 threats	Stressors																											
Resource use conflict	Conflict over resource access and use	Low	Low	Low	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
	Anti-social behavior and unsafe practices	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Minimal	Low	Minimal	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Low	Low	Moderate	Low	Moderate	Low	
	Overcrowding / congestion	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Moderate	Low	Minimal	Minimal	Minimal	Low	Moderate	Low
	Loss or decline of marine industries	Moderate	Low	Moderate	Low	Minimal	Low	Minimal	Minimal	Minimal	Moderate	Low	Moderate	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal	Moderate	Moderate	Moderate	Minimal	Minimal	Minimal
	Excessive or illegal extraction	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low
Environmental	pollution and sewage overflows (such as outfalls, STPs, etc)	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Low	Low	Low	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Low	Minimal	Minimal	
	Water pollution on environmental values - urban stormwater discharge	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Low	Moderate	Moderate	
	Water pollution on environmental values - Agricultural diffuse source runoff	Moderate	Low	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Low	Moderate	Low	
	Water pollution on environmental values - litter, solid waste, marine debris and microplastics	Low	Moderate	Low	Low	Moderate	Low	Moderate	Moderate	Moderate	Low	Moderate	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Low	Low	Moderate	Low	Moderate	Low	
	Wildlife disturbance (Shorebirds, Turtles, Whales) by dog walkers, 4WD, marine vessels, etc	Low	Low	Low	Low	Low	Low	Moderate	Moderate	Moderate	Minimal	Minimal	Minimal	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low
	Habitat (physical) disturbance (e.g. from foreshore development, commercial and recreational fishing methods, four wheel driving, and extractive industries (mining).	Low	Low	Low	Low	Low	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low
	Reductions in abundances of species and trophic levels	Low	Low	Low	Low	Low	Low	Moderate	Moderate	Moderate	High	High	High	Moderate	Moderate	Moderate	Low	Low	Low	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Low	Low	Low
	Pests and diseases	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	Low	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
	Modified hydrology/hydraulics and flow regime	Low	Low	Low	Moderate	Moderate	Moderate	Low	Low	Low	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
	Sediment contamination (toxicants in sediment; dioxins in Sydney Harbour, Cooks River)	Low	Moderate	Low	Low	Moderate	Low	Low	Moderate	Low	Low	Moderate	Low	Low	Low	Low	Low	Low	Low	Low	Moderate	Low	Low	Moderate	Low	Low	Moderate	Low
Climate change stressors (sea level rise, altered storm/cyclone activity, flooding, climate and sea temperature rise, altered ocean currents and nutrient concentrations, etc)	High	High	High	High	High	High	High	High	High	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Low	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	
Governance of the marine estate	Inadequate, inefficient regulation, over-regulation (agencies)	Moderate	Moderate	Moderate	Low	Low	Low	Low	Moderate	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
	Lack of or ineffective community engagement or participation in governance	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Moderate	Moderate	Moderate	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
	Lack of community awareness of the marine estate, associated threats and benefits, regulations and opportunities for participation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Moderate	Low	Low	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	Low	Low	Low	Low
	Lack of compliance with regulations (by users) or lack of compliance effort (by agencies)	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Moderate	Moderate	Moderate	Low	Low	Low
Public safety	Wildlife interactions (e.g. shark bite, jellyfish, boat striking a whale)	Moderate	Low	Low	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal
	Seafood contamination	Low	Moderate	Low	Low	Minimal	Low	Minimal	Minimal	Minimal	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	Low	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Minimal
	Other water pollution/contamination affecting human health and safety (such as toxic algal blooms, e. coli concentrations, etc)	Low	Low	Low	Low	Low	Low	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Critical knowledge gaps	Inadequate social and economic information	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Lack of access availability	Limited or lack of access infrastructure to the marine estate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Moderate	Low	Moderate	Low
	Loss of public access (either by private development or Government area closures)	Low	Low	Low	Low	Low	Low	Low	Low	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	Low

Key to cell numbers to assist in navigating justifications

Tier 1 benefits		Social benefits																		Economic benefits								
		Participation						Enjoyment						Cultural heritage & use						Indirect values			Viability of businesses			Direct values		
		Safety, health & wellbeing (including relaxation)			Socialising & sense of community			Enjoying the biodiversity & beauty of the marine estate			Consumptive use			Tangible Aboriginal cultural heritage (historic objects, places, items, and source of food)			Intangible Aboriginal heritage (traditions, practices, knowledge, spiritual values)			Intrinsic & bequest values			Employment & value of production			Individual enjoyment value (consumer surplus)		
Tier 2 benefits		North	Central	South	North	Central	South	North	Central	South	North	Central	South	North	Central	South	North	Central	South	North	Central	South	North	Central	South	North	Central	South
<b>Social and Economic Threats</b>																												
<b>Tier 1 threats</b>																												
<b>Stressors</b>																												
<b>Resource use conflict</b>	Conflict over resource access and use	1			2			3			4			5			6			7			8			9		
	Anti-social behavior and unsafe practices	10			11			12			13			14			15			16			17			18		
	Overcrowding/congestion	19			20			21			22			23			24			25			26			27		
	Loss or decline in marine industry viability or ability to operate	28			29			30			31			32			33			34			35			36		
	Excessive or illegal extraction	37			38			39			40			41			42			43			44			45		
<b>Environmental</b>	Water pollution on environmental values - point source pollution and sewage overflows (such as outfalls, STPs etc)	46			47			48			49			50			51			52			53			54		
	Water pollution on environmental values - urban stormwater discharge	55			56			57			58			59			60			61			62			63		
	Water pollution on environmental values - Agricultural diffuse source runoff	64			65			66			67			68			69			70			71			72		
	Water pollution on environmental values - litter, solid waste, marine debris and microplastics	73			74			75			76			77			78			79			80			81		
	Wildlife disturbance (Shorebirds, Turtles, Whales) by dog walkers, 4WD, marine vessels, etc	82			83			84			85			86			87			88			89			90		
	Habitat (physical) disturbance from foreshore development, commercial and recreational fishing methods, boating and boating infrastructure, recreation and tourism (four wheel driving, beach grooming) and extractive industries (mining).	91			92			93			94			95			96			97			98			99		
	Reductions in abundances of top and lower order trophic levels from commercial, recreational and charter fishing	100			101			102			103			104			105			106			107			108		
	Pests/diseases	109			110			111			112			113			114			115			116			117		
	Modified hydrology/hydraulics and flow regime	118			119			120			121			122			123			124			125			126		
	Sediment contamination (toxicants in sediment; dioxins in Sydney Harbour, Cooks River)	127			128			129			130			131			132			133			134			135		
Climate change stressors (sea level rise, altered storm/cyclone activity, flooding, climate and sea temperature rise, altered ocean currents and nutrient inputs)	136			137			138			139			140			141			142			143			144			
<b>Governance of the marine estate</b>	Inadequate, inefficient regulation or over-regulation (agencies)	145			146			147			148			149			150			151			152			153		
	Lack of or ineffective community engagement or participation in governance (lack of evidence; lack of political standing; casual users who may not have English as 1st language, too much/display of information)	154			155			156			157			158			159			160			161			162		
	Lack of community awareness of the marine estate, associated threats and benefits, regulations and opportunities for participation	163			164			165			166			167			168			169			170			171		
	Lack of compliance with regulations (by users) or lack of compliance effort (by agencies)	172			173			174			175			176			177			178			179			180		
<b>Public safety</b>	Wildlife interactions (e.g. shark bite, jellyfish, boat striking a whale)	181			182			183			184			185			186			187			188			189		
	Seafood contamination	190			191			192			193			194			195			196			197			198		
	Other water pollution/contamination affecting human health and safety (such as toxic algal blooms, e. coli concentrations, etc.)	199			200			201			202			203			204			205			206			207		
<b>Critical knowledge gaps</b>	Inadequate social and economic information	208			209			210			211			212			213			214			215			216		
<b>Lack of access availability</b>	Limited or lack of access infrastructure to the marine estate	217			218			219			220			221			222			223			224			225		
	Loss of public access (either by private development or Government area closures)	226			227			228			229			230			231			232			233			234		

## Appendix D Social and Economic Risk Matrix and Evidence

Draft Statewide TARA – social and economic justification table.

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence	Spatial extent	Temporal	Trend
					A, L, I (?)	Local (site) Regional Statewide	1-2 years 10 years 20 years	Decreasing Stable Increasing
1	Moderate	Possible	Low	<p>Conflict between sectors relating to resource access and use is common across the state. While highly localised and sectoral (rather than community wide) these issues were considered to be of a moderate consequence because they occur with sufficient frequency and regularity to justify consideration at a state wide spatial scale. Specific examples including the <i>possible</i> impacts to safety, health and wellbeing include:</p> <ul style="list-style-type: none"> <li>• Safety: anecdotal reports of physical threats assaults and intimidations between competing sectors or between individuals within a sector and links between high value resources (esp. abalone) and organised crime (expert opinion). Danger from competing activities such as powered vessels and passive uses (swimmers) [1]</li> <li>• The Marine Estate Community Survey results identified danger to swimmers from watercraft as the third priority social threat for the NSW general population (31%) and the South East (36%) region. Intercept survey participants in Hawkesbury / Pittwater shared this third priority (23%). Impacts of fishing on snorkeling and Scuba diving were identified as a lower priority threat [1].</li> <li>• Health: implications for mental and physical health associated with above mentioned conflict and dispute, especially within the commercial fishing</li> </ul>	L	Local but common across the state in localised settings	1-2 years	Stable

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				<p>sector. FRDC study by King <i>et al.</i> highlighted the impact of conflict between recreational and commercial fishers on the mental health of fishers. In addition lack of bonding social capital within the industry is having a detrimental impact on fisher health and ability to engage with the community and policy makers [2, 3]</p> <ul style="list-style-type: none"> <li>Wellbeing (including relaxation): the relaxation benefits associated with use of the coast can be threatened by competing use of coastal land (e.g. development of the coastal zone) and restriction of public access (e.g. through area closures, physical barriers, changes to access arrangements such as roads etc.). An upcoming report into recreational fishing motivations highlights the importance of relaxation and escape as a key motivation of the vast majority of recreational fishers throughout the state. Barriers identified through this study included concerns associated with conflict with commercial fishing and loss of access through MPAs [4].</li> </ul>					
2	Moderate	Possible	Low	<p>Socialising and sense of community are threatened when groups become marginalised or isolated. There are a number of examples of highly sectoral and localised instances resource conflict. The moderate consequence ranking reflects the major impacts of resource conflict on these sectoral groups. These include:</p> <ol style="list-style-type: none"> <li>Increasing feelings of marginalisation</li> </ol>	L	Local but common across the state in localised settings	1-2 years	Stable	

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal		Trend Decreasing Stable Increasing
						Local (site) Regional Statewide		1-2 years 10 years 20 years		
				<p>occurring within the NSW commercial fishing industry as a result of poor relationships with some sections of the community, including ongoing lobbying throughout the state to have areas closed to commercial fishing [3]</p> <ol style="list-style-type: none"> <li>Conflict between different cultural groups within the community – e.g. animosity towards Asian, European and Pacific Island nationalities around different conceptions of what constitutes acceptable fishing practices ([4] and see [5]).</li> <li>Concerns around marginalisation and discrimination within Indigenous communities relating to cultural fishing and Indigenous commercial fishing [3, 6-8]</li> </ol> <p>There is limited information to determine the extent to which these impacts are threatening community wide socialisation and cohesion, however they do suggest the likelihood is <i>possible</i>.</p>						
3	Minor	Possible	Minimal	<p>Conflict over resource use and access may impact enjoyment and appreciation of biodiversity if members of the community believe that beauty or biodiversity values are declining as a result of the actions of a particular sector or user group. For example divers/passive users may feel that their enjoyment and appreciation is impacted by extractive users (e.g. of divers and fishing in Sweeney report, also known as the Marine Estate Community Survey [1]).</p> <p>The level of community support for MPAs, and marine</p>	L	Local		1-2 years	Stable	

Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				<p>biodiversity protection is high and MPAs are considered the primary tool for biodiversity protection. In the 2009 'Who Cares about the Environment Report', 85% of respondents agreed or strongly agreed that some areas of the marine environment should be protected, even if it means recreational fishing and commercial fishing is excluded [40]. In the 2012 Who Cares about the Environment Report, an increasing trend was captured that the community thought the most important environment initiative is the creation of new national parks, reserves, conservation areas or marine parks (increased to 2% from &lt;0.5% in 2009) [41]. The Marine Estate Community Survey results identified that 67% of people feel that some areas of the marine estate should be protected, even if it means recreation and commercial fishing is excluded and only 3% disagree. Despite this high level of support resistance from the recreational and commercial fishing sectors may threaten the ability of the State to further expand the NSW MPA networks or strengthen existing zoning arrangements. In addition the nature of debates around MPA protection can be highly divisive and polarised, threatening community cohesion [6].</p> <p>The consequences of these conflicts are considered <i>minor</i> since they are largely temporary or concentrated on individual sectors. Likelihood, particularly in relation to conflicts relating to MPAs, is also influenced by new approaches to managing the marine estate which acknowledge some of the fundamental issues that</p>				

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				recreational fishers have with MPAs (i.e. by managing according to threats rather than perceived conservation targets) should assist to manage some of this conflict. Likelihood is therefore considered to be <i>possible</i> .				
4	Moderate	Possible	Low	The consequence of resource conflict on consumptive use is considered <i>moderate</i> as it is highly sectoral and relate almost exclusively to the major consequences for recreational and commercial fishing resulting from conflict between these sectors. Both sectors believe the actions of the other results in decline in their consumptive use values – recreational fishers consider commercial extraction to be impacting their catches which influences them to lobby for closures or further restrictions in commercial fishing [4]. If successful, this has the potential to limit the ability of the industry to supply seafood markets despite widespread consumer demand for local seafood and bait products [3]. The NSW Marine Estate Community Survey results highlighted that the NSW general population values the variety of seafood to catch and eat (34%). This priority benefit was also similar across the North East, Central and South East regions. The likelihood of these consequences is influenced by the regulations and management arrangements implemented to mitigate resource conflict between these sectors and is therefore considered <i>possible</i> .	L	Regional	1-2 years	Stable
5	Minor	Likely	Low	Conflict over resource use and allocation is already occurring between the recreational, commercial and	L	Local	1-2 years	Increasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal		Trend Decreasing Stable Increasing
						Local (site) Regional Statewide		1-2 years 10 years 20 years		
				<p>cultural fishing sectors. Aspirations around improved cultural fishing rights are likely to be resisted by other sectors and conflict will increase as these rights are pursued. Moderate consequences on this sector (or an overall <i>minor</i> consequence community wide) are therefore <i>likely</i> and include concerns around marginalisation and discrimination within Indigenous communities relating to cultural fishing and Indigenous commercial fishing [3, 6-8]</p> <p>Examples highlighted in workshop discussions include: local South Coast Abalone and some issues with pipis on the north coast. Risk relates to equitable resource allocation and particularly to community attitudes and beliefs around which sectors should be prioritised in resource allocation exercises. For example interviews and other interactions with recreational fishers indicate that some feel there are equity issues around fishing regulations (e.g. allowable catch) between the recreational and cultural fishing sectors which may increase the risk of social conflict in relation to this issue.</p> <p>Reduced fish stocks was raised by Aboriginal people who were consulted in the Hawkesbury bioregion as an impact on cultural fishing particularly evident around Lake Macquarie [36].</p>						
6	Minor	Likely	Low	Intangible Aboriginal heritage can be impacted by conflict over resource access and use. There are many factors affecting the capacity to conduct cultural	L	Local		1-2 years	Increasing	

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				traditions, ranging from poor health of elders, to access restrictions on resources and resource collecting places [7], therefore negative impacts specifically relating to resource conflict are considered to be of moderate consequence for the Indigenous community (or an overall <i>minor</i> consequence community wide).				
7	Minor	Likely	Low	<p>The intrinsic benefit of the marine estate was identified as one of the most important economic benefits identified in the Marine Estate Community Survey [1]. Conflict between sectors diminishes the intrinsic and bequest values held by people, although given these incidents are highly localised, the consequence at a community-wide scale is expected to be only minor.</p> <p>See examples of conflict over resource use provided in justification 1 for instances that could impact intrinsic values.</p>	L	Local	1-2 years	Increasing
8	Minor	Likely	Low	<p>Resource use conflict can have impacts on the viability of businesses (e.g. commercial fishing vs. rec fishing will impact the viability of commercial fishers and businesses that support recreational fishers). These impacts have the potential to be significant for that user group, but minor at a community-wide scale.</p> <p>Extractive industries which negatively impact the marine estate by disturbing habitats or removing environmental assets could also negatively impact on other businesses such as tourism operators. However, the net economic impact of such activities may not be</p>	L	Local (e.g. Pittwater)	1-2 years	Increasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				necessarily negative (i.e. the economic benefits of extraction could equal or outweigh the lost economic benefits from tourism activities).				
9	Minor	Likely	Low	<p>Conflict over resource use will diminish direct values where people are unable to access or enjoy the marine estate. For instance, conflict between competing sectors may make recreational areas more threatening for people to visit, thereby diminishing their enjoyment value.</p> <p>Groups that are marginalised or isolated as a result of conflict over resource use are also likely to see their direct use benefits diminished.</p> <p>Given the highly localised nature of these incidents, the community-wide impact is only likely to be minor.</p>	L	Local	1-2 years	Increasing
10	Moderate	Likely	Moderate	<p>While there are some safety concerns from unsafe practices, largely associated with inappropriate use of powered vessels [1], this is effectively managed through enforcement of maritime safety regulations by water police and maritime officers, reducing the likelihood of these consequences. The more significant community wide impact relates to impacts of wellbeing, especially relaxation.</p> <p>The Marine Estate Community Survey results identified anti-social behaviour as the main threat to the social benefits of the NSW marine estate by the NSW general population (58%). This is also the case in North East Region (60%) and South East Region (72%) and a second priority in the Central region</p>	L	Local	1-2 years	Increasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				<p>(60%). Similarly, anti-social behaviour affecting safety and enjoyment was the second highest social threat for the Coffs Harbour (43%), Newcastle (44%), Sydney (41%) and Batemans Bay (35%) participants. This threat was listed as the highest threat by Ballina (48%), Hawkesbury/Pittwater (54%) and Eden (49%) intercept survey participants [1].</p> <p>Continued and ongoing experiences of anti-social behaviour are likely to deter community use of the marine estate. The notion of what constitutes anti-social behaviour is likely to differ significantly across the community. Inappropriate use or anti-social behaviour is variously described as loud or obnoxious behaviour, leaving rubbish behind, drunkenness, illegal fishing or overfishing etc. More research is required to understand differing community expectations (social norms) in relation to appropriate use of the marine estate. The high level of community concern about this issue suggests <i>moderate</i> (discernible and ongoing) state and community wide consequences are <i>likely</i> as a result of anti-social behaviour.</p>					
11	Moderate	Likely	Moderate	<p>Social benefits and values cannot be considered as homogenously applicable across the community. Different sections of the community seek different benefits from their recreational activities, some of the activities are incompatible (e.g. jet skis vs quiet contemplation), and increased population and increasing competition for use of the marine estate is likely to impact some individuals/ groups more than</p>	L	Local		1-2 years	Increasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				others. There was a high level of concern in relation to this threat in the Marine Estate Community Survey across all three regions, suggesting this may already be impacting community cohesion and social relationships. The high level of community concern about this issue suggests <i>moderate</i> (discernible and ongoing) state and community wide consequences are <i>likely</i> as a result of anti-social behaviour.				
12	Moderate	Likely	Moderate	As well as impacting social relationships conflicting ideas about what constitutes acceptable use of the marine estate may have differential impacts on community enjoyment of the biodiversity and beauty of the marine estate. Literature contained within leisure studies (e.g. recreational opportunity spectrums/ tourism opportunity spectrums etc.) demonstrate that some users seek 'wilderness' type experiences while other look for more active ways of enjoying the natural environment [9]. Major impacts are likely to be felt particularly by users who value these wilderness experiences. More broad community wide impacts are likely if continued anti-social behaviour diminishes the ability for people to connect with and appreciate the natural environment. The high level of community concern about this issue suggests <i>moderate</i> (discernible and ongoing) state and community wide consequences are <i>likely</i> as a result of anti-social behaviour.	L	Local	1-2 years	Increasing
13	Minor	Possible (N&S)	Minimal (N&S)	Moderate impacts (overall minor community wide consequences) may be associated with a loss of	L	Local	1-2years	Stable

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
		Likely (C)	Low (C)	consumptive use if recreational fishing declines in response to anti-social behaviour. The likelihood of these consequences is unknown but considered <i>possible</i> . The greater population of the Central Region increases the likelihood to <i>likely</i> .					
14	Moderate	Almost certain	Moderate	Anti-social behaviour and unsafe practices can impact on tangible Aboriginal cultural heritage such as source of food and damage or vandalism of significant cultural heritage places or artefacts [7]. Loss or damage to significant places is almost certain to have major consequences on the tangible cultural heritage of affected Aboriginal communities and moderate statewide consequences.	L	Local		1-2 years	Increasing
15	Moderate	Likely	Moderate	Anti-social behaviour and unsafe practices can impact on intangible Aboriginal heritage including ability to practice cultural or traditional use of sites [7]. There are many factors affecting the capacity to conduct cultural traditions, ranging from poor health of elders, to access restrictions on resources and resource collecting places [7], therefore negative impacts specifically relating to anti-social behaviour are considered to be of moderate consequence for the Indigenous community.	I	Local		1-2 years	Increasing
16	Moderate	Possible (N&S) Likely (C)	Low (N&S) Moderate (C)	Anti-social behaviour and unsafe practices are seen as key threats to the safety and enjoyment people derive from the marine estate as identified by the Marine Estate Community Survey [1] which diminishes the intrinsic and bequest values they derive. The impacts are likely to be more significant at a localised scale where people have strong perceptions about some	L	Local		1-2 years	Increasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				<p>localities (e.g. perceptions of Cronulla remain as a result of the 2005 riots).</p> <p>Anti-social behaviour is highly localised and therefore unlikely to have widespread or long-term impacts on intrinsic and bequest values, leading to a consequence rating of moderate. The strong focus on anti-social behaviour in the community survey suggests that the community is aware of current issues and that future consequences are likely to occur.</p> <p>Occurrence and impacts are expected to be greater in the higher density Central region.</p>					
17	Moderate	Possible (N&S) Likely (C)	Low (N&S) Moderate (C)	<p>Anti-social behaviour may have significant impacts on the viability of businesses and on employment in situations where people are deterred from visiting the marine estate. In particular, businesses that rely on visitors &amp; tourists could be significantly impacted (e.g. tourism operators, cafes &amp; restaurants, fishing operators).</p> <p>In instances where anti-social behaviour is highly localised and ongoing, impacts on local businesses may be severe (e.g. businesses closing down due to low demand for goods and services), leading to a moderate consequence level.</p> <p>Occurrence and impacts are expected to be greater in the higher density Central region.</p> <p>(See example: Sydney Morning Herald 'Tourism braces for job losses if trouble persists' 19/12/2005; <a href="http://www.smh.com.au/news/national/tourism-braces-">http://www.smh.com.au/news/national/tourism-braces-</a></p>	L	Local	1-2 years	Increasing	

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				<a href="http://for-job-losses-if-trouble-persists/2005/12/18/1134840742474.html?page=fullpage#contentSwap1">for-job-losses-if-trouble-persists/2005/12/18/1134840742474.html?page=fullpage#contentSwap1</a>				
18	Moderate	Possible (N&S) Likely (C)	Low (N&S) Moderate (C)	<p>Different user groups in the community engage in different activities in the marine estate, and some activities for which people gain enjoyment value may be perceived by others as anti-social (e.g. loud and disruptive activities generate individual enjoyment value for those engaged in the activity but diminish usage value for others).</p> <p>In some cases, anti-social behaviour may deter people from visiting the marine estate, thereby diminishing the direct value that would be derived. The Marine Estate Community Survey identified danger to swimmers (e.g. from jet skis and boats) as the fourth most significant threat to social benefits and by extension, to the economic benefits of direct use [1].</p> <p>Given the trade-offs of enjoyment value between competing users, the net impact is likely to be only low, with moderate impacts in the higher population density Central region..</p>	L	Local	1-2 years	Increasing
19	Moderate	Likely (N&S) Almost certain (C)	Moderate	<p>Threats related to resource conflict (see justification 1) and anti-social behaviour (see justification 10) is likely to be exacerbated by overcrowding or congestion issues. Drivers include reduced access (regulatory or physical) for some or all sectors, causing concentration of use, and increasing population.</p> <p>The Marine Estate Community Survey identified overcrowding as a potential social threat that may</p>	L	Local	10 years	Increasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				impact on their desire to use the marine estate [1]. Therefore moderate consequences are considered likely in response to the threat of overcrowding and almost certain in Central region due to higher population levels.					
20	Moderate	Likely (N&S) Almost certain (C)	Moderate	Threats related to resource conflict (see justification 2) and anti-social behaviour (see justification 11) are likely to be exacerbated by overcrowding or congestion issues. Drivers include reduced access (regulatory or physical) for some or all sectors, causing concentration of use, and increasing population. Therefore <i>moderate</i> consequences are considered <i>likely</i> in response to the threat of overcrowding and <i>almost certain</i> in Central region due to higher population levels	L	Local		10 years	Increasing
21	Moderate	Possible	Low	Threats related to resource conflict (see justification 12) and anti-social behaviour (see justification 21) are likely to be exacerbated by overcrowding or congestion issues. Drivers include reduced access (regulatory or physical) for some or all sectors, causing concentration of use, and increasing population. There is evidence that overcrowding is of particular concern to surfers especially when it leads to instances of 'localism' [37]  The Marine Estate Community Survey results identified loss of appeal due to overcrowding was identified as the top third social threat by the NSW general population (31%), North East (33%) and Central (35%) regions. Intercept survey participants in Sydney also identified overcrowding as their third priority threat	L	Local		10 years	Increasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				(22%). Analysis of perceived social threats indicates that people are cautious that tourism should not cause over-crowding in popular tourist destinations. Overcrowding can have a negative impact on people's enjoyment of the marine estate as well as impacting on the environment [1]. Therefore <i>moderate</i> consequences are considered <i>possible</i> in response to the threat of overcrowding.					
22	Moderate	Possible	Low	Threats related to resource conflict (see justification 4) are likely to be exacerbated by overcrowding or congestion issues. Drivers include reduced access (regulatory or physical) for commercial or recreational fishing sectors, causing concentration of use, and increasing population. Moderate consequences are considered <i>possible</i> in response to the threat of overcrowding.	L	Local		10 years	Increasing
23	Minor	Almost certain	Low	Overcrowding/congestion can impact on tangible Aboriginal heritage e.g. source of food by too much competition causing a reduction in natural resources [7].	I	Local		1-2 years	Increasing
24	Minor	Almost certain	Low	Overcrowding/congestion can impact on intangible Aboriginal Heritage. It can impact on use of marine organisms in cultural practices such as burial sites, or in ceremonial use, post-contact sites of resource gathering and/or associated communal activities e.g. campsites, meeting places [7] e.g. of places such as Mystery Bay which have traditionally been important camps for Aboriginal people but are now popular camping sites within non-Indigenous communities as	I	Local		1-2 years	Increasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				well.					
25	Moderate	Likely (C) Possible (N&S)	Low (N&S) Moderate (C)	The 'loss of appeal due to overcrowding' was identified as the third most significant social threat to the marine estate as identified in the Marine Estate Community Survey [1], which suggests the community is concerned with this issue and that their intrinsic and bequest values are under threat. In the central region where the population density is greater, the likelihood of negative consequences is expected to be higher. Therefore, the consequence level is rated as moderate and likelihood is <i>likely</i> in the central region and <i>possible</i> in the north and south regions Overcrowding is expected to increase as an issue due to population increases in NSW.	L	Local		1-2 years	Increasing
26	Insignificant	Unlikely	Minimal	Overcrowding and congestion are unlikely to have negative impacts on the viability of businesses and on employment, as overcrowding should contribute to more business opportunities rather than less (more visitors means more customers). Therefore the negative consequences are rated as insignificant.  In the long term and without adequate policy responses, overcrowding and congestion may cause areas to become run-down, thereby negatively impacting business viability.	I	Local		1-2 years; potential longer term impacts - 10 years	Increasing
27	Moderate	Possible (N&S) Likely	Low (N&S) Moderate	The 'loss of appeal due to overcrowding' was identified as the third most significant social threat as identified in the Marine Estate Community Survey [1], which	L	Local		1-2 years	Increasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
		(C)	(C)	<p>directly impacts the individual enjoyment value people derive. As with justification 25, the likelihood in the central region is expected to be higher than in the northern and southern regions.</p> <p>Conversely, overcrowding suggests that many people currently derive value from using the marine estate (because they choose to visit it), and therefore the net enjoyment value impact may be overstated.</p> <p>Overcrowding is expected to increase as an issue due to population increases in NSW.</p>					
28	Minor (C) Moderate (N&S)	Likely	Low (C) Moderate (N&S)	<p>Marine industries deliver a range of social and economic benefits to community wellbeing, including the mental and physical wellbeing associated with employment and income, potential health benefits associated with seafood consumption and the possibility of future health benefits associated with marine biotechnology and pharmaceuticals. Threats to the viability of these industries are usually cumulative and may include:</p> <ul style="list-style-type: none"> <li>• Social licence: currently a major concern for the commercial fishing industry and to a lesser extent the recreational fishing and aquaculture industries</li> <li>• Degradation of the marine resources the industries rely on (see environmental threats listed below): currently a major concern for the aquaculture industry, especially in relation to disease and water quality concerns</li> <li>• Competition with other sectors for limited resources or access (see Justification 1): currently</li> </ul>	A	Regional	10 years	Stable	

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				<p>of concern to the commercial and recreational sectors, however evidence suggests many mutually beneficial links between these sectors too [3]. More broadly the cumulative impact of competition between housing/foreshore development, tourism, agriculture and a range of marine industries over use of coastal land can impact viability (eg increasing privatisation of wharves and harbours and associated costs for boat based businesses of mooring, repairs and docking etc).</p> <ul style="list-style-type: none"> <li>• Regulation (see regulation stressors) increasing costs of business, complexity of administrative arrangements or regulatory burden and limiting capacity for growth or investment through regulatory uncertainty: currently of concern for some aspects of commercial fishing [3] and a potential issue for emerging marine industries.</li> <li>• External economic and social pressures (e.g. downturns in tourism, downturns in markets): of particular concern for the marine tourism sector</li> </ul> <p>These concerns are of greater significance (moderate) in rural areas which are more reliant on maritime industries (north and south regions) and a <i>minor</i> consequence for central region. The current pressures experienced by a range of marine industries suggest these consequences are <i>likely</i></p>					
29	Minor (C) Moderate	Possible	Minimal (C) Low	Changes in the economic viability of traditional maritime industries can impact the community sense of	A	Regional		20 years	Increasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
	(N&S)		(N&S)	identity and place e.g. recent research undertaken indicated that the majority of NSW coastal residents would be concerned about the potential loss of community identity and character from further declines in the NSW commercial fishing and aquaculture industries [3], indicating an impact on the sense of community would be <i>possible</i> . This is likely to be of greater concern ( <i>moderate</i> ) for regional communities. Consequences would be less pronounced in more diversified economies in the Central Region ( <i>minor</i> ).					
30	Minor	Unlikely	Minimal	Decline in marine industries may impact enjoyment of marine biodiversity values/beauty in the marine tourism sector if opportunities for enjoyment and appreciation are limited by loss of businesses such as scenic tours, diving operations, whale watching etc. <i>Minor</i> consequences are considered <i>unlikely</i> .	L	Regional		10 years	Stable
31	Moderate	Likely (N & S) Possible (C)	Moderate (N & S), Low (C)	As detailed in justification 28 the cumulative threats on viability of particularly the commercial fishing sector relating to social licence, competition with other sectors and regulatory pressure has potentially significant sectoral specific consequences for that industry and wider implications for the availability of goods or services to local communities. The most likely marine industries facing significant viability challenges in NSW at present appear to be commercial fishing and aquaculture. Recent research undertaken indicates that local seafood is highly valued by regional communities [3] and opportunities to access fresh seafood from other sources/areas is more restricted in these regions,	A	Regional		1-2 years	Increasing (short term) Longer term decreasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				therefore the likelihood of the moderate consequence is higher in these regions ( <i>likely</i> in north and south, <i>possible</i> in central). Decline in local seafood will also have flow on impacts to a range of businesses that service the fishing industry and sell its products, including regional tourism [3].					
32	Minor	Possible	Minimal	There is some localised evidence that decline in marine industry viability may have impacted culturally significant sites (e.g. fishing hut at Trial Bay). This impacts are highly localised ( <i>minor</i> consequences) and inferred ( <i>possible</i> likelihood)	I	Local		10 years	Stable
33	Minor	Likely	Low	Decline in marine industry viability particularly professional fishing and aquaculture may impact the ability of Indigenous people to maintain traditional connections and employment in these industries. There is considerable evidence that Indigenous people employed in these industries consider their jobs as part of their cultural identity [6, 34]	L	Statewide		10 years	Increasing
34	-	-	Minimal	Not applicable. Where intrinsic value is understood as the inherent value of the marine estate, in and of itself, intrinsic value benefits are unlikely to be impacted by declining marine business viability.	-	-		-	-
35	Major	Possible	Moderate	If marine businesses viability declines, this will have direct impact on employment and production. In locations where marine industries are significant local employers or contribute significantly to local economies, consequences could be substantial as they would affect multiple user groups (business owners, support business, employees, families of	I	Local		20 years	Increasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				employees etc.). The likelihood of 'possible' has been assigned. There is limited information on the net decline in marine businesses, and regarding the growth of new marine businesses (such as related to tourism). It is recognised that the economy is not static, and net declines are not expected to be long term in economically diverse areas.					
36	-	-	Minimal	Not applicable, individual enjoyment value is unlikely to be impacted by declining marine business viability. Where declining business viability is a function of reduced demand, consumer surpluses are not expected to be impacted.	-	-	-	-	-
37	Moderate	Possible	Low	Illegal market sales of aquaculture and fisheries products presents a serious risk to consumer safety and the reputation of seafood. The extent of illegal market sales is not known, but the impact of seafood safety incident associated with such sales would extend not only to legitimate aquaculture produce but to seafood in general. This flow-on effect to the wider seafood industry was seen during the Wallis Lake hepatitis outbreak in 1997 where seafood sales nationally were seriously impacted. Potentially serious but not irreversible ( <i>moderate</i> ) consequences for human health are therefore <i>possible</i> .	L	Statewide	Unknown	Unknown	Unknown
38	Minor	Possible	Minimal	Concern over illegal use lies at the heart of some of the conflict experienced between recreational fishers, with some recreational fishers expressing significant dissatisfaction with enforcement of fishing regulations	L	Local	1-2 years	Stable	

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				in recent research into recreational fishing motivations and attitudes (see also regulation stressors) [4] Sectoral, localised and temporary ( <i>minor</i> ) consequences are therefore consider <i>possible</i>					
39	Minor	Possible	Minimal	Illegal use has the potential to impact biodiversity values through overharvesting, which will have flow on impacts on people's enjoyment of those values. Sectoral, localised and temporary ( <i>minor</i> ) consequences are therefore consider <i>possible</i> .	L	Regional		10 years	Stable
40	Minor	Almost certain	Low	Theft and poaching of fisheries resources is of concern to the aquaculture and commercial fishing sectors. This impacts the economic viability of these industries and in turn the availability of these resources to seafood consumers. It also has the potential to impact marine tourism operations such as diving charters, who rely on healthy marine ecosystems for their businesses. Moderate consequences for these sectors ( <i>minor</i> for overall community) on consumptive use are therefore considered <i>almost certain</i> .	L	Local		1-2 years	Stable
41	Moderate	Possible	Low	Excessive or illegal extraction can impact on tangible Aboriginal heritage e.g. source of food by causing a reduction in natural resources [7].	L	Unknown		Unknown	Unknown
42	Minor	Possible	Minimal	Excessive or illegal extraction can impact on intangible Aboriginal heritage by causing a reduction in natural resources. e.g. transfer of traditional knowledge, ability to conduct cultural significant ceremonies or events involving seafood consumption [7]	L	Unknown		Unknown	Unknown
43	Minor	Possible	Minimal	The Marine Estate Community Survey did not identify excessive or illegal extraction as an economic or social	L	Local		20 years	Unknown

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Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				threat [1], implying that the impacts on intrinsic and bequest values are only minor. In the longer term and in cases where fish stocks are depleted or habitats significantly disturbed etc., consequences may be more significant but there is limited evidence suggesting this will occur.				
44	Moderate	Possible	Low	This issue may negatively impact on viability of businesses where illegal extraction depletes resources (e.g. fishing operators losing businesses as illegal or excessive extraction depletes fish stocks).  However, negative impacts are likely to be major for only one user group (businesses) and the current regulatory and compliance framework in NSW makes the likelihood of such a consequence only 'possible'.	L	Local	20 years	Increasing
45	Moderate	Possible	Low	Excessive or illegal extraction is expected to have only minor impacts on general usage value, as the threats from these stressors are not identified by the community in the Marine Estate Community Survey [1]. Negative impacts are expected to be more significant for user groups who derive their enjoyment value from the depleted resources (e.g. recreational fishers, tourism operators, scuba divers), but similarly with justification 45, the likelihood of such consequences are assumed to be only 'possible'.	A	Local	20 years	Increasing
46	Insignificant	Possible	Minimal	The consequences of water pollution events associated with point source discharges and sewage overflows are likely to be localised and temporary impacts on wellbeing associated with relaxation and	A	Local	10 years	Stable

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent			Trend
						Local (site)	Regional	Statewide	
								1-2 years 10 years 20 years	Decreasing Stable Increasing
				<p>enjoyment. The Marine Estate Community Survey highlighted water pollution as a significant concern for the public [1]. 72% thought the most important benefits was clean waters that support a variety of habitats and marine life. Therefore, <i>insignificant</i> consequences are considered <i>possible</i> in response to the threat of sewage and industrial.</p> <p>With regard to ocean and estuarine waters the environmental TARA found that potential impacts of “industrial discharges” are likely to be localised to areas with industry. The risk associated with “sewage effluent and septic runoff” was low in ocean waters and localised around outfalls and moderate (North and South Regions) to high (Central Region) in estuarine waters, but septics contributed to the risk and the impacts were likely to be localised.</p>					
47	Minor	Possible (N&S) Almost certain (C)	Minimal (N&S) Low (C)	<p>Given the importance of the NSW coast as a place of socialisation and social connections the impacts of pollution will be significant if it inhibits or discourages the use of the coast [1]. Therefore, <i>minor</i> consequences are considered <i>possible</i> in response to the threat of sewage and industrial discharges in the north and south regions and <i>almost certain</i> in the central region, due to the higher impact of pollution events in this region.</p> <p>With regard to ocean and estuarine waters the environmental TARA found that potential impacts of “industrial discharges” are likely to be localised to</p>	L	Local		1-2 years	Stable

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend
								Decreasing Stable Increasing
				areas with industry. The risk associated with “sewage effluent and septic runoff” was low in ocean waters and localised around outfalls and moderate (North and South Regions) to high (Central Region) in estuarine waters, but septics contributed to the risk and the impacts were likely to be localised.				
48	Minor	Almost certain	Low	<p>Loss of amenity associated with pollution from sewerage and industrial sources are likely to significantly impact people’s relationship with the coast and their ability to appreciate marine biodiversity. This is reflected in the high levels of concern relating to marine pollution demonstrated through the Marine Estate Community Survey [1].</p> <p>The Marine Estate Community Survey results identified fifty-five percent of the NSW general population considers the potential loss of appeal due to pollution/littering as the second highest social threat. This also follows the North East region (49%) and South East region (40%) however the central region (60%) sees it as its top threat. Similarly, the Coffs Harbour (49%), Newcastle (57%), Sydney (54%), Batemans Bay (40%) intercept survey participants identified loss of appeal due to water pollution, litter as their highest social threat. The Ballina (40%) Hawkesbury/Pittwater (52%) and Eden (37%) participants identified water pollution/litter as their second highest threat [1]. Therefore <i>minor</i> consequences are considered <i>almost certain</i>.</p>	L	Local	1-2 years	Stable

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Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent			Trend Decreasing Stable Increasing
						Local (site)	Regional	Statewide	
				With regard to ocean and estuarine waters the environmental TARA found that potential impacts of “industrial discharges” are likely to be localised to areas with industry. The risk associated with “sewage effluent and septic runoff” was low in ocean waters and localised around outfalls and moderate (North and South Regions) to high (Central Region) in estuarine waters, but septic contributed to the risk and the impacts were likely to be localised.					
49	Minor	Possible (N&S) Almost certain (C)	Minimal (N&S) Low (C)	<p>These potential pollution events may also impact on consumptive use by decreasing the enjoyment or frequency of recreational water based activities and the viability and trust in professional fishing and aquaculture industries and the products they supply. These <i>minor</i> consequences are considered <i>possible</i> in response to the threat of sewage and industrial discharges in the north and south regions and <i>almost certain</i> in the central region, due to the higher impact of pollution events in this region.</p> <p>With regard to ocean and estuarine waters the environmental TARA found that potential impacts of “industrial discharges” are likely to be localised to areas with industry. The risk associated with “sewage effluent and septic runoff” was low in ocean waters and localised around outfalls and moderate (North and South Regions) to high (Central Region) in estuarine waters, but septic contributed to the risk and the impacts were likely to be localised.</p>	A	Local		1-2 years	Stable

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Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
50	Minor	Possible	Minimal	<p>Water pollution can impact on tangible Aboriginal cultural heritage such as source of food [7]. Toxicity of fish caught was raised by Aboriginal people consulted in the Hawkesbury bioregion as of particular concern in Sydney Harbour and also reported in Lake Macquarie [36].</p> <p>Water pollution can also cause damage to places associated with cultural practices and traditions.</p> <p>With regard to ocean and estuarine waters the environmental TARA found that potential impacts of “industrial discharges” are likely to be localised to areas with industry. The risk associated with “sewage effluent and septic runoff” was low in ocean waters and localised around outfalls and moderate (North and South Regions) to high (Central Region) in estuarine waters, but septic contributed to the risk and the impacts were likely to be localised.</p>	L	Local		1-2 years	Stable
51	Minor	Possible	Minimal	<p>Environmental degradation can impact on intangible Aboriginal heritage in particular on spiritual connections. This also includes damage to places associated with cultural practices and traditions [7].</p> <p>With regard to ocean and estuarine waters the environmental TARA found that potential impacts of “industrial discharges” are likely to be localised to areas with industry. The risk associated with “sewage effluent and septic runoff” was low in ocean waters and localised around outfalls and moderate (North and South Regions) to high (Central Region) in estuarine</p>	L	L		1-2 years	Stable

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				waters, but septics contributed to the risk and the impacts were likely to be localised.					
52	Minor	Possible (N&S) Almost certain (C)	Minimal (N&S) Low (C)	<p>Water pollution including point source pollution and sewage overflows, was identified as the greatest threat to economic activity in the Marine Estate Community Survey (focussed on impacts on businesses and tourism) and the second greatest threat to social benefits [1]. The impacts are likely to be measurable and on-going at a state-wide scale, although the risk is likely higher in more populated areas (higher in the central region).</p> <p>With regard to ocean and estuarine waters the environmental TARA found that potential impacts of “industrial discharges” are likely to be localised to areas with industry. The risk associated with “sewage effluent and septic runoff” was low in ocean waters and localised around outfalls and moderate (North and South Regions) to high (Central Region) in estuarine waters, but septics contributed to the risk and the impacts were likely to be localised.</p>	A	Statewide, regional (populated areas)	1-2 years	Stable	
53	Minor	Possible (N&S) Almost certain (C)	Minimal (N&S) Low (C)	<p>Water pollution including point source pollution and sewage overflows was identified as the greatest threat to local businesses and tourism in the Marine Estate Community Survey [1].</p> <p>The Marine Estate Community Survey results highlighted that water pollution affecting local businesses/tourism and loss of natural areas reserved</p>	A	Statewide, regional (populated areas)	1-2 years	Increasing	

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				<p>for tourism were identified as the top two economic threats by intercept survey participants across the seven locations. Water pollution was the primary threat for Coffs Harbour (46%) and Eden (46%) participants, and loss of natural areas reserved for tourism for Ballina (50%), Newcastle (53%), Sydney (61%), Hawkesbury (52%) and Batemans Bay (39%) [1].</p> <p>With regard to ocean and estuarine waters the environmental TARA found that potential impacts of “industrial discharges” are likely to be localised to areas with industry. The risk associated with “sewage effluent and septic runoff” was low in ocean waters and localised around outfalls and moderate (North and South Regions) to high (Central Region) in estuarine waters, but septic contributed to the risk and the impacts were likely to be localised.</p>					
54	Minor	Possible (N&S) Almost certain (C)	Minimal (N&S) Low (C)	<p>Water pollution was identified as the greatest threat to economic activity in the Marine Estate Community Survey (focussed on impacts on businesses and tourism) and the second greatest threat to social benefits [1]. As with intrinsic values (justification 52), individual enjoyment values are likely to face greater impacts in more populated areas where point source pollution is greater (higher in the central region).</p> <p>Individuals that use the marine estate for recreational purposes, such as swimmers, surfers and tourists will likely see impacts on their enjoyment value (if not be deterred from using the marine estate).</p>	A	Statewide, regional (populated areas)	1-2 years	Increasing	

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				With regard to ocean and estuarine waters the environmental TARA found that potential impacts of “industrial discharges” are likely to be localised to areas with industry. The risk associated with “sewage effluent and septic runoff” was low in ocean waters and localised around outfalls and moderate (North and South Regions) to high (Central Region) in estuarine waters, but septic contributed to the risk and the impacts were likely to be localised.					
55	Moderate	Likely (N&S) Almost certain (C)	Moderate	<p>The environmental TARA found that urban stormwater would impact across all three regions with higher impacts in the central from the combined stressors of toxic contaminants, nutrients, suspended sediments. Nutrients are present as bioavailable dissolved inorganic forms. Reduced salinities impact biota in saltmarsh, mangroves and seagrass and other intertidal habitats (including listed species such as Posidonia). The scale of the impact was more frequently localised for the north and south regions.</p> <p>Impacts on safety, health and wellbeing relates mostly to impacts on recreation and enjoyment from short term and localised beach closures following storm events. For the health implications of potential impacts on seafood quality (especially aquaculture) refer to cell 199.</p> <p>The NSW general community listed water pollution from sediment or run-off (29%) as a third priority threat.</p>	L	Local	10 years	Stable	

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				<p>The North East, Central and South East regions shared the same priorities however water pollution from sediment or run-off as a second priority threat (30%, 33% and 37% respectively) [1].</p> <p><i>Moderate</i> consequences are therefore considered <i>possible</i> in response to the threat of stormwater discharges in the north and south regions and <i>almost certain</i> in the central region, due to the higher impact of pollution events in this region.</p>					
56	Moderate	Likely(N &S) Almost certain (C)	Moderate	<p>Impacts on socialisation and community life of urban stormwater discharge relates mostly to reduced capacity of socialisation and interaction associated with short term and localised beach closures following storm events. <i>Moderate</i> consequences are considered <i>possible</i> in response to the threat of stormwater discharges in the north and south regions and <i>almost certain</i> in the central region, due to the higher impact of pollution events in this region.</p> <p>For Environmental TARA outcomes see cell 55 above. For the social implications from the environmental impacts refer to Cell 47 above. For the health implications refer to cell 200.</p>	L	Local		10 years	Stable
57	Moderate	Likely (N&S) Almost certain (C)	Moderate	<p>Impacts on enjoyment of biodiversity and beauty as a result of urban stormwater discharge relate mostly to reduced capacity of interact with nature through swimming, diving or snorkelling following short term and localised beach closures. Therefore <i>moderate</i> consequences are considered <i>possible</i> in response to</p>	L	Local		10 years	Stable

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				the threat of stormwater discharges in the north and south regions and <i>almost certain</i> in the central region, due to the higher impact of pollution events in this region. For Environmental TARA outcomes see cell 55 above. For the social implications from the environmental impacts refer to Cell 48 above. For the health implications refer to cell 201.				
58	Moderate	Likely (N&S) Almost certain (C)	Moderate	Impacts on consumptive use from stormwater discharge relates mostly to impacts on seafood quality (especially aquaculture), scientific reference sites and participation in marine tourism. <i>Moderate</i> consequences are considered <i>possible</i> in response to the threat of stormwater discharges in the north and south regions and <i>almost certain</i> in the central region, due to the higher impact of pollution events in this region.  For Environmental TARA outcomes see cell 55 above. For the social implications from the environmental impacts refer to Cell 49 above. For the health implications refer to cell 202.	L	Local	10 years	Stable
59	Moderate	Likely (N&S) Almost certain (C)	Moderate	Water pollution can also cause damage to places associated with cultural practices and traditions.  For Environmental TARA outcomes see cell 55 above. For the social implications from the environmental impacts refer to Cell 50 above. For the health implications refer to cell 203.	I	Unknown	Unknown	Unknown

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
60	Moderate	Likely (N&S) Almost certain (C)	Moderate	<p>Environmental degradation can impact on intangible Aboriginal heritage in particular on spiritual connections. This also includes damage to places associated with cultural practices and traditions [7].</p> <p>For Environmental TARA outcomes see cell 55 above.. For the social implications from the environmental impacts refer to Cell 51 above. For the health implications refer to cell 204.</p>	I	Unknown	Unknown	Unknown	
61	Moderate	Likely (N&S) Almost certain (C)	Moderate	<p>Awareness of urban stormwater discharge stressors in the marine estate (and therefore the impact on intrinsic values) will have measurable and on-going negative impacts at a state-wide level. This is particularly the case for those people whose intrinsic values are linked to environmental benefits such as biodiversity, as urban stormwater run-off also threatens these environmental benefits.</p> <p>The environmental TARA reported both sewerage and industrial discharges as having impacts from combined stressors of nutrients, suspended sediments and toxic contaminants. This was higher in the central compared to north and south regions due to higher population density and industrialisation.</p> <p>For Environmental TARA outcomes see cell 55 above. For the social implications from the environmental impacts refer to Cell 52 above. For the health implications refer to cell 205.</p>	A	State-wide, regional (populated areas)	1-2 years	Increasing	

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
62	Moderate	Possible (N&S) Likely (C)	Low (N&S) Moderate (c)	<p>The environmental TARA reported both sewerage and industrial discharges as having impacts from combined stressors of nutrients, suspended sediments and toxic contaminants. This was higher in the central compared to north and south regions due to higher population density and industrialisation.</p> <p>Local Businesses that are dependent on the marine estate for their viability, such as commercial fishers and tourist operators, may experience major to catastrophic impacts on production, and therefore on employment, due to events such as closures and fish kills. Examples of closures include that of the Hunter Prawn trawler fishery due to elevated levels of the chemical, Perfluorooctane Sulfonate (PFOS) . At a State-wide scale, the consequences of these impacts are categorised as Moderate.</p> <p>For Environmental TARA outcomes see cell 55 above. For the social implications from the environmental impacts refer to Cell 53 above. For the health implications refer to cell 199.</p>	A	State-wide, regional (populated areas)	1-2 years	Increasing	
63	Moderate	Likely (N&S) Almost certain (C)	Moderate	<p>The environmental TARA reported both sewerage and industrial discharges as having impacts from combined stressors of nutrients, suspended sediments and toxic contaminants. This was higher in the central compared to north and south regions due to higher population density and industrialisation. Individuals that use the marine estate for recreational purposes, such as swimmers, surfers and tourists may be deterred to visit the marine estate because of urban stormwater</p>	A	Statewide, regional (populated areas)	1-2 years	Increasing	

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				run-off, therefore resulting in a major impact on their enjoyment value, resulting in a moderate consequence rating.  For Environmental TARA evidence see cell 55 above. For the social implications from the environmental impacts refer to Cell 46 above. For the health implications refer to cell 199.					
64	Moderate	Possible (C) Likely (N&S)	Low (C) Moderate (N&C)	The environmental TARA found that agricultural sources had major impacts almost certain due to elevated nutrients, sediments, potential contaminants and turbidity, and sedimentation. The risk ratings were sometimes higher in the north and south regions due to a higher portion of estuaries with agricultural activity in their catchment compared to the Central region. Major impacts for the listed seagrass <i>Posidonia</i> were noted for the north and south regions. The background report refers to closures of the Richmond River following an ASS pollution event. The Marine Estate Community Survey highlighted water pollution as a significant concern for the public [1]. 72% thought the most important benefits was clean waters that support a variety of habitats and marine life The impacts of these pollution events on community health, safety and enjoyment are likely to relate mostly to decreased opportunities for use for recreational activities associated with short term and localised 'blackwater' events and a general loss in wellbeing associated with concern over environmental decline. <i>Moderate</i> consequences are considered <i>possible</i> in	L	Unknown	Unknown	Unknown	

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				response to the threat of agricultural runoff in the central region and <i>likely</i> in the north and south regions				
65	Moderate	Possible (C) Likely (N&S)	Low (C) Moderate (N&S)	For the Environmental TARA evidence, refer to cell 64 above. The impacts of these pollution events on socialisation and sense of community are likely to relate mostly to decreased opportunities for use for interactions associated with recreational activities due to short term and localised 'blackwater' events. <i>Moderate</i> consequences are considered <i>possible</i> in response to the threat of agricultural runoff in the central region and <i>likely</i> in the north and south regions	L	Unknown	Unknown	Unknown
66	Moderate	Likely	Moderate	For the Environmental TARA evidence, refer to cell 64 above. For the social implications refer to the evidence presented in 57 above.	L	Unknown	Unknown	Unknown
67	Moderate	Possible (C) Likely (N&S)	Low (C) Moderate (N&S)	For the Environmental TARA evidence, refer to cell 64 above. For the social implications refer to the evidence presented in 58 above. Agricultural runoff have the potential to have significant, albeit temporary and localised, impacts on consumptive use especially if it results in blackwater and fish kill events such as those experienced periodically in the Richmond River. <i>Moderate</i> consequences are considered <i>possible</i> in response to the threat of agricultural runoff in the central region and <i>likely</i> in the north and south regions.	L	Unknown	Unknown	Unknown
68	Moderate	Likely	Moderate	Water pollution can also cause damage to places associated with cultural practices and traditions.  For the Environmental TARA evidence, refer to cell 64	L	Unknown	Unknown	Unknown

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Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				above. For the social implications refer to the evidence presented in 59 above.					
69	Moderate	Likely	Moderate	Environmental degradation can impact on intangible Aboriginal heritage in particular on spiritual connections. This also includes damage to places associated with cultural practices and traditions [7].  For the Environmental TARA evidence, refer to cell 64 above. For the social implications refer to the evidence presented in 60 above.	L	Unknown	Unknown	Unknown	Unknown
70	Moderate	Likely (N&S)/ Possible (C)	Moderate (N&S)/ Low (C)	The environmental TARA found agricultural diffuse source run-off impacted environmental benefits due to elevated nutrients, sediments, potential contaminants and turbidity, and sedimentation. The risk ratings were sometimes higher in the north and south regions due to a higher portion of estuaries with agricultural activity in their catchment compared to the Central region.  The consequence level is judged to be moderate, because awareness of agricultural source run-off stressors in the marine estate (and therefore the impact on intrinsic values) will have measurable and on-going negative impacts at a state-wide level. This is particularly the case for those people whose intrinsic values are linked to environmental benefits such as biodiversity, given the environmental impacts mentioned above.	A	Statewide, regional (regional areas with more agricultural activity)	1-2 years	Increasing	
71	Moderate	Likely (N&S)/	Moderate (N&S)/	The environmental TARA found agricultural diffuse source run-off impacted environmental benefits due to	A	Statewide, regional	1-2 years	Increasing	

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
		Possible (C)	Low (C)	<p>elevated nutrients, sediments, potential contaminants and turbidity, and sedimentation. The risk ratings were sometimes higher in the north and south regions due to a higher portion of estuaries with agricultural activity in their catchment compared to the Central region.</p> <p>Local Businesses that are dependent on the marine estate for their viability, such as commercial fishers and tourist operators, may experience major to catastrophic impacts on production, and therefore on employment, due to events such as closures and fish kills. Examples of fish kills include recurring events in the Richmond river. At a State-wide scale, the consequences of these impacts are categorised as Moderate.</p>		(regional areas with more agricultural activity)			
72	Moderate	Likely (N&S)/ Possible (C)	Moderate (N&S)/ Low (C)	<p>The environmental TARA found agricultural diffuse source run-off impacted environmental benefits due to elevated nutrients, sediments, potential contaminants and turbidity, and sedimentation. The risk ratings were sometimes higher in the north and south regions due to a higher portion of estuaries with agricultural activity in their catchment compared to the Central region.</p> <p>Individuals that use the marine estate for recreational purposes, such as swimmers, surfers and tourists will likely see major impacts on their enjoyment value (if not be deterred from using the marine estate), therefore resulting in a moderate consequence rating.</p>	A	Statewide, regional (regional areas with more agricultural activity)	1-2 years	Increasing	
73	Moderate	Possible	Low	The environmental TARA considered marine debris	L	Unknown	Unknown	Unknown	

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
		(N&S) Likely (C)	(N&S) Moderate (C)	<p>and littering from a range of sources and references evidence of microplastics, marine debris and other contaminants impacting marine fauna. Some data from necropsies by Taronga Zoo in bioregion on ingestion of debris in threatened species. In particular discarded fishing gear and debris from rec fishers poses a threat to turtles, seals and seabirds through ingestion and entanglement. The community survey indicated that the greatest threat to social benefits identified was loss of appeal due to water pollution/littering (55%) and also Littering/dumping/rubbish/marine debris was identified as the greatest threat to the environment (47%).</p> <p>The impacts of marine debris and littering on health safety and wellbeing refer mostly to impacts on enjoyment and recreation associated with activities in the marine estate. Encountering rubbish can impact on safety (e.g. exposure to glass and other sharp objects, syringes, human or animal waste etc.) and relaxation (e.g. marine estate users interviewed in a number of forums indicated annoyance and anger about encountering other people's rubbish when enjoying the coast). <i>Moderate</i> consequences are considered <i>possible</i> in response to the threat of rubbish and debris in the less populated north and south regions and <i>likely</i> in the central region.</p>					
74	Moderate	Possible (N&S) Likely	Low (N&S) Moderate	The impacts of marine debris and littering on socialisation and sense of community refer mostly to impacts on use of the marine estate as a place of	L	Unknown	Unknown	Unknown	

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Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
		(C)	(C)	connection and interaction. <i>Moderate</i> consequences are considered <i>possible</i> in response to the threat of rubbish and debris in the less populated north and south regions and <i>likely</i> in the central region. Refer to cell 73 and 47					
75	Moderate	Likely	Moderate	The impacts of marine debris and littering on enjoyment of biodiversity and beauty refer mostly to impacts on the aesthetic beauty of the landscape from visible litter and rubbish, as well as a decline in enjoyment and appreciation from witnessing impacts on marine animals from plastic and fishing debris (e.g. entanglement, ingestion etc.). <i>Moderate</i> consequences are considered <i>likely</i> in response to the threat of rubbish and debris. Refer to cell 73 and 48	L	Unknown	Unknown	Unknown	Unknown
76	Moderate	Possible (N&S) Likely (C)	Low (N&S) Moderate (C)	The impacts of marine debris and littering on consumptive use refer mostly to impacts on recreational and professional fishing plastics that may flow from increases in micro-plastics are ingested by target species. Fishing rubbish and litter may also impact the social licence of recreational fishers which may in turn impact overall participation. <i>Moderate</i> consequences are considered <i>possible</i> in response to the threat of rubbish and debris in the less populated north and south regions and <i>likely</i> in the central region. Refer to cell 73 and 49	L	Unknown	Unknown	Unknown	Unknown
77	Moderate	Likely	Moderate	Water pollution can also cause damage to places associated with cultural practices and traditions. Refer to cell 73 and 50	L	Unknown	Unknown	Unknown	Unknown
78	Moderate	Likely	Moderate	Environmental degradation can impact on intangible	L	Unknown	Unknown	Unknown	Unknown

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Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				Aboriginal heritage in particular on spiritual connections. This also includes damage to places associated with cultural practices and traditions [7].  Refer to cell 73 and 51					
79	Moderate	Possible (N&S)/ Likely (C)	Low (N&S)/ Moderate (C)	The environmental TARA considered marine debris and littering from a range of sources and references evidence of microplastics, marine debris and other contaminants impacting marine fauna. Some data from necropsies by Taronga Zoo in the bioregion on ingestion of debris in threatened species. In particular discarded fishing gear and debris from rec fishers poses a threat to turtles, seals and seabirds through ingestion and entanglement. The community survey indicated that the greatest threat to social benefits identified was loss of appeal due to water pollution/littering (55%) and also Littering/dumping/rubbish/marine debris was identified as the greatest threat to the environment (47%).  This indicates that intrinsic values are also likely to be threatened, although given marine litter is only one component of the broader concerns about pollution, the impact of this stressor is assigned as a moderate consequence level. As with justification 61, the likelihood is higher in the central region due to increased population density.	A	Statewide, regional (populated areas)	1-2 years	Increasing	
80	Moderate	Possible (N&S)/	Low (N&S)/	The environmental TARA considered marine debris and littering from a range of sources and references	A	Statewide, regional	1-2 years	Increasing	

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Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
		Likely (C)	Moderate (C)	<p>evidence of microplastics, marine debris and other contaminants impacting marine fauna. Some data from necropsies by Taronga Zoo in the bioregion on ingestion of debris in threatened species. In particular discarded fishing gear and debris from rec fishers poses a threat to turtles, seals and seabirds through ingestion and entanglement.</p> <p>These stressors will likely cause major impacts impact on businesses that that are dependent on the marine estate for their viability, such as commercial fishers and tourist operators, and therefore a moderate consequence rating has been assigned. As with justification 62, the likelihood is higher in the central region due to increased population density.</p>		(populated areas)			
81	Moderate	Possible (N&S)/ Likely (C)	Low (N&S)/ Moderate (C)	<p>The environmental TARA considered marine debris and littering from a range of sources and references evidence of microplastics, marine debris and other contaminants impacting marine fauna. Some data from necropsies by Taronga Zoo in the bioregion on ingestion of debris in threatened species. In particular discarded fishing gear and debris from rec fishers poses a threat to turtles, seals and seabirds through ingestion and entanglement.</p> <p>Individuals that use the marine estate for recreational purposes, such as swimmers, surfers and tourists will likely see major impacts on their enjoyment value (if not be deterred from using the marine estate because of litter), therefore resulting in a moderate consequence rating.</p>	A	State-wide, regional (populated areas)	1-2 years	Increasing	

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Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
82	Moderate	Possible	Low	<p>Sweeney research shows that 82% of the NSW community considers it is important to maintain the abundance and diversity of marine life in the marine estate. Wildlife appreciation activities was identified as the fifth highest recreational activity at 51%.</p> <p>Wildlife is also an important social benefit identified within the Sweeney results:</p> <ul style="list-style-type: none"> <li>• The second highest benefit was an abundance of marine life (42%)</li> <li>• The third highest that the marine estate contains unique biodiversity that cannot be found anywhere in the world</li> <li>• And the fourth highest that it provides a way to observe and interact with a variety of marine life (27%).</li> </ul> <p>Whales are highly valued species from a social perspective as evidenced by:</p> <ul style="list-style-type: none"> <li>• by 30,607 likes on the Wild About Whales facebook page that the National Parks &amp; Wildlife Service manages</li> <li>• the high level of media interest when the whale watching season commences and when any wildlife incidents occur.</li> </ul> <p>For the environmental TARA the evidence notes that the area for four wheel drives, is limited, although some illegal activity occurs. Major impacts possible in localised areas. The threat to cetaceans from whale</p>	L	Unknown	Unknown	Unknown	

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Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				and watching activities is rated as moderate. High levels of whale tourism in all regions. There is limited research on impacts e.g. noise, disturbance, displacement, stress, reduced fitness, behavioural change. Beach nourishment and grooming was noted to impact on nesting and foraging shorebirds and nesting turtles. Highly localised impacts from dog walking, walking on beaches, foraging etc.				
83	Moderate	Possible	Low	Impacts on people's relationship with the coast (e.g. loss of appeal due to decline in wildlife) will also impact social connections. Refer to cell 82	I	Unknown	Unknown	Unknown
84	Moderate	Almost certain	Moderate	Refer to cell 82. Impacts here relate to reduced biodiversity and opportunity to enjoy shorebirds, turtles etc. Sweeney research shows that 82% of the NSW community considers it is important to maintain the abundance and diversity of marine life in the marine estate.  Wildlife disturbance and any declines in threatened and protected species (including shorebirds, seabirds, turtles and whales) will impact on the intrinsic values derived from the marine estate given: <ul style="list-style-type: none"> <li>the high level of interest the general NSW community has in threatened and protected species including seabirds, shorebirds, turtles</li> <li>the high level of interest in whales as evidenced by 30,607 likes on the Wild About</li> </ul>	A	Local	10 years	Unknown

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				<p>Whales facebook page that the National Parks &amp; Wildlife Service manages</p> <ul style="list-style-type: none"> <li>the high level of media interest when the whale watching season commences and when any wildlife incidents occur.</li> <li>the high level of intrinsic value placed on the marine life demonstrated in the Marine Estate Community Survey [1] as evidenced by:</li> <li>abundance of marine life being identified as the second highest benefit derived from the marine estate (42%)</li> <li>protecting and rehabilitating remaining coastal wetland and habitats being identified as the second highest opportunity for the marine estate</li> </ul> <p>These impacts are therefore likely to be felt across the entire population.</p>					
85	Minor	Unlikely	Minimal	Given wildlife watching is not considered an extractive activity; there will be little impact on consumptive use. Refer to cell 82	I	Local		10 years	Stable
86	Moderate	Almost certain	Moderate	Wildlife disturbance can impact on totemic or culturally significant species.  Refer to cell 82	L	Statewide		1-2 years	Increasing
87	Moderate	Almost certain	Moderate	Wildlife disturbance can impact on totemic or culturally significant species  For the environmental TARA the evidence notes that the area for four wheel drives, is limited, although	L	Local		10 years	Unknown

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				some illegal activity occurs. Major impacts possible in localised areas. The threat to cetaceans from whale and watching activities is rated as moderate. High levels of whale tourism in all regions. There is limited research on impacts e.g. noise, disturbance, displacement, stress, reduced fitness, behavioural change. Beach nourishment and grooming was noted to impact on nesting and foraging shorebirds and nesting turtles. Highly localised impacts from dog walking, walking on beaches, foraging etc.					
88	Minor	Likely	Low	Concern over habitat disturbance and physical damage were lower in the Marine Estate Community Surveys conducted by Sweeney [1], possibly indicating lower levels of awareness or concern about the impacts of these activities or possibility indicating a belief that these activities are not occurring at significant levels at present. The impacts from dog walkers, 4WDs and marine vessels are similarly unlikely to be widespread.	L	Local	10 years	Increasing	
89	Minor	Possible	Minimal	The impacts from dog walkers, 4WDs and marine vessels are unlikely to be widespread (as above), and the threats from habitat disturbance and physical damage are unlikely to cause significant impacts to employment and value of production.	L	Local	10 years	Increasing	
90	Minor	Likely	Low	Wildlife disturbance will impact those that value direct interaction and enjoyment of biodiversity and wildlife, including snorkelers, divers; those involved in nature based passive use, and fishers. However, the disturbance itself may be caused by activities that	L	Local	10 years	Increasing	

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				contribute to the individual enjoyment value of other members of the community. The net impacts are likely to be minor, and therefore result an overall risk rating of low.				
91	Moderate	Possible	Low	<p>Activities resulting in high levels of physical disturbance for the Environmental TARA include land clearing, foreshore development, estuary entrance modifications, Large commercial vessels and associated port activities and industries, boating and commercial fishing. Concern over habitat disturbance and physical damage were lower in the Marine Estate Community Surveys conducted by Sweeney [1], Overdevelopment of the coast, and by extension habitat loss and disturbance, came out at the fourth highest threat in the survey This possibly indicates lower levels of awareness or concern about the impacts of these activities or possibility indicating a belief that these activities are not occurring at significant levels at present. Despite this there are notable potential impacts on health and wellbeing associated with habitat damage relating to:</p> <ul style="list-style-type: none"> <li>• Impacts on health/safety associated with water quality concerns related to habitat disturbance (e.g. ASS) (see justification 199)</li> <li>• Declines in fish abundance associated with loss of nursery areas for important seafood species and flow on impacts on health and wellbeing for seafood consumers and recreational fishers (see justification 94)</li> </ul>	L	Local	10 years	Increasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				<ul style="list-style-type: none"> <li>Increased stress or anxiety associated with environmental concerns associated with witnessing habitat destruction or damage or overall loss of relaxation opportunities associated with decline in environmental values.</li> <li>Increased concern over declines in threatened species such as shorebirds, seabirds and turtles associated with loss of important breeding and foraging areas</li> <li>Also, the top environmental opportunity identified in Sweeny was to protect and rehabilitate remaining coastal wetlands and habitat (41%). This demonstrates the community, despite not identifying habitat loss and disturbance as a priority threat, still cares about coastal habitats.</li> </ul> <p>The value of interactions with nature as a contributor to individual wellbeing is gaining increasing recognition, <i>moderate</i> consequences associated with habitat loss are therefore considered <i>possible</i>, taking into account the broad suite of habitat protection measures now in place within the marine estate.</p>					
92	Moderate	Possible	Low	<p>As per justification 47, impacts on the people's relationship with the coast (e.g. loss of appeal due to habitat loss, decline in recreational fishing opportunities) will also impact social connections. <i>Moderate</i> consequences associated with habitat loss are considered <i>possible</i>, taking into account the broad</p>	L	Unknown	Unknown	Unknown	Unknown

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				suite of habitat protection measures now in place within the marine estate. Refer to cell 91 for environmental TARA evidence.					
93	Moderate	Likely	Moderate	Habitat loss and disturbance will disproportionately impact those that value direct interaction and enjoyment of biodiversity and wildlife, including snorkelers, divers; those involved in nature based passive use and fishers. Given the high level of intrinsic value placed on the marine environment demonstrated in the Marine Estate Community Survey [1] these impacts are also likely to be felt across the entire population as evidenced by: <ul style="list-style-type: none"> <li>abundance of marine life being identified as the second highest benefit derived from the marine estate (42%)</li> <li>protecting and rehabilitating remaining coastal wetland and habitats being identified as the second highest opportunity for the marine estate</li> <li>overdevelopment of the coast (and by extension habitat loss and disturbance) coming out as the fourth highest threat to the marine estate (22%).</li> </ul> <p><i>Moderate</i> consequences associated with habitat loss are considered <i>likely</i>, taking into account the broad suite of habitat protection measures now in place within the marine estate. Refer to cell 91 for environmental TARA evidence</p>	L	Local	10 years	Increasing	
94	Moderate	Likely	Moderate	Declines in fish abundance associated with loss of	L	Local	10 years	Increasing	

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				nurse areas for important seafood species will be of major concern for commercial fishers, seafood consumers and recreational fishers. This is likely to translate into moderate community wide consequences. Refer to cell 91 for environmental TARA evidence					
95	Moderate	Likely	Moderate	Habitat (physical disturbance) from human activity such as dredging, fishing, boat anchors and other human activities that can cause damage to heritage sites such as shipwrecks [38] and to Aboriginal totemic species [7]. The stressor can also cause damage to places associated with cultural practices and traditions and to totemic or culturally significant species.  Refer to cell 91 for environmental TARA evidence	L	Statewide	1-2 years	?	
96	Moderate	Likely	Moderate	Habitat (physical disturbance) can cause destruction of intangible Aboriginal heritage and potentially impact on totemic species. Further, when the cultural landscape damaged it can impact on spiritual connections. A/Prof. Stephan Schnierer notes threat is non-Indigenous use and management that fails to accommodate Aboriginal connections to Sea country [8]. Refer to cell 91 for environmental TARA evidence	L	Statewide	1-2 years	Increasing	
97	Minor	Likely	Low	Concerns about habitat disturbance and physical damage were relatively low in the Marine Estate Community Survey. However, where habitat disturbance and physical damage do occur, it is expected that intrinsic and bequest values will be	L	Local	10 years	Increasing	

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				impacted. Refer to cell 91 for environmental TARA evidence				
98	Minor	Possible	Minimal	Impacts on employment and production from habitat and physical disturbances will be mixed; tourism operators may be negatively impacted if resources are depleted or habitats changed, while some businesses will benefit (cafes and restaurants may attract more customers due to foreshore development improving access). In some cases, business would derive income from the stressor activities (e.g. foreshore development, boating infrastructure and recreation). Therefore the net impact is assigned as only 'minor' and the likelihood rating at only 'possible'. Refer to cell 91 for environmental TARA evidence	A	Local	10 years	Increasing
99	Minor	Likely	Low	Concerns about habitat disturbance and physical damage were relatively low in the Marine Estate Community Survey [1], suggesting that the impact of this stressor on individual enjoyment values would be limited. In some cases, people would derive higher usage values from the stressor activities (e.g. foreshore development, boating infrastructure and recreation). Refer to cell 91 for environmental TARA evidence	A	Local	10 years	Increasing
100	Moderate	Possible	Low	Impacts relating to the decline in fish abundance may include a number of possible Community health implications: <ul style="list-style-type: none"> <li>The FRDC Valuing Coastal Fisheries report indicates that the wider NSW public puts a high value on locally caught seafood, and many think</li> </ul>	L	Statewide	10 years	Stable

Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				<p>local product is better for their health [3]. Decline in availability of local seafood may result in some overall decline in seafood consumption.</p> <ul style="list-style-type: none"> <li>Escape and relaxation are one of the primary motivations for recreational fishers. Recreational fishers in NSW show varying levels of 'consumptive orientation' (i.e. desire to catch fish) however the option of catching fish is a large part of the appeal of the fishing experience [4]. Therefore declines in fish abundance have potential to impact the relaxation benefits of recreational fishing. The environmental TARA reported commercial fishing impacts on abundancies of top and lower trophic levels coasts and oceans and estuary general as High on the basis of potential changes to trophic structure and uncertainties in understanding the effect of the fish stocks on ecosystem function.</li> </ul> <p>Bycatch is a key consideration for why the commercial fishing risks are higher than the recreational fishing risks for the same species/habitats. It is important to note that reforms and management responses are already underway</p> <p>The consequences of declines in fish abundance on human health and safety are likely to be concentrated more significantly on consumptive users and of major concern for these users. The overall consequence level is therefore considered to be <i>moderate</i>.</p>				

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
101	Moderate	Possible	Low	Current disputes between commercial and recreational sectors demonstrate the potentially divisive influence that competition for a limited resource can have on community harmony and cohesion. This could be expected to be exacerbated by further reductions in the available resource. In addition the socialisation aspects of recreational fishing is a major motivation for participation and this may decline if fish abundances are impacted [4]. The consequences of declines in fish abundance on socialisation are likely to be concentrated more significantly on consumptive users and of major concern for these users. The overall consequence level is therefore considered to be <i>moderate</i> . These consequences are considered <i>possible</i> . Refer to Cell 100 for comments on environmental TARA findings.	L	Local		10 years	Stable
102	Moderate	Likely	Moderate	Impacts will be concentrated on those users that value direct interactions with marine wildlife (including fish). The Marine Estate Community Survey results [1] identified that overfishing is considered the second highest threat (18%) when unprompted regarding what threats to the benefits derived from the marine estate are. However, there was little evident understanding among the community of exactly what constitutes overfishing. Results indicated that the NSW community is aware of the threat of overfishing, with the majority of the community (67%) agreeing that some areas of the Marine Estate should be protected, even if it means that recreational and commercial fishing is excluded. Recreational and commercial fishers	L	Statewide		10 years	Stable

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal		Trend	
						Local (site)	Regional	Statewide	1-2 years	10 years	20 years
				<p>recognise the need to conserve and support marine life so that future generations will be able to appreciate the Marine Estate as they have. Similarly, those involved in promoting development recognise that the natural beauty of the Marine Estate is a key reason why people want to live in or near the coast of NSW. Further, Batemans Bay participants highlighted overfishing (25%) as their second highest priority. Eden survey participants chose illegal catching or taking of fish and other marine life (28%) as their priority environmental threats</p> <p>Impacts will also be felt by those in the community that considers it important there is the following environmental benefits:</p> <ul style="list-style-type: none"> <li>• Clean waters that support a variety of habitats and marine life (72%)</li> <li>• an abundance of marine life (42%) unique biota that cannot be found anywhere else in the world (38%).</li> </ul> <p>The consequences of declines in fish abundance on enjoyment of biodiversity values is therefore considered to be <i>moderate</i> across the whole community. These consequences are considered <i>likely</i>. Refer to Cell 100 for comments on environmental TARA findings.</p>							
103	Major	Likely	High	Declines in fish abundance will impact those sectors	L		Regional		10 years		Stable

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				that value or rely on extractive use (i.e. fishers) by reducing their capacity to catch fish or their ability to go fishing (e.g. through increased regulations or costs introduced to manage this decline). The threats associated with localised depletion of fish stocks, are likely to contribute to substantial measurable and ongoing negative social and economic impacts on consumptive use overall ( <i>major</i> ), with potentially catastrophic impacts for the commercial/recreational fishing industry. This threat may have further implications for other industries, who are reliant upon healthy and biodiverse ecosystems, such as the dolphin watch industry, scuba diving, snorkelling and charter vessels. This may threaten the future social benefits and economic viability of some, or all, of these industries. Refer to Cell 100 for comments on environmental TARA findings					
104	Major	Possible	Moderate	Reductions in abundances of top and lower order trophic levels can impact tangible Aboriginal cultural heritage by depleting marine resources [7]. The significance of seafood for Aboriginal health and wellbeing suggests that <i>major</i> consequences would be <i>possible</i> for this section of the community from such a decline ( <i>Moderate</i> overall). Refer to Cell 100 for comments on environmental TARA findings	L	Unknown	Unknown	Unknown	Unknown
105	Moderate	Possible	Low	Reductions in abundances of top and lower order trophic levels can impact on intangible Aboriginal	L	Unknown	Unknown	Unknown	Unknown

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Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				heritage as environmental degradation can impact on spiritual connections e.g. totemic species, culturally significant species, links to Country, food sources [7]. Refer to Cell 100 for comments on environmental TARA findings				
106	Moderate	Likely	Moderate	Declining fish abundance may have some impact on intrinsic values, with the Marine Estate Community Survey identifying the loss of fish resulting from over-fishing as a threat to social benefits [1]. The perceived threat to intrinsic and bequest values is expected to be experienced by a greater breadth of the community than where economic benefits are more directly related to use values. Refer to Cell 100 for comments on environmental TARA findings	L	Statewide	10 years	Increasing
107	Moderate (N & S), Minor (C)	Likely	Moderate (N & S), Low (C)	Declining fish abundance is likely to have significant economic impacts to businesses at a local scale, with the viability of commercial and recreational fishers being significantly affected. The threat of decline may be greater in areas with more pressure on fish habitats (higher in central than in north and south); the net economic impacts may be felt more in economies with a greater dependence upon fisheries businesses. Refer to Cell 100 for comments on environmental TARA findings	L	Local and Statewide	10 years	Increasing
108	Minor	Likely	Low	Declining fish abundance may have some impact on individual enjoyment values, with the Marine Estate Community Survey identifying the loss of fish resulting from over-fishing as a threat to social benefits [1]. One user group, recreational fishers, will face greater	L	Local and Statewide	10 years	Increasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				negative impacts Refer to Cell 100 for comments on environmental TARA findings				
109	Moderate	Likely	Moderate	<p>The impacts of pests and disease are particularly significant (major) for the aquaculture industry and seafood consumers:</p> <ul style="list-style-type: none"> <li>• There is a history of pest and disease outbreaks in the Hawkesbury Bioregion having major adverse impacts on aquaculture, production, employment and the quality and reputation of seafood. QX is active, and has caused the almost complete collapse of production in the Hawkesbury River and Georges River. This effect has been on-gong since 1994 in the Georges River and in the Hawkesbury since 2004.</li> <li>• Pacific Oyster Mortality Syndrome (POMS) affected growers in the Georges River in 2010. More recently, POMS caused a second major collapse in production in the Hawkesbury River in 2013. The agent that causes POMS has been detected in Brisbane Waters leading to a quarantine closure but the disease has not been observed in the wild populations of Pacific Oysters. The Brisbane Waters oyster industry is anticipating growing sterile triploid Pacific Oysters but runs the risk of adverse impacts from POMS. POMS was first detected in Sydney Harbour and it is assumed that this disease remains prevalent in this estuary.</li> </ul>	L	Local	10 years	Stable

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Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				<p>These impacts are likely to continue until disease resistant stock is developed through breeding programs or alternate species are commercialised. The history of the impact of pest and disease on the NSW aquaculture industry indicates that the current impacts are likely to continue for a long time and that new impacts from previously unknown pests and diseases is highly likely. Overall community wide impacts are therefore considered to be moderate and likely.</p> <p>The environmental report refers to Sydney Rock Oyster disease QX and the Pacific Oyster exotic disease. A stressor associated with degradation in the environmental report is the introduction of pest species. In some areas the only riparian vegetation present is introduced species, such as willow, camphor laurel, privet, lantana and a host of other weed species.</p> <p>As per workshop discussion – emphasis on impacts to aquaculture industry and seafood contamination concerns, decline in trust in local seafood products. Example of oyster industry in the Hawkesbury that has endured two devastating disease outbreaks in the last ten years, namely QX in 2005 which impacted Sydney Rock Oysters and POMS (Pacific Oyster Mortality Syndrome) which virtually wiped out all Pacific Oysters in the Lower Hawkesbury suddenly in January 2013 (DPI, 2013). Prior to this outbreak, the industry consisted of 15 oyster businesses with \$2.4 million worth of oysters sold annually (DPI, 2013). The</p>				

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				industry is also valued for the employment it provides and its contribution to the character of the lower Hawkesbury River Estuary. The oyster production areas are well downstream of the likely impact area. Other example discussed was Wallis Lake Hepatitis issue.					
110	Minor	Likely	Low	As per justification 101 – the impacts of pests and disease may result in localised sectoral disputes (e.g. between fishing/aquaculture industry and shipping/boating) over resource allocation and appropriate management of pest and weed species. Impacts are likely to be concentrated more significantly on consumptive users and of moderate concern for these users. The overall consequence level is therefore considered to be <i>minor</i> . These consequences are considered <i>likely</i> . Refer also to cell 109.	L	Local	10 years	Stable	
111	Moderate	Possible	Low	Impacts will be highly dependent on the nature of the environmental impacts and will be concentrated on those users who value direct interactions with biodiversity values. For example community concern over Crown of Thorns Starfish – thought to be responsible for 50% of the loss of coral cover in GBRMPA ( <a href="http://www.gbrmpa.gov.au/about-the-reef/animals/crown-of-thorns-starfish">http://www.gbrmpa.gov.au/about-the-reef/animals/crown-of-thorns-starfish</a> ) demonstrates however that some pest species can cause wider community impacts relating to loss of intrinsic values. The overall consequence level is therefore considered to be <i>moderate</i> . These consequences are considered	L	Regional	10 years	Stable	

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				<i>possible</i> . Refer also to cell 109.					
112	Moderate	Likely	Moderate	As per justification 109 – pests and disease can have major impacts on consumptive use, especially the aquaculture industry, but may also impact fishers depending on the nature of the threat. Impacts are likely to be concentrated more significantly on these consumptive users and be of major concern for these users. Wider community wide impacts on seafood availability are also likely. The overall consequence level is therefore considered to be <i>moderate</i> . These consequences are considered <i>likely</i> . Refer also to cell 109.	L	Local		10 years	Stable
113	Moderate	Possible	Low	Pests and diseases can impact on tangible Aboriginal cultural heritage as environmental degradation can impact on spiritual connections e.g. totemic species, culturally significant species, links to Country, food sources [7]. Refer also to cell 109.	L	Unknown		Unknown	Unknown
114	Moderate	Possible	Low	Pests and diseases can impact on intangible Aboriginal heritage as environmental degradation can impact on spiritual connections (e.g. totemic species, culturally significant species, links to Country, food sources) [7]. Refer also to cell 109.	L	Unknown		Unknown	Unknown
115	Moderate	Possible	Low	Limited information on the impact of pests/diseases on intrinsic values. This concern was not highlighted in the Marine Estate Community Survey [1]. Where pests/diseases do occur, it is expected that intrinsic and bequest values will be impacted. Refer also to cell 109.	I	Regional		20 years	Increasing
116	Moderate	Possible	Low	Pests/diseases will impact on tourism operators,	I	Regional		20 years	Increasing

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Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				commercial fishers, aquaculture producers where impacts on habitats and marine life are significant. Impact dependent on the scale and impact of the pest/diseases. Refer also to cell 109.					
117	Moderate	Possible	Low	Pests/diseases will impact on recreational fishers where impacts on habitats and marine life are significant. Impact dependent on the scale and impact of the pest/diseases. Other enjoyment use benefits likely limited as enjoyment values are independent of this threat, and therefore the community wide consequence level is likely only minor. Refer also to cell 109.	I	Regional		20 years	Increasing
118	Minor	Likely	Low	Consequences of modified flows on human health and wellbeing are likely to be largely sectoral and site specific. Moderate and high risk ratings are shown in the environmental TARA that relate mostly to sediment resuspension, turbidity, ASS activation and potential toxin release, with impacts minor at a local scale. Opening of entrances to intermittent estuaries disrupts many ecological processes, and permanent openings can result in artificially saline estuaries and changed biological assemblages. They relate mostly to sectoral concerns around ICOL opening and closing regimes and potential impacts on enjoyment and use. Overall community wide consequences are considered to be <i>minor and likely</i> .	L	Local		10 years	Stable
119	Moderate	Likely	Moderate	Consequences of modified flows on socialisation and sense of community are likely to be largely sectoral	L	Local		10 years	Stable

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Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				and site specific, relates mostly to common community disputes over whether to artificially open ICOLS and impacts on socialisation associated with declines in water quality or loss of water flows (e.g. siltation of lake systems). Overall community wide consequences are considered to be <i>moderate</i> and <i>likely</i> . Refer also to cell 118.					
120	Minor	Likely	Low	Consequences of modified flows on enjoyment of marine biodiversity and beauty are likely to be largely sectoral and site specific. Different community perceptions of what constitutes a 'natural' environment will influence the extent to which their enjoyment of biodiversity is impacted. Overall community wide consequences are considered to be <i>minor</i> and <i>likely</i> . Refer also to cell 118.	L	Local		10 years	Stable
121	Moderate	Likely	Moderate	Consequences of modified flows on consumptive use largely sectoral and site specific, relates largely to impacts of fish abundance for commercial and recreational sectors and impacts on water quality (e.g. northern rivers fish kills). Overall community wide consequences are considered to be <i>moderate</i> and <i>likely</i> . Refer also to cell 118.	L	Local		10 years	Stable
122	Moderate	Possible	Low	The stressor modified freshwater flows can impact on tangible Aboriginal cultural heritage by negatively affecting fish stocks. Aboriginal people consulted in the Hawkesbury bioregion noted that modified flows have negatively affected fish stocks especially in the Newcastle/Worimi area [36]. Refer also to cell 118.	L	Unknown		Unknown	Unknown
123	Moderate	Possible	Low	The stressor modified freshwater flows can impact on	L	Unknown		Unknown	Unknown

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Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				intangible Aboriginal heritage as environmental degradation can impact on spiritual connections e.g. totemic species, culturally significant species, links to Country, food sources. It can also cause damage to places associated with cultural practices and traditions [7] Refer also to cell 118.					
124	Minor	Likely	Low	Limited information available. Modified hydrology/hydraulics and flow regime issues are largely site-specific.	I	Local		20 years	Stable
125	Minor	Likely	Low	Limited information available. Modified hydrology/hydraulics and flow regimes issues are largely site-specific.	I	Local		20 years	Stable
126	Minor	Likely	Low	Limited information available. Modified hydrology/hydraulics and flow regimes issues are largely site-specific and unlikely to have widespread impacts.	I	Local		20 years	Stable
127	Moderate	Possible (N&S) Likely (C)	Low (N&S) Moderate (C)	<p>The consequences of sediment contamination will be localised but major in impacted areas (or <i>moderate</i> overall), with impacts on wellbeing associated with relaxation and enjoyment. This is considered <i>possible</i> in North and South regions and <i>likely</i> in Central Region.</p> <p>The environmental TARA reported higher levels of contamination of sediments in the central region. Impacts in the north and south regions were limited and highly localised. Activities contributing included shipping, industrial discharges, catchment sources. Dredging was associated with resuspension of</p>	L	Local		10 years	Stable

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				contaminated sediments. In the central region estuaries where the sediment is contaminated (e.g. Port Kembla) re-suspension increases the likelihood that the contaminants can affect organisms living in the water. In the northern and southern regions the level of activity is likely to result in limited and localised impacts. The report also notes that Heavy metals can concentrate in soft sediments, bioaccumulate in species including oysters and seagrasses and reduce the diversity of invertebrates in soft sediments.					
128	Moderate	Likely(N &S) Almost certain (C)	Low (N&S) Moderate (C)	The consequences of sediment contamination are likely to be localised but major in impacted areas (or <i>moderate</i> overall), if it inhibits or discourages the use of the coast as a place for social connections and community use. This is considered <i>possible</i> in North and South regions and <i>likely</i> in Central Region.	L	Local	10 years	Stable	
129	Moderate	Likely(N &S) Almost certain (C)	Low (N&S) Moderate (C)	The high levels of concern relating to marine pollution demonstrated through the Marine Estate Community Survey suggest that people's enjoyment and appreciation of nature can be to be impacted by concerns relating to sediment contamination and other forms of pollution. Consequences are <i>moderate</i> and <i>possible</i> , and <i>likely</i> in the Central Region.	L	Local	10 years	Stable	
130	Moderate	Likely(N &S) Almost certain (C)	Low (N&S) Moderate (C)	The closure of Sydney Harbour to commercial fishing due to sediment contamination demonstrates the ability for this issue to impact on consumptive use. Consequences are major for individual sectors or <i>moderate</i> overall. They are <i>possible</i> in North and South regions and <i>likely</i> in the Central Region.	L	Local	10 years	Stable	

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
131	Mod	Possible	Low	Sediment contamination can impact on tangible Aboriginal cultural heritage as environmental degradation can impact on spiritual connections e.g. totemic species, culturally significant species, links to Country, food sources [7].	L	Unknown	Unknown	Unknown	Unknown
132	Mod	Possible	Low	Sediment contamination can impact on intangible Aboriginal cultural heritage as environmental degradation can impact on spiritual connections e.g. totemic species, culturally significant species, links to Country, food sources. It can also cause damage to places associated with cultural practices and traditions [7].	L	Unknown	Unknown	Unknown	Unknown
133	Minor (N&S) Moderate (C)	Likely	Low (N&S) Moderate (C)	Some impacts from beach closures following storm events and on fish abundance. Given low frequency of events, impacts on intrinsic benefits are likely minor. Impacts are expected to be greater in areas of greater population density and waste production.	I	Local	20 years	Stable	Stable
134	Minor (N&S) Moderate (C)	Likely	Low (N&S) Moderate (C)	Sediment contamination impacts on tourism operators during events (unable to conduct business for short periods) and on fishing operators where fish quality is impacted. In some cases, impacts may be major for regions or industry sectors, especially if sediment contamination is ongoing. Impacts are expected to be greater in areas of greater population density and waste production.	L	Local	20 years	Stable	Stable
135	Minor (N&S) Moderate (C)	Likely	Low (N&S) Moderate (C)	See justification 133; low frequency of events means the overall consequence on enjoyment values is only minor. Impacts are expected to be greater in areas of greater population density and waste production.	I	Local	20 years	Stable	Stable

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
136	Major	Likely	High	<p>Loss of beach amenity highlighted in [38] report would have significant social and economic implications. Coastal erosion and changes to beach morphology associated with storm surge/damage, sea level rise will affect beach and foreshore amenity/access and coastal vistas at various locations along the NSW coast. Coastal reforms program is currently tackling this issue at a state-wide scale.</p> <p>Consequences of climate change include impacts on health, safety and wellbeing associated with loss of beach amenity through increased frequency of dangerous storm events, potential increase in abundance of jellyfish and changes in abundance of valued marine species.</p> <p>Climate change / global warming / natural disasters was identified as a mid-level environmental threat in the community survey results, rating between a fourth and ninth priority threat [1] Within the 20 year time frame, sea level rise and altered storm and cyclone activity were likely to have the highest impacts. At the 50 year time frame assessed for the environmental tara, aspects such as ocean acidification and sea temperature rise also were attributed a number of High scores. In the 20 year timeframe, planning decisions to account for the 50 or hundred year projections will have social and economic impacts.</p> <p>Overall community wide consequences are considered</p>	L	Local	10 years	Stable	

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				to be <i>major</i> , given the <i>likely</i> wide scale loss of enjoyment and recreational opportunities associated with damage and loss of foreshore areas					
137	Major	Likely	High	As per justification 136, <i>likely</i> consequences of damage and loss associated with increased frequency and severity of storm and erosion events include implications for socialisation and sense of community. Given the importance of the coast to Australian culture and identity these consequences are considered to be <i>major</i> . Refer to cell 136	L	Local		10 years	Stable
138	Major	Almost certain	High	As per justification 136, consequences of damage and loss associated with increased frequency and severity of storm and erosion events are <i>almost certain</i> to include implications for aesthetic impacts of increased beach hardening and loss of 'natural' beach settings. Climate change may also impact on MPAs and changes in biodiversity values they protect (see justification 139). These consequences are considered <i>major</i> . Refer to cell 136	A	Local		10 years	Stable
139	Moderate	Likely	Moderate	Climate change is affecting ocean temperatures, the supply of nutrients, ocean chemistry, food chains, wind systems, ocean currents and extreme events such as cyclones. All of these variables have the potential to affect the distribution, abundance, breeding cycles and migrations of marine plants and animals that people rely on for food, income and enjoyment. Evidence is emerging that marine organisms may be responding faster to climate change than land-based plants and animals. As the climate warms, marine plants and	L	Local		10 years	Stable

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				animals are shifting towards the poles changing marine food webs and impacting the plants, and animals (including people and the corresponding social and economic benefits) that depend on them. Consequences of these changes for consumptive use are expected to be <i>moderate</i> and <i>likely</i> , and include changes in abundance in marine species valued for consumptive use and impacts of acidification on aquaculture operations and on crustaceans more broadly. Refer to cell 136					
140	Mod	Likely	Moderate	Climate change stressors such as sea level rise can cause the benefit of tangible cultural heritage not being realised as environmental degradation can impact on spiritual connections e.g. totemic species, culturally significant species, links to Country and food sources [7]. Refer to cell 136	I	Statewide		1-2 years	Increasing
141	Mod	Possible	Low	Climate change stressors can impact on intangible Aboriginal cultural heritage as environmental degradation can impact on spiritual connections e.g. totemic species, culturally significant species, links to Country and food sources. It can also cause damage to places associated with cultural practices and traditions [7] Refer to cell 136	I	Statewide		Next 20 years	Increasing
142	Moderate	Likely	Moderate	Impacts of climate change likely to have significant impacts on the intrinsic benefits some people and communities derive from the marine estate, including extractive users and passive users. At a statewide level, the impact is expected to be moderate, with some communities more exposed to the	A	Statewide		20 years +	Increasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				consequences of climate change experiencing major negative impacts (e.g. where beaches are washed away, access is severely restricted due to water levels, marine habitats significantly altered). Refer to cell 136					
143	Moderate	Likely	Moderate	As with justification 142, impacts on specific businesses and employment maybe significant. Structural adjustments will occur in the economy in response to climate change and the net economic impact is likely to be moderate (e.g. some livelihoods may be significantly impacted). Refer to cell 136	A	Statewide		20 years +	Increasing
144	Moderate	Likely	Moderate	Impacts of climate change likely to have significant impacts on the enjoyment benefits some people and communities derive from the marine estate. In particular, more extreme weather events, flooding and impacts on marine habitats will negatively impact a range of marine estate user groups (tourists, residents, fishers etc.). See also issues raised in justification 142.	A	Statewide		20 years +	Increasing
145	Moderate	Likely	Moderate	The principle threats from regulation relates to regulation which is developed without full consideration of the social, environmental and economic impacts it may have. Examples to date are sector specific and can have impact on the health and safety of these coastal users: <ul style="list-style-type: none"> <li>E.g. commercial fishing regulations which restrict crew numbers or encourage fishers to work in unsafe conditions (e.g. poor weather) In Australia and overseas the wellbeing of fishers and fishing families and communities impacted by poor regulation has been highlighted as a matter of</li> </ul>	L	Regional		1-2 years	Stable

Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				<p>significant concern [2, 10-13].</p> <ul style="list-style-type: none"> <li>E.g. Indigenous communities: Current restrictions inhibit community involvement in Aboriginal commercial fishing, practices particularly the beach haul fishery, and place considerable constraints on the ability of Aboriginal commercial fishers to pass on their cultural and environmental knowledge to the next generation, causing reductions in wellbeing. Licences in the commercial fishing industry are now largely out of reach for many within Indigenous communities of NSW despite the likely social and economic benefits of engaging more Aboriginal people in the fishing industry – including post-harvest [6, 8, 14-16].</li> <li>Recreational fishing: minor loss of some social benefits of recreational fishing through restrictions from MPAs, including loss of enjoyment and inconvenience, and stress relating to concerns over knowledge of regulations and boundaries [4, 6]. In addition research following the GBRMP rezoning identified changes in fishing frequency and satisfaction, reduced fishing quality, restricted access to areas considered to be of high quality for recreational fishing, increased crowding in areas that remain open to fishing, and increased likelihood of localized depletions in popular recreational fishing locations [17]. It is important to recognise these impacts in the context of the wellbeing benefits that other users derive from</li> </ul>				

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				<p>MPAs and other conservation management regulations. For example, The marine estate community survey results highlighted that Coffs Harbour (23%) and Hawkesbury / Pittwater (17%) participants identified not enough restrictions of recreational fishing as their third highest threat. Over-restriction of recreational fishing is seen as a third priority threat for Batemans Bay (23%) and Eden (18%) participants.</p> <p>The community survey results also highlighted increasing costs to access and use the NSW marine estate (42%), North East (38%), Central (44%) and South East 36%) are seen as having the potential to cause major damage to the tourism industry and other marine industries in NSW. Similarly, increasing costs to access and use the Marine Estate was identified as the third highest economic threat by Coffs Harbour (24%), Ballina (23%), Newcastle (29%), Sydney (22%), and Hawkesbury/Pittwater (24%) participants. Batemans Bay participants listed declining levels of coastal and marine-based tourism (23%) as their third priority, while Eden participants selected increasing costs and regulation of local businesses (25%) [1].</p> <ul style="list-style-type: none"> <li>• Broader community concerns relating to anti-social behaviour as the primary threat to social benefits in NSW indicate there may be some argument that particular offensive behaviours are if not under regulated than at least under-enforced. This</li> </ul>				

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				requires further investigation. Given the largely sectoral nature of the impacts the overall consequence is considered to be <i>moderate</i> and <i>likely</i> .				
146	Moderate	Possible	Low	Examples highlighted in Justification 145 also have implications for community harmony and socialisation e.g. restrictions on community interaction with commercial beach hauling may have negatively influenced community understanding and perceptions of the commercial fishing industry, and the ability of Aboriginal communities to exchange cultural knowledge. Given the largely sectoral nature of the impacts the overall consequence is considered to be <i>moderate</i> and <i>possible</i> .	L	Local	10 years	Stable
147	Moderate	Possible (N & S) and Likely (C)	Low (N & S) and Moderate (C)	Under-regulation can also have significant impacts on community enjoyment of beauty or biodiversity values, particularly if the community believes these values are not being adequately protected [18]. E.g. high levels of support for MPAs are demonstrated through numerous studies including Sweeney report [1]. MPAs, particularly no take zones, provide dedicated opportunities for enjoyment and appreciation of nature by separating passive and consumptive users. Given the high level of community support for MPAs the absence of these protection measures can be considered to have moderate consequences. The likelihood of these consequences is <i>possible</i> in North and South regions where MPAs are already established and <i>likely</i> in Central region where limited	L	Local	10 years	Stable

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				MPA protection exists at present.					
148	Moderate	Likely	Moderate	As per justification 145, cumulative impacts of multiple sources of regulation can impact all marine sectors, including consumptive users. Given the largely sectoral nature of the impacts the overall consequence is considered to be <i>moderate</i> and <i>likely</i> .	L	Regional		10 years	Stable
149	Moderate	Likely	Moderate	Inadequate, inefficient regulation or over-regulation can impact on tangible Aboriginal heritage. The principle threats from regulation relates to regulation which is developed without full consideration of the social, environmental and economic impacts it may have. For instance current restrictions inhibit community involvement in Aboriginal commercial fishing, practices particularly the beach haul fishery, and place considerable constraints on the ability of Aboriginal commercial fishers to pass on their cultural and environmental knowledge to the next generation, causing reductions in wellbeing. Licences in the commercial fishing industry are now largely out of reach for many within Indigenous communities of NSW despite the likely social and economic benefits of engaging more Aboriginal people in the fishing industry – including post-harvest [6, 8, 14-16]. Restrictions on resource collection for social events. For example in the Hawkesbury bioregion there is restriction on pipis for consumption via regulation There is also restriction on access to camping / collecting places where social events occur. There is also inadequate recognition of rights and	I	Statewide		1-2	Stable / Increasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				interests in the Marine Estate. Lack of recognition of the special place of Aboriginal people as original custodians with special rights and interests and concomitant changes to regulations. In addition management regimes that don't recognise Aboriginal values are also a threat.					
150	Mod	Likely	Moderate	Inadequate, inefficient regulation or over-regulation can impact on intangible Aboriginal heritage as there is inadequate regulation to protect significant species has impacted in the benefit of religious/spiritual significance being realised [7]. There is also a loss or diminution in cultural practices and knowledge such as creation stories and dreaming tracks. There is also a reduced community capacity to undertake cultural practices i.e. knowledge is not being transferred, elders are unwell etc [7].	I	S		1-2 years	Stable / Increasing
151	Insignificant	Possible	Minimal	Impacts of over regulation and inefficient regulation likely to be insignificant for intrinsic benefits, as intrinsic benefits are derived from knowing that the marine estate is there and can be visited rather than the practicalities of accessing and using the marine estate. Regulation is more likely to impact users of the marine estate.	L	Statewide		10 years	Stable/decreasing
152	Minor	Likely	Low	The Marine Estate Community Survey identified increasing costs and regulation of local businesses as the fourth largest threat to economic activity [1]. Impacts are likely to be minor as they are relevant to only one group (businesses) and are unlikely to have	L	Statewide		10 years	Stable/decreasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				significant measurable impacts on production or employment				
153	Minor	Likely	Low	Impacts on enjoyment values are likely to be minor, with impacts only felt by specific groups (e.g. people wanting to pilot boats and jetskis in the marine estate but which are restricted in area and speed). Overall risk level is only low as impacts will be contained to such user groups and are likely only marginal.	L	Statewide	10 years	Stable/decreasing
154	Minor	Likely	Low	Governance processes that are seen to be unfair or inequitable, or 'imposed' on communities without adequate consultation can have highly deleterious impacts on the mental health of individual stakeholders [2]. It may also impact broader community wide feelings of trust in government. Given the largely sectoral nature of the impacts the overall consequence is considered to be <i>minor</i> and <i>likely</i> .	A	Regional	10 years	Stable
155	Minor	Likely	Low	Effective participation and engagement of communities is fundamental to achieving socially and economically equitable outcomes for communities. The risk of ineffective or inadequate engagement is that vested interested or noisy minorities can influence outcomes that are against the interest or wishes of the wider community. Community engagement, not carefully managed, can also exacerbate or create division within the community rather than encouraging deliberation and negotiation [19] These consequences are <i>likely</i> to be of moderate concern to individual stakeholder groups (overall <i>minor</i> consequence).	A	Regional	10 years	Stable

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				<p>Note: Many of the respondents feel the sheer volume of background reports to review is too lengthy, and difficult to understand by the general community. The community are being invited to consider and comment on the TARA on the condition they have undertaken a thorough review of the background reports, AND are able to provide new evidence to support a different view. Critical review of the background material by the community is not reasonably practical.</p> <p>It was felt the language and technical jargon used in the community consultation process will not solicit a response from casual users of the marine estate, or particular segments of the community that would be impacted including those with English as a second language. For example, in the Hawkesbury community engagement process, many respondents felt terms such as “spatial management” was ambiguous and did not adequately reflect the intention of the suggested management initiative. Many respondents felt the term “closures” or “restrictions” is a more accurate reflection of the intention of the suggested management initiative and would have solicited a polar response.</p> <p>The community faces a difficult choice when considering the time and effort required reviewing the volume of material to offer meaningful feedback.</p>					
156	Moderate	Possible	Low	There is building evidence that the levels of community engagement and participation in governance have a direct link to ecosystem health and with <i>moderate</i> flow on impacts on community enjoyment of biodiversity values <i>possible</i> [20, 21] It is also likely to influence	L	Regional		10 years	Stable

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				compliance with regulations which may also impact people enjoyment of beauty and biodiversity values.					
157	Moderate	Possible	Low	As per justification 156 engagement in governance process has a direct link to the success of management and compliance with regulations, which in turn influence availability of fisheries resources and the quality of other forms of consumptive use such as tourism. These consequences are considered to be <i>moderate and possible</i> .	L	Regional		10 years	Stable
158	Moderate	Possible	Low	The lack of community engagement or participation in governance stressor has an impact on tangible Aboriginal cultural heritage. There is inadequate consultation with Aboriginal communities affected. Aboriginal people are concerned that they do not have enough say in management and planning and decisions are made that greatly affect their lives without them having any effective input. Aboriginal people as a rule, have no confidence in the government to manage the natural environment, given the legacy of the last 200 years. Understandably, they consider that more traditional forms of natural resource management could be more effective and are concerned that there are not enough avenues for this to happen [7].	L	Local		1-2 years	Increasing
159	Mod	Likely	Moderate	The lack of community engagement or participation in governance stressor has an impact on intangible Aboriginal heritage. See above for justification.	I	Unknown		Unknown	Unknown
160	Minor	Possible	Minimal	Similar to justification for 154: Governance processes that are seen to be unfair or inequitable, or 'imposed'	L	Statewide		10 years	Stable

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Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				on communities without adequate consultation can have deleterious impacts on the mental health of individual stakeholders. It may also impact broader community wide feelings of trust in government, which will impact intrinsic and bequest values.					
161	Minor	Possible	Minimal	Similar for justification to 160, with impacts on employers and employees. Impacts on actual production and employment likely to be minor	L	Statewide	10 years	Stable	
162	Minor	Possible	Minimal	See justification for 160	L	Statewide	10 years	Stable	
163	Minor	Possible	Minimal	<p>There is some concern about children's increasing disconnections from nature and their food sources, sometimes known as 'nature deficit disorder'. The health and wellbeing implications of this disconnection are unknown but are of concern to medical practitioners [22]. While a lack of awareness or knowledge of the marine estate is unlikely to have significant impacts on community safety health and wellbeing it should be noted that encouraging greater knowledge and understanding may also encourage greater use of the marine estate. This may, in turn, have substantial community health benefits, particularly in relation to mental health and relaxation.</p> <p>One of the themes that came out of the Marine Estate Community Survey was a general lack of awareness or opinion on current management and threats of the marine estate [1].</p> <p><i>Minor consequences on community health and</i></p>	I	Statewide	10 years	Stable	

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Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				wellbeing are therefore considered <i>possible</i> as a result of lack of knowledge or awareness of the marine estate.				
164	Minor	Possible	Minimal	As per justification 163. <i>Minor</i> consequences on socialisation and sense of community are considered <i>possible</i> as a result of lack of knowledge or awareness of the marine estate.	I	Statewide	10 years	Stable
165	Moderate	Likely	Moderate	<p>A lack of knowledge and awareness of the marine estate may detract from the full extent to which people can appreciate and enjoy the benefits it provides. It may also influence the extent to which the community supports difficult management decisions considered necessary for environmental protection [23]. Finally, it may also impact the behaviour of marine estate users – those with a greater knowledge and awareness of the benefits provided by the marine estate may be more likely to act in ways that support and sustain it [24].</p> <p>One of the themes that came out of the Marine Estate Community Survey was a general lack of awareness or opinion on current management and threats of the marine estate [1].</p> <p><i>Moderate</i> consequences on enjoyment of biodiversity values are therefore considered <i>likely</i> as a result of lack of knowledge or awareness of the marine estate.</p>	L	Statewide	10 years	Stable
166	Minor	Likely	Low	As per justification 165, a lack of knowledge and understanding of the marine estate may influence fishing behaviour and compliance with regulations,	L	Statewide	10 years	Stable

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Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				which may in turn impact the health of local fisheries and the enjoyment of the experience of other users. One of the themes that came out of the Marine Estate Community Survey was a general lack of awareness or opinion on current management and threats of the marine estate [1]. <i>Minor</i> consequences on consumptive use values are therefore considered <i>likely</i> as a result of lack of knowledge or awareness of the marine estate.					
167	Moderate	Likely	Moderate	Lack of community awareness of the marine estate can have an impact on tangible Aboriginal cultural heritage. There is inadequate understanding of Aboriginal worldviews of culture and nature as a single entity, and further a miss-match between Aboriginal and non-Aboriginal world views [7].	L	Unknown	Unknown	Unknown	Unknown
168	Moderate	Almost certain	Moderate	Lack of community awareness of the marine estate can have an impact on intangible Aboriginal heritage. There is inadequate understanding of Aboriginal worldviews of culture and nature as a single entity, and further a miss-match between Aboriginal and non-Aboriginal world views. While there is widespread recognition of the importance of sacred places within coastal planning and management more complex cultural practices and relationships with landscape and community are less well understood and this may lead to unintentional impacts on intangible values [7].	L	Unknown	Unknown	Unknown	Unknown
169	Moderate	Possible	Low	One of the themes that came out of the Marine Estate Community Survey was a general lack of awareness or opinion on current management and threats of the	L	Statewide	10 years	Stable	

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Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				marine estate [1]. The Hawkesbury assessment has demonstrated that information failure can lead to a range of environmental, social and economic threats; these may in turn, impact upon intrinsic values.					
170	Moderate	Possible	Low	One of the themes that came out of the Marine Estate Community Survey was a general lack of awareness or opinion on current management and threats of the marine estate [1]. This risk is assumed to be low. The Hawkesbury assessment has demonstrated that information failure can lead to a range of environmental, social and economic threats; these may in turn, impact upon production.	L	Statewide		10 years	Stable
171	Moderate	Possible	Low	One of the themes that came out of the Marine Estate Community Survey was a general lack of awareness or opinion on current management and threats of the marine estate [1]. The Hawkesbury assessment has demonstrated that information failure can lead to a range of environmental, social and economic threats; these may in turn, impact upon individual enjoyment value.	L	Statewide		10 years	Stable
172	Moderate	Likely (N&S) Almost certain (C)	Moderate	Anti-social behaviour was the number 1 concern of marine estate users in the Sweeney research – this is likely to relate to 2 main areas, a lack of compliance with social norms (e.g. acceptable noise levels, appropriate behaviour) and secondly a lack of compliance with regulations (littering, fisheries regulations etc.). Research into recreational fisher attitudes indicated a high level of concern about illegal activity and enforcement levels, and broader interviews	L	Local		1-2 years	Unknown

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				with marine estate users by Voyer also indicated that users have a high degree of concern about equity and justice e.g. other users doing the wrong thing and getting away with it [4, 18]. Anger, resentment and frustration about illegal activity is therefore likely to impact individual stress levels, and have <i>moderate</i> impacts on relaxation. Likelihood almost certain in Central region where negative interactions more common due to population levels.					
173	Moderate	Likely	Moderate	One of the most concerning aspects of illegal behaviour in relation to socialising and sense of community is that it is often used to make generalisations about particular sections of the community, as demonstrated in recent research into recreational fisher attitudes [4] In particular this relates to conflict between different cultural groups within the community – e.g. animosity towards Asian, European and Pacific Island nationalities around compliance with fishing regulations ([4] and see [5]). This has also been seen in conflicts between recreational, commercial and Indigenous fishers and community members relating to perceptions about illegal fishing activities [3]. This can impact community cohesion and harmony as well as having major impacts on user groups who are the subject of generalisations such as these [2]. Overall community-wide consequences are therefore considered to be <i>moderate</i> and <i>likely</i>	L	Local	1-2 years	Unknown	
174	Moderate	Likely	Moderate	Lack of compliance with regulations put in place to manage, protect and enhance biodiversity values or	L	Local	10 years	Unknown	

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				maintain the aesthetic beauty of the coast would be <i>likely</i> to have discernible and ongoing impacts ( <i>moderate</i> ) on the enjoyment and appreciation of these values.					
175	Moderate	Likely	Moderate	Lack of compliance with regulations put in place to manage, protect and enhance fisheries or other forms of consumptive use (e.g. controls on visitor numbers/vessel anchoring or mooring areas) is likely to have ongoing impacts on the ongoing success of these management arrangements with flow on impacts on the viability of these activities. Overall community-wide consequences are considered to be <i>moderate</i> and <i>likely</i> .	L	Local	10 years	Unknown	
176	Moderate	Possible	Low	Regulations which govern the use and management of significant cultural sites and artefacts are crucial to their ongoing protection. A lack of compliance with these regulations is therefore a key threat. Overall community-wide consequences are considered to be <i>moderate</i> and <i>possible</i> .	I	Unknown	Unknown	Unknown	
177	Minor	Possible	Minimal	There are few specific regulatory protections for intangible cultural heritage therefore a lack of compliance with regulations is unlikely to significantly impact these benefits. Exceptions exist in protected areas and other management regulations which have been developed in consultation with Indigenous communities and are specifically designed to allow for continued connections to culture and traditions (e.g. special purpose zones in BMP and SIMP). Overall community-wide consequences are considered to be	I	Unknown	Unknown	Unknown	

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				<i>minor and possible.</i>				
178	Moderate	Possible	Low	Lack of compliance with regulations is linked to anti-social behaviour and has a similar risk profile (see justification 16). Illegal activities are likely to impact perceptions of the marine estate, thereby negatively impacting on intrinsic and bequest values. However, at a community wide scale the consequence is likely to be moderate and the overall risk low.	A	Local	1-2 years	Unknown (?)
179	Major	Possible	Moderate	Similar to justification 17. Illegal activities have the potential to create long-term negative impacts on businesses and employment, Commercial fishers may also be significantly impacted where their livelihoods are under threat from overfishing and habitat destruction related to illegal activities.	A	Local	1-2 years	Unknown (?)
180	Moderate	Possible	Low	Similarly to justifications 178 and 179, lack of compliance with regulations can negatively impact on enjoyment value. In particular, when illegal activities deter people from visiting or enjoying the marine estate, their use values are lost. Although this may be an issue in some localities, the community-wide impacts are relatively moderate as illegal activities are generally isolated incidents.	A	Local	1-2 years	Unknown (?)
181	Moderate	Likely (N) Possible (C & S)	Moderate (N) Low (C & S)	Information is needed to ascertain whether risks to personal safety (real or perceived) operate as a threat or deterrent to beach users. Risk to personal safety may have a high consequence either moderate or major over short temporal intervals, such as following shark sightings or attacks. This would increase overall risk rating and may be important to how the shark	A	Local	1-2 years	Increasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				<p>meshing programs and other public safety issues are managed.</p> <p>Recent spate of shark incidents on the North Coast near Ballina in 2015 have resulted in reduced surfing activity, impacts on scheduling of surf lifesaving activities and implementation of shark research to address regional concerns/media coverage.</p> <p>While there is evidence of short term and immediate impacts on beach usage following attacks research by Gibbs &amp; Warren indicate that overall beach users interact regularly with shark and it does not seem to deter longer term usage patterns [25].</p> <p>Overall risk rating is therefore determined to be <i>moderate</i>, with likelihood possible in southern and central regions and likely in the northern region.</p>					
182	Minor	Likely	Low	Impact associated with decreased community use of the coast for socialisation associated with shark interactions and jellyfish etc. are likely to be short term and localised. [25] Overall risk rating is therefore determined to be <i>minor</i> and <i>likely</i> .	A	Local		1-2 years	Increasing
183	Minor	Unlikely	Minimal	Impacts associated with decreased enjoyment of the beauty and biodiversity of the coast associated with shark interactions and jellyfish etc are likely to be short term, localised and concentrated on user groups such as snorkelers, divers, swimmers and surfers. Overall risk rating is therefore determined to be <i>minor</i> and <i>unlikely</i> .	L	Local		1-2 years	Increasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
184	Minor	Unlikely	Minimal	Impacts associated with consumptive use associated with shark interactions and jellyfish etc. are likely to be short term, localised and concentrated on tourism operators. Overall risk rating is therefore determined to be <i>minor</i> and <i>unlikely</i> .	L	Local		1-2 years	Increasing
185	Insignificant	Unlikely	Minimal	No foreseen impacts associated with tangible cultural heritage associated with shark interactions and jellyfish etc.	I	Unknown		Unknown	Unknown
186	Insignificant	Unlikely	Minimal	No foreseen impacts associated with intangible cultural heritage associated with shark interactions and jellyfish etc.	I	Unknown		Unknown	Unknown
187	Minor (S & C) / Moderate (N – cumulative impact due to frequency of northern NSW shark attacks)	Possible	Minimal (S&C)/ Low(N)	In the case of shark attacks (the most high profile wildlife incidents), the impacts on intrinsic and bequest values can be significant in the short term but minimal in the long term. For example, a Four Corners episode ('Shark Alarm' broadcast 8/2/2016) highlighted contemporary fears in the community of shark attacks, and represented negative impacts on the intrinsic values the community places on the marine estate. Depending upon the frequency of attacks, these fears are not likely to persist through multiple years, nor have a large community-wide impact. In the northern region where shark attacks have been more frequent in recent years and concerns already exist within the tourism sector the consequence is assumed to be higher.	L	Local		1-2 years	Unknown (?)
188	Minor (S&C), Moderate	Possible	Minimal (S&C)/ Low (N)	See justification 187; similar impacts for businesses (e.g. tourism operators, businesses dependent on beach traffic).	L	Local		1-2 years	Unknown (?)

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
	(N)								
189	Minor (S&C), Moderate (N)	Possible	Minimal (S&C)/ Low(N)	See justification for 187, similar impacts for enjoyment value benefits. In particular, when beaches are closed or people are deterred from visiting the marine estate.	L	Local		1-2 years	Unknown (?)
190	Moderate	Possible (N&S) Likely (C)	Low (N&S) Moderate (C)	Seafood contamination can have significant health implications for communities. While a community as a whole will be impacted there are also more concentrated socio-economic impacts on industries that rely on unpolluted water and sediments, especially aquaculture and fisheries. The major impacts of seafood contamination on commercial fishers in the Williamstown area suggests that this could have overall moderate consequences for communities. This is possible in north and south regions and likely in the more industrialised areas of Central region.	L	Regional		1-2 years	Stable
191	Moderate	Possible (N&S) Unlikely (C)	Low (N&S) Minimal (C)	Seafood contamination may have limited impacts on socialising associated with seafood consumption. If seafood contamination leads to loss of aquaculture or fishing industries from a region this may impact community sense of identity in regional areas as indicated by community surveys associated with FRDC wild-catch and aquaculture projects. Overall risk rating is therefore determined to be <i>moderate</i> and <i>possible</i> in regional areas in north and south regions where there are stronger links with established marine industries. Likelihood is unlikely in Central region but may have concentrated localised impacts on fishing villages such as Patonga, Brooklyn and Wisemans Ferry. [3]	L	Regional		1-2 years	Stable

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
192	Minor	Unlikely	Minimal	No foreseen impacts on enjoyment of biodiversity or beauty of marine estate	I	Local		10 years	Stable
193	Moderate	Almost certain	Moderate	Seafood contamination can have major impacts on consumptive use including the viability of fishing and aquaculture industries as demonstrated in Williamstown (prawns) and Hawkesbury River (oysters). These impacts are largely sectoral but can have broader impacts across the community if it lowers community trust in seafood quality ( <i>moderate</i> ). These consequences are <i>almost certain</i> if contamination does occur.	L	Regional		10 years	Stable
194	Moderate	Possible	Low	Seafood contamination stressor has an impact on the toxicity of fish caught which was raised by Aboriginal people consulted in the Hawkesbury bioregion as of particular concern in Sydney Harbour and also reported in Lake Macquarie [36]. Aboriginal people frequently eat wild pipis, oysters and other shellfish that are known to be vulnerable to contamination issues. Therefore major impacts ( <i>moderate</i> overall) on Indigenous communities may be <i>possible</i> .	L	Statewide		1-2	Increasing
195	Moderate	Possible	Low	Seafood contamination may impact on the practise of cultural fishing and associated transfer of knowledge and cultural ceremonies in which seafood is important. Therefore major impacts ( <i>moderate</i> overall) on Indigenous communities may be <i>possible</i> .	I	Unknown		Unknown	Unknown
196	Minor	Unlikely (N&S) Possible (C)	Minimal (N&S) Low (C)	Seafood contamination impacts are unlikely to have significant measurable impacts at a community-wide scale as consumption of seafood is only a small component of the intrinsic value people derive,	L	Local		10 years	Unknown (?)

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Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				although some cases which impact intrinsic benefits exist (e.g. impact on perceptions of safety of seafood resulting from Williamstown RAAF contamination). Risks likely to be greater in the central region with more industrialisation, urbanisation and contamination risk.					
197	Minor	Unlikely (N&S)/ Possible (C)	Minimal (N&S) Low (C)	Similar risk profile to justification 196. In some cases, economic impacts on businesses and employment may be severe (e.g. if a widespread outbreak affecting a key fish species undermined the entire fishing industry) but the evidence does not suggest that such an event is likely.	L	Local		10 years	Unknown (?)
198	Insignificant	Unlikely (N&S) Possible (C)	Minimal	Enjoyment value is limited to the lost enjoyment from being unable to consume seafood from the marine estate in the event of contamination. This is a small component of the benefits derived from the marine estate, meaning the consequence level is insignificant. People are also likely to substitute locally-caught seafood in the event of a contamination if they are concerned about food safety, therefore reducing net impact on enjoyment value.	L	Local		10 years	Unknown (?)
199	Moderate	Possible	Low	The environmental TARA reported sources of water pollution as having major impacts almost certain from combined stressors of nutrients, suspended sediments and toxic contaminants. This was higher in the central compared to north and south regions. Agricultural sources were considered an equally high threat across all three regions. Water can have direct and indirect impact on human health through contamination of	L	Local		10 years	Increasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				seafood, direct ingestion or skin complaints from contact, loss in opportunities for relaxation and enjoyment. While a community as a whole will be impacted there are also more concentrated socio-economic impacts on industries that rely on unpolluted water, especially aquaculture and fisheries. The Sweeney report highlighted water pollution as a significant concern for the public. Impacts are likely to be short term and localised. Therefore <i>moderate</i> community wide consequences on human health and wellbeing are <i>possible</i> .				
200	Moderate	Possible	Low	Given the importance of the NSW coast as a place of socialisation and social connections the impacts of pollution and litter will be significant if it inhibits or discourages the use of the coast [1]. Impacts are likely to be short term and localised. Therefore <i>moderate</i> community wide consequences on socialisation and sense of community are <i>possible</i> .	L	Local	10 years	Increasing
201	Moderate	Possible	Low	Loss of amenity associated with pollution and contamination are likely to significantly impact people's relationship with the coast and their ability to appreciate marine biodiversity. This is reflected in the high levels of concern relating to marine pollution demonstrated through the Sweeney report [1]. Therefore <i>moderate</i> community wide consequences on biodiversity appreciation are <i>possible</i> .	L	Local	10 years	Increasing
202	Minor	Possible	Minimal	Contamination of seafood associated with marine pollution would be the main impact on consumptive use and this is addressed in justification 194. <i>Minor</i>	L	Local	10 years	Increasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				consequences outside of seafood contamination are considered <i>possible</i> but re likely to be short term and localised.				
203	Moderate	Possible	Low	Impacts on tangible cultural heritage may be significant. Pollution or contamination impacts the ability or Aboriginal communities to make use of important sites or participate in important cultural practises.	I	Unknown	Unknown	Unknown
204	Moderate	Possible	Low	Impacts on intangible cultural heritage may be significant. Pollution or contamination impacts the ability or Aboriginal communities to make use of important sites or participate in important cultural practises.	I	Unknown	Unknown	Unknown
205	Moderate	Possible	Low	Water pollution was identified as a major threat to the environment in the Marine Estate Community Survey (top 3 issues were littering/rubbish, oil and chemical spills, and water pollution from sediment and run-off) and the greatest threat to economic activity [1]. This suggests the public are highly concerned with water pollution issues, with pollution causing a substantial measurable and on-going negative impact. Where concerns emerge regarding human health in relation to use of the marine estate of major impacts to of intrinsic benefits are expected.	A	Local	20 years	Increasing
206	Moderate	Possible	Low	The impact of water pollution on businesses and tourism operators was nominated as the greatest threat to economic activity in the Sweeney research. A significant water pollution event (such as at the Williamstown RAAF base) could have substantial and	A	Local	20 years	Increasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				ongoing impacts on a range of local businesses and employment. See justification for 205 for further explanation.				
207	Major	Possible	Low	See justification 205; impacts for enjoyment values more localised.	A	Local	20 years	Increasing
208	Moderate	Likely	Moderate	Key knowledge gaps exist around the different ways in which coastal users value the coast and how particular activities and management changes are likely to impact these values. In particular the cumulative impacts of socio economic threats is an area that has received limited research attention to date and this is recognised as a current data gap in the TARA process. It is understood that different communities are likely to respond in different ways to the identified threats and associated management changes (e.g. see [26, 27]). It is difficult, however, to determine the complex interactions of socio-economic, demographic, political and environmental factors which influence these differences. Cumulative impacts associated with the socio-economic threats considered in the TARA can be thought about in two main ways. Firstly the cumulative impacts of multiple stressors, or the increasing likelihood of a single stressor over time, may influence the resilience of a community to additional threats. Secondly, the cumulative impact of external factors associated with demographics, socio-economics and historical or legacy issues may also influence the vulnerability of a population to particular stressors. A lack of understanding of the resilience	I	Statewide	10 years	Decreasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				levels of different communities is likely to inhibit the development of appropriate management strategies. <i>Moderate</i> community wide consequences on human health and wellbeing are therefore considered <i>likely</i> as a result of inadequate information to guide decision making.					
209	Moderate	Likely	Moderate	As per justification 208– a lack of understanding of the way the marine estate facilitates and builds community cohesion and division may limit the ability of management responses to be sensitive to protecting or enhancing social relationships. <i>Moderate</i> community wide consequences on socialisation and sense of community are therefore considered <i>likely</i> as a result of inadequate information to guide decision making.	I	Statewide	10 years	Decreasing	
210	Moderate	Likely	Moderate	Different community perceptions of 'beauty' and 'biodiversity' are likely to be key drivers in their attitudes towards management responses and the extent to which they feel impacted by environmental changes [28]. These need to be better understood in the development of management responses. This is especially important in understanding how environmental change associated with climate change, extractive use and other stressors may interact with community values to determine how communities will respond and react to these changes. <i>Moderate</i> community wide consequences on enjoyment of biodiversity values and beauty are therefore considered <i>likely</i> as a result of inadequate information to guide decision making.	I	Statewide	10 years	Decreasing	

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Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
211	Moderate	Likely	Moderate	The social and economic aspects of fisheries management in NSW is understudied, although there is increasing work being done in this area around the world. This works point to the importance of studying social, economic and environmental drivers which influence the success of management strategies in an integrated manner. Without doing so there is a risk that fisheries will be managed in ways that may be environmentally sustainable but result in social and economic failures (or vice versa) [e.g. see 10]. <i>Moderate</i> community wide consequences on consumptive use are therefore considered <i>likely</i> as a result of inadequate information to guide decision making.	L		Statewide	10 years	Stable
212	Moderate	Likely	Moderate	Inadequate scientific information stressor has an impact on tangible aboriginal cultural heritage. There is a knowledge gap around the views and aspirations of Aboriginal people in regard to the NSW marine estate. Further research is also needed around fisheries [7]. <i>Moderate</i> community wide consequences are therefore considered <i>likely</i> as a result of inadequate information to guide decision making.	I		Statewide	10 years	Decreasing
213	Moderate	Likely	Moderate	Inadequate scientific information stressor has an impact on intangible aboriginal heritage. There is a knowledge gap around the views and aspirations of Aboriginal people in regard to the NSW marine estate. Further research is also need around fisheries e.g. more work is also needed in the Twofold Shelf marine bioregion in regard to cultural resource use beyond	L		Unknown	Unknown	Unknown

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				abalone [7]. <i>Moderate</i> community wide consequences are therefore considered <i>likely</i> as a result of inadequate information to guide decision making.					
214	Moderate	Likely	Moderate	Key knowledge gaps and inadequate scientific information have been identified through the marine estate management process, although their impacts on intrinsic benefits are difficult to quantify. Given that that the Hawkesbury assessment has demonstrated that information failure can lead to a range of environmental, social and economic threats; these may in turn, impact upon intrinsic values.	I	Statewide	20 years	Unknown (?)	
215	Moderate	Likely	Moderate	See justification for 223. The Hawkesbury assessment has demonstrated that information failure can lead to a range of environmental, social and economic threats; these may in turn, impact upon production and employment	I	Statewide	20 years	Unknown (?)	
216	Moderate	Likely	Moderate	See justification for 223; The Hawkesbury assessment has demonstrated that information failure can lead to a range of environmental, social and economic threats; these may in turn, impact upon individual enjoyment value	I	Statewide	20 years	Unknown (?)	
217	Moderate	Likely	Moderate	The benefits from recreational boating are reliant on adequate land-water interface based infrastructure such as boat launching facilities, access points, slipways, boat storage facilities (on-water, dry storage, trailered), wharfs, pontoon, jetties, moorings and marinas. Many of the social and economic benefits rely on people being able to access the State's waterways by	I	Local	10 years	Increasing	

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Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent			Trend		
						Local (site)	Regional	Statewide			
						1-2 years	10 years	20 years	Decreasing	Stable	Increasing
				<p>boat, either through land based infrastructure (e.g. boat ramps) or water based infrastructure (e.g. moorings). Vessel ownership in NSW is forecast to grow placing increased pressure on the need for boat storage and waterways access infrastructure.</p> <p>The lack of access to the marine estate is a moderate threat to economic and social benefits including harbour cruises, scuba diving and snorkelling tours, charter vessels, charter fishing, fishing vessels, adventure sports and whale and dolphin watching industries (all which rely on boat storage and waterway access facilities).</p> <p>The lack of boat storage and waterway access facilities is also a deterrent to boat ownership, and a threat to social benefits including enjoyment on the water, socialising, water activities, and interacting with the marine environment.</p> <p>The provision of boat storage and access facilities relies mostly on private sector investment from marina operators. The lack of boat storage and access facilities is a threat to economic benefits including direct employment, direct revenue, and indirect spending related to travel and tourism.</p> <p>As per workshop discussion – there are disabled access issues for island in the bioregion</p>							
218	Moderate	Likely	Moderate	Refer to justification 217	I	Local		10 years		Increasing	
219	Moderate	Likely	Moderate	Refer to justification 217	I	Local		10 years		Increasing	

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Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
220	Moderate	Likely	Moderate	Refer to justification 217	I	Local		10 years	Increasing
221	Minor	Unlikely	Minimal	Lack of infrastructure is not known to be impacting tangible or intangible cultural heritage values.	I	Unknown		Unknown	Unknown
222	Minor	Unlikely	Minimal	Lack of infrastructure is not known to be impacting tangible or intangible cultural heritage values.	I	Unknown		Unknown	Unknown
223	Insignificant	Possible	Minimal	Impacts of limited access infrastructure such as crowded boat ramps were identified in the Marine Estate Community Survey as the fifth greatest social threat to the marine estate [1]. This suggests that intrinsic values are impacted by perceived lack of public access. However, given public access is more relevant to users of the marine estate, as opposed to non-use intrinsic values, the consequence are likely insignificant and overall risk rating minimal.	A	Local		1-2 years	Increasing
224	Moderate	Likely	Moderate	The negative impacts on current employment or production of a lack of access infrastructure are unlikely to be widespread, as businesses will only operate where there is access (and therefore customers). The opportunity costs are more significant and likely.	A	Local		1-2 years	Increasing
225	Minor	Possible (N&S) Likely (C)	Low(N&S) Moderate (C)	Limited access infrastructure has the potential to impact on enjoyment values where people are deterred from undertaking activities in the marine estate or where their enjoyment is negatively impacted by congested access and waiting times. The impacts are likely to be highly localised and vary based on seasons (e.g. overcrowded infrastructure on weekends and in school holidays during Summer). The overall risk level is likely to be low for the north	A	Local		1-2 years	Increasing

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Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				and south regions, as the community wide impacts are relatively minor in the context of the entire marine estate. In the central region where population is larger and there is more pressure on access infrastructure, the likelihood and therefore the risk level and opportunity costs are expected to be higher.					
226	Moderate	Possible	Low	<p>Public use of and ownership of the coast has been fiercely defended in Australia for close to 200 years. Wellbeing benefits associated with the coast have also been long recognised [29, 30] and benefits to health and wellbeing from spending time in nature. Any privatisation of the coast is therefore likely to be of significant concern to NSW coastal communities. This will be of increasingly relevant to future debates over shoreline hardening to protect private property at the expense of public beach amenity.</p> <p>The Marine Estate Community Survey results identified a lack of public access was also recognised as potential social threats that may impact on their desire to use the marine estate. Lack of public access to areas of the marine estate was listed as a third priority social threat for the Coffs Harbour (23%), Ballina (25%), Newcastle (24%), Sydney (21%), Batemans Bay (30%) and Eden (28%) participants. In addition, the loss of natural areas reserved for tourism was also a priority threat for participant in the NSW community (51%) and participants in the North East (51%), Central (56%) and South East 39%).</p>	L	Local	10 years	Increasing	

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Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				<p>Access restrictions through MPAs and other protected areas is seen as both beneficial and detrimental to community wellbeing depending on value systems, beliefs and practices of the people involved [18]. There is a body of evidence now which points to widespread community support for MPAs and associated community benefits as well as a range of negative social impacts. Negative impacts relate largely to loss of traditional use of important areas, particularly for Indigenous Australians, and lost or forgone opportunities for fishing experiences and fishing related income. MPAs which can manage these risks to an acceptable level have the opportunity for provide substantial community wide benefits.</p> <p>Loss of public access is therefore considered to be of a <i>moderate</i> consequence, however only <i>possible</i> likelihood given management mechanisms in place to preserve and protect public space.</p>					
227	Moderate	Possible	Low	<p>As per justification 226 – impact relating to socialisation and sense of community may be significant in localised areas where private development restricts access to public areas.</p> <p>Changes or limitations on community use and access to particular areas associated with physical closures e.g. of national park campgrounds, day use areas or access tracks may impact the ability of the community to socialise and interact in traditionally used areas. In addition the social aspects of fishing are highly valued</p>	L	Local		10 years	Increasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent			Trend		
						Local (site)	Regional	Statewide			
						1-2 years	10 years	20 years	Decreasing	Stable	Increasing
				<p>by a large proportion of recreational fishers and MPAs may also have an influence on these activities [4, 6, 17].</p> <p>Loss of public access is therefore considered to be of a <i>moderate</i> consequence, however only <i>possible</i> likelihood given management mechanisms in place to preserve and protect public space and balance competing uses in MPA management.</p>							
228	Moderate	Possible	Low	<p>As per justification 226 – impact relating to enjoyment of biodiversity and beauty may be significant in localised areas.</p> <p>Changes or limitations on community use and access to particular areas associated with physical closures e.g. of national park campgrounds, day use areas or access tracks may impact the ability of the community to enjoy the beauty and biodiversity values of those locations. This needs to be weighed up against the threats to these values from allowing continued visitation.</p> <p>Loss of public access is therefore considered to be of a <i>moderate</i> consequence, however only <i>possible</i> likelihood given management mechanisms in place to preserve and protect public space and balance competing uses in protected area management.</p>	L	Local		10 years			Increasing
229	Moderate	Likely	Moderate	As per justification 226, private development on the coast or in properties surrounding estuaries is likely to	I	Local		10 years			Increasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
				<p>have moderate consequence on consumptive use if it restricts the ability of recreational and commercial fishers to make use of public waterways. Impacts may extend to tourism operators in localised areas.</p> <p>The impacts of MPAs, recreational fishing havens and recreational saltwater fishing closures are concentrated on extractive users and therefore the threats to fishing consumptive use are the most substantial threats in relation to this stressor.</p> <p>Loss of public access is therefore considered to be of a <i>moderate</i> consequence and <i>likely</i>.</p>					
230	Moderate	Likely	Moderate	<p>Impacts are largely cumulative and relate to historic and ongoing loss of access to the coast associated with urbanisation, private development and protected area closures. This may lead to damage to cultural sites or artefacts and limit the opportunities for access to food sources [34]</p> <p>This stressor has an impact on tangible Aboriginal cultural heritage such as land tenure (private land), public access to cultural areas (e.g. closures, gates), or socio-economic factors such as ability to undertake commercial fishing and aquaculture.</p> <p>Restrictions on resource collection for social events. In the Hawkesbury bioregion there is restrictions on pipis for consumption via the regulation. Aboriginal people consulted in the Hawkesbury bioregion noted that pipis across the bioregion and abalone on the south coast are particular issues where regulation of cultural</p>	L	Unknown	Unknown	Unknown	

Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent			Trend		
						Local (site)	Regional	Statewide			
						1-2 years	10 years	20 years	Decreasing	Stable	Increasing
				<p>fishing/recourse collection is affecting economic benefits [36].</p> <p>There are also restrictions on access to camping/collecting places where social events occur. There is a lack of government or industry support for Aboriginal commercial fishing, businesses such as ecotourism or employment opportunities in the marine estate. In addition there is inadequate recognition of rights to benefit economically from commercial fishing.</p> <p>Past regulatory changes have impacted on the ability of the Aboriginal community to obtain/maintain commercial fishing licences despite strong historic links to the industry. Commercial fisheries have historically been a significant contributor to the community health and wellbeing and cultural lives of Aboriginal communities. Current restrictions inhibit community involvement in Aboriginal commercial fishing, practices particularly the beach haul fishery, and place considerable constraints on the ability of Aboriginal commercial fishers to pass on their cultural and environmental knowledge to the next generation, causing reductions in wellbeing. Licences in the commercial fishing industry are now largely out of reach for many within Indigenous communities of NSW despite the likely social and economic benefits of engaging more Aboriginal people in the fishing industry – including post-harvest [8, 6, 14, 16]. Dr Sue Feary (2015) report [7] notes lack of access to</p>							

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				aquaculture venture opportunities. DPI Fisheries: notes that access to aquaculture sites and other commercial fisheries related opportunities is provided by the existing management framework. Existing aquaculture sites are available to any participant through the free market. Sites that are not currently used for aquaculture may be applied for by any person. This issue may be related more to a lack of resources rather than a lack of site availability.				
231	Moderate	Likely	Moderate	Impacts are largely cumulative and relate to historic and ongoing loss of access to the coast associated with urbanisation, private development and protected area closures [34]. Access issues impact on intangible Aboriginal cultural heritage. For example unable to access places associated with cultural practices and traditions. Loss of traditional knowledge, such as creation stories and dreaming tracks. Reduced community capacity to undertake cultural practices i.e. knowledge is not being transferred, elders are unwell etc.  A/Prof Stephan Schnierer peer review report [8] notes threat is non-Indigenous use and management that fails to accommodate Aboriginal connections to Sea country.	L	Unknown	Unknown	Unknown
232	Major	Possible	Moderate	Loss of public access has the potential to impact on intrinsic values, particular given, the strong belief in protecting public ownership of the coast (see justification 226).	L	Local	10 years	Increasing

## Appendix D Social and Economic Risk Matrix and Evidence

Cell no.	Consequence (C)	Likelihood (L)	Overall risk rating (C x L)	Justification narrative/evidence	Confidence A, L, I (?)	Spatial extent		Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
						Local (site)	Regional Statewide		
233	Moderate	Possible	Low	Net impacts on businesses and employment is likely to be insignificant; there may be business opportunities in private business developments or in other closures. Some impacts on tourism operators and commercial fishers may occur if public access is severely restricted.	L	Local		10 years	Increasing
234	Moderate	Possible	Low	Enjoyment values may be moderately affected in some areas where lack of public access is significant. For example, new inappropriate coastal developments could have significant localised impacts on the ability of the community to access beaches, estuaries and parks. Given the points raised in justification 226, the likelihood of this occurring is still relatively low, but of greater likelihood than in justifications 232 & 233 because of the direct impacts on enjoyment and use values.	L	Local		10 years	Increasing

## Appendix D Social and Economic Risk Matrix and Evidence

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## Appendix E Glossary of Terms

# Glossary of terms

These terms are used consistently by the Authority in the delivery of their priority actions and initiatives within the **Schedule of Works**

**Activity** – something occurring in the marine estate. This may be a community benefit and/or a threat to an environmental asset or social, cultural or economic values, for example, boating, fishing, dredging or shipping.

**Asset** - the physical features of the marine estate, but does not include people. There are three main types of assets:

- environmental assets – the natural attributes, components and living resources of the marine estate for example habitat (e.g. beaches or rocky shores) or threatened species,
- cultural assets – structures, places or associations that form or contribute to cultural identity,
- infrastructure assets – functional structures installed for people to use and interact with the marine estate.

**Benefit** – see 'community benefit'.

**Community benefit** – anything that contributes to the wellbeing of the community. There are three separate categories of community benefits: economic, social and environmental benefits. Many community benefits are based on what people think is important (what they value). A community benefit of the marine estate could be:

- swimming at the beach,
- boating in an estuary,
- doing something as a hobby (e.g. fishing, kayaking, surfing, bird watching, etc.),
- running a business (e.g. whale watching business, charter fishing, commercial fishing, etc.),
- clean waters and marine biodiversity,
- intrinsic values i.e. valuing the environment regardless of direct benefits.

The *Marine Estate Management Act 2014* uses the term 'community value' for this.

**Community wellbeing** – the overall aggregate of economic, social and environmental benefits.

**Community wellbeing lens** – this is considering the benefits and costs to the community as a whole rather than a particular user group, sector or industry.

**Consequence** – the result of something happening, including a change in circumstances affecting objectives. It can be certain or uncertain and have positive or negative effects on objectives. A consequence can be expressed qualitatively or quantitatively.

**Cumulative impact, threats or risks** – the impact (positive or negative) resulting from the effects of one or more impacts, and the interactions between those impacts, added to other past, present and reasonably foreseeable future pressures.

**Cultural use** – the use of the marine estate to demonstrate or perform skills, arts, beliefs and customs and to pass these on from one generation to the next.

**Ecological** – the relationship between organisms and their environment.

**Economic** – the production, distribution, and use of income, wealth, and commodities.

**Economic benefits** – benefits derived by the community from the marine estate that are of an economic or financial nature.

**Effect** – a deviation from the measured status. Effects can be positive or negative.

**Environmental benefit** – benefits derived by the community from an environmental asset.

**Evidence** - relevant and credible information sources relating to threats and risks (environmental, social or economic) such as scientific research or reports, unpublished data/research or supporting background reports.

**Impact** – the outcome of the direct or indirect effect of activities and natural events on the assets or values of the environmental, social or economic components (i.e. pressure + response).

**Key stressors** – These are stressors that are responsible for impacts on environmental assets and related risks to community benefits e.g. an activity such as storm water discharge can adversely impact environmental assets through several key stressors, such as water pollution, marine debris and sediment contamination.

**Likelihood** – the chance of something happening.

**Marine estate** – as defined in the *Marine Estate Management Act 2014* means:

- the coastal waters of New South Wales within the meaning of Part 10 of the *Interpretation Act 1987*
- estuaries (being any part of a river whose level is periodically or intermittently affected by coastal tides) up to the highest astronomical tide
- lakes, lagoons and other partially enclosed bodies of water that are permanently, periodically or intermittently open to the sea
- coastal wetlands (including saltmarsh, mangroves and seagrass), lands immediately adjacent to, or in the immediate proximity of, the coastal waters of New South Wales that are subject to oceanic processes (including beaches, dunes, headlands and rock platforms)
- any other place or thing declared by the regulations to be the marine estate
- but does not include any place or thing declared by the regulations not to be the marine estate.

**Open access resource** – resources that can be accessed by anyone at any time.

**Opportunity** – a time, set of circumstances or activity that makes it possible to improve community wellbeing.

**Over-exploitation** – harvesting species or resources at rates faster than natural populations or resources can recover.

**Priority threat** - those threats that have the greatest risk of producing adverse effects on the flow of benefits from the marine estate. A threat was considered to be a **statewide priority** if it had a high or moderate risk level for each of the three regions across the state (i.e. north, central and south). Risk levels of high or moderate in only one or two regions lead to those threats being identified as **regional priorities**.

**Priority risk** – is a term used in the [NSW Marine Estate Threat and Risk Assessment Draft Report](#) and refers to a risk level of high or moderate.

**Quality of evidence** – a rating of the quality of available evidence e.g. adequate, limited or inferred to convey the level of confidence in the knowledge and deal with uncertainty and/or absence of evidence.

**Region** – the section of NSW that the TARA has been applied to. North region is from Tweed Heads to Stockton, Central region from Stockton to Shellharbour and South region from Shellharbour to NSW/Victorian border.

**Residual risk** – the risk remaining after taking current management efforts into account (these efforts are called risk treatment or risk management).

**Resilience** – the maximum change (or disturbance) that can occur before a population or system can no longer resist it or recover from it. The change (or disturbance) can be:

- “pulse” – an acute, short-term change that results in a temporary response
- “press” – a sustained or chronic change that could cause a long-term response
- “catastrophic” – a major, long-term change from which a population or system is unlikely to recover.

**Resource use** – Resource uses and activities resulting in stressors to environmental assets arising from these activities e.g. recreational fishing.

**Resource use conflict** – disagreements and disputes over access to and control of natural resources.

**Risk** – the chance of something happening that will have an impact on achieving environmental, social or economic objectives.

**Risk analysis** – a process to comprehend the nature or level of risk.

**Risk assessment** – overall process of risk identification, risk analysis and risk evaluation.

**Risk context** – the internal and external environment in which the government and broader community seek to achieve their objectives.

**Risk criteria** – terms of reference against which the significance of a risk is evaluated. They are based on objectives and risk context and can be derived from standards, laws, policies and other requirements.

**Risk evaluation** – the process for deciding whether the risk and its magnitude are acceptable or tolerable. The evaluation does this by comparing the results of risk analysis to agreed criteria.

**Risk identification** – process of finding, recognising and describing risks. It involves the identification of risk sources, events, their causes and potential consequences. It can draw on historical data, analysis, informed and expert opinions, and surveys of stakeholder needs.

**Risk level** – magnitude of a risk or combination of risks, generally expressed in terms of the combination of consequences and their likelihood e.g. high, moderate, low or minimal.

**Risk management** – coordinated activities to direct and control threats with regard to risk.

**Risk management framework** – a set of components that provides the foundations and management arrangements for designing, implementing, monitoring, reviewing and continually improving risk management.

**Risk owner** – the agency or stakeholder with the accountability and authority to manage a risk.

**Risk perception** – a stakeholder’s view on a risk.

**Risk treatment** – a process to modify the risk (e.g. avoiding it, removing the source, changing the likelihood or consequences, sharing the risk or retaining and managing the risk by informed decisions). Management controls introduced by government are examples of risk treatments.

**Social** – of or relating to the life and relations of people in a community.

**Social benefits** – the social and relational benefits the community derives from the marine estate.

**Social and economic benefit** – also called community benefit, this is anything that contributes to the wellbeing of the community.

## Appendix F Method for Calculating Prioritisation Scores

### Prioritisation Scoring Method

A tally of the number of High, Moderate and Low risk cells has been undertaken and is presented in the following matrices. A scoring system was applied to identify priority risks to the marine estate, considering the number of High and Moderate risks. For each High risk the stressor was attributed a score of 3, Moderate risks were given a score of 2. The count of low cells was not included in the prioritisation score as the trigger for management response is a High or Moderate risk level (refer also to Section 2.9). A risk rating of Low indicates that the risk is currently acceptable but still needs to be considered and tracked over time.

An activity was considered a statewide priority only if it had a Moderate or High risk level for each of the three regions across the state (north, central and south). For High or Moderate risks in only one or two regions, the risk was considered a priority just for that region.

The three TARA matrices are shown in the following pages, with the tally of High, Moderate and Low risks and the score calculations as well as an indication of whether they are a statewide priority.

### Combined Environmental Scores

After the separate scores for the estuarine and coastal and marine areas had been calculated, they have been combined to a single prioritised environmental list. This involved considering and ranking the scores from the two separate matrices. The individual scores for the coastal and marine areas and estuaries, and the priority order for the environmental list are shown in Tables F1 to F4. The estuaries had a much greater proportion of 'Moderate' and 'High' risks compared to coastal and marine areas, therefore estuary risks tend to dominate the combined results.





### Social and Economic TARA - Statewide

Tier 1 benefits		Social benefits																		Economic benefits									TALLY			Score	Statewide Priority
		Participation						Enjoyment						Cultural heritage & use						Indirect values			Viability of businesses			Direct values							
		Safety, health & wellbeing (including relaxation)			Socialising & sense of community			Enjoying the biodiversity & beauty of the marine estate (social intrinsic value)			Consumptive use (extracting)			Tangible Aboriginal cultural heritage (historic objects, places, items, and source of food)			Intangible Aboriginal heritage (traditions, practices, knowledge, spiritual values)			Intrinsic & bequest values (economic intrinsic value)			Employment & value of production			Individual enjoyment value (consumer surplus)			High (priority)	Moderate (priority)	Low (track over time)		
Tier 2 benefits		North	Central	South	North	Central	South	North	Central	South	North	Central	South	North	Central	South	North	Central	South	North	Central	South	North	Central	South	North	Central	South	High (priority)	Moderate (priority)	Low (track over time)	Score	Statewide Priority
<b>Social and Economic Threats</b>																																	
<b>Tier 1 threats</b>																																	
<b>Stressors</b>																																	
<b>Resource use conflict</b>	Conflict over resource access and use	Low	Low	Low	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	0	0	24	0	N
	Anti-social behavior and unsafe practices	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Minimal	Low	Minimal	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Low	Low	Moderate	Low	Low	Moderate	Low	0	18	7	36	Y
	Overcrowding / congestion	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Moderate	Low	Minimal	Minimal	Minimal	Low	Moderate	Low	0	8	16	16	Y
	Loss or decline of marine industries	Moderate	Low	Moderate	Low	Minimal	Low	Minimal	Minimal	Minimal	Moderate	Low	Moderate	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal	Moderate	Moderate	Moderate	Minimal	Minimal	Minimal	0	7	7	14	Y
	Excessive or illegal extraction	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	0	0	15	0	N
<b>Environmental</b>	pollution and sewage overflows (such as outfalls, STPs, etc)	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Low	Low	Low	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	0	0	8	0	N	
	Water pollution on environmental values - urban stormwater discharge	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Low	Moderate	Moderate	Moderate	0	25	2	50	Y	
	Water pollution on environmental values - Agricultural diffuse source runoff	Moderate	Low	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	0	21	6	42	Y
	Water pollution on environmental values - litter, solid waste, marine debris and microplastics	Low	Moderate	Low	Low	Moderate	Low	Moderate	Moderate	Moderate	Low	Moderate	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Low	Low	Moderate	Low	Low	Moderate	Low	0	15	12	30	Y
	Wildlife disturbance (Shorebirds, Turtles, Whales) by dog walkers, 4WD, marine vessels, etc	Low	Low	Low	Low	Low	Low	Moderate	Moderate	Moderate	Minimal	Minimal	Minimal	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	0	9	12	18	Y
	Habitat (physical) disturbance (e.g. from foreshore development, commercial and recreational fishing methods, four wheel driving, and extractive industries (mining))	Low	Low	Low	Low	Low	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	0	12	12	24	Y
	Reductions in abundances of species and trophic levels	Low	Low	Low	Low	Low	Low	Moderate	Moderate	Moderate	High	High	High	Moderate	Moderate	Moderate	Low	Low	Low	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Low	Low	Low	3	11	13	31	Y
	Pests and diseases	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	Low	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	0	6	21	12	Y
	Modified hydrology/hydraulics and flow regime	Low	Low	Low	Moderate	Moderate	Moderate	Low	Low	Low	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	0	6	21	12	Y
	Sediment contamination (toxicants in sediment; dioxins in Sydney Harbour, Cooks River)	Low	Moderate	Low	Low	Moderate	Low	Low	Moderate	Low	Low	Moderate	Low	Low	Low	Low	Low	Low	Low	Low	Moderate	Low	Low	Moderate	Low	Low	Moderate	Low	0	7	20	14	N
Climate change stressors (sea level rise, altered storm/cyclone activity, flooding, climate and sea temperature rise, altered ocean currents and nutrient concentrations, etc)	High	High	High	High	High	High	High	High	High	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Low	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	9	15	3	57	Y	
<b>Governance of the marine estate</b>	Inadequate, inefficient regulation, over-regulation (agencies)	Moderate	Moderate	Moderate	Low	Low	Low	Low	Moderate	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	0	13	11	26	Y
	Lack of or ineffective community engagement or participation in governance	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Moderate	Moderate	Moderate	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	0	3	15	6	Y
	Lack of community awareness of the marine estate, associated threats and benefits, regulations and opportunities for participation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Moderate	Low	Low	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	Low	Low	Low	Low	0	9	12	18	Y
<b>Public safety</b>	Lack of compliance with regulations (by users) or lack of compliance effort (by agencies)	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Moderate	Moderate	Moderate	Low	Low	Low	0	15	9	30	Y
	Wildlife interactions (e.g. shark bite, jellyfish, boat striking a whale)	Moderate	Low	Low	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	0	1	8	2	N
	Seafood contamination	Low	Moderate	Low	Low	Minimal	Low	Minimal	Minimal	Minimal	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	Low	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Minimal	0	4	12	8	Y
<b>Critical knowledge gaps</b>	Other water pollution/contamination affecting human health and safety (such as toxic algal blooms, e. coli concentrations, etc)	Low	Low	Low	Low	Low	Low	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	0	0	24	0	N	
	Inadequate social and economic information	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	0	27	0	54	Y
<b>Lack of access availability</b>	Limited or lack of access infrastructure to the marine estate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Moderate	Low	Moderate	Low	0	16	2	32	Y		
	Loss of public access (either by private development or Government area closures)	Low	Low	Low	Low	Low	Low	Low	Low	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	0	12	15	24	Y	

## Appendix F Method for Calculating Prioritisation Scores

## Combined Priority Threats for the Environmental TARA

Table F1: Priorities for the Statewide

Raw Estuarine Areas (Statewide)	Score	Raw Coast and Marine Waters (Statewide)	Score	Combined Environmental (Statewide)	Score
Estuary entrance modifications	63	Climate Change (20yrs)	49	Estuary entrance modifications	63 - in estuaries 9 – in coastal and marine
Urban stormwater discharge	59	Commercial Fishing – Ocean Trawl	17	Urban stormwater discharge	59 – in estuaries 11 – in coastal and marine
Agricultural diffuse source runoff	59	Commercial Fishing – Ocean Trap and Line	16	Agricultural diffuse source runoff (in estuaries)	59 – in estuaries
Clearing riparian and adjacent habitat including wetland drainage	52	Recreational Fishing – Boat-based line and trap fishing	12	Clearing riparian and adjacent habitat including wetland drainage (in estuaries)	52 – in estuaries
Recreation and tourism -Boating and boating infrastructure	48	Foreshore development	12	Climate Change (20yrs)	45 – in estuaries 49 – in coastal and marine
Climate Change (20yrs)	45	Urban stormwater discharge	11	Recreation and tourism -Boating and boating infrastructure (in estuaries)	48 – in estuaries
Navigation & entrance management and modification, harbour maintenance, etc.	39	Commercial Fishing – Ocean Haul	11	Navigation & entrance management and modification, harbour maintenance (in estuaries)	39 – in estuaries
Sewage effluent and septic runoff	37	Recreational Fishing – Shore-based line and trap fishing	10	Sewage effluent and septic runoff (in estuaries)	37 – in estuaries
Stock grazing of riparian and marine vegetation	36	Estuary entrance modification	9	Stock grazing of riparian and marine vegetation (in estuaries)	36 – in estuaries
Modified Freshwater flows	35	Beach nourishment and grooming	8	Foreshore development	35 in estuaries 12 – in coastal and marine

## Appendix F Method for Calculating Prioritisation Scores

Raw Estuarine Areas (Statewide)	Score	Raw Coast and Marine Waters (Statewide)	Score	Combined Environmental (Statewide)	Score
Foreshore development	35	Recreational Fishing – Hand gathering	8	Modified Freshwater flows (in estuaries)	35 – in estuaries
Recreation and tourism – Four wheel driving	24	Charter activities – whale and dolphin watching	6	Recreation and tourism – Four wheel driving (in estuaries)	24– in estuaries
Commercial Fishing- Estuary General	16	Shipping – Small commercial vessels	6	Commercial Fishing – Ocean Trawl	17– in coastal and marine
Oyster Aquaculture	12			Commercial Fishing – Ocean Trap and Line	16– in coastal and marine
Recreational Fishing – Shore-based line and trap fishing	10			Commercial Fishing- Estuary General (in estuaries)	16– in estuaries
Recreational Fishing – Boat-based line and trap fishing	10			Recreational Fishing – Boat-based line and trap fishing	10– in estuaries 12– in coastal and marine
Beach nourishment and grooming	10			Oyster Aquaculture (in estuaries)	12– in estuaries
				Commercial Fishing – Ocean Haul	11– in coastal and marine
				Recreational Fishing – Shore-based line and trap fishing	10– in estuaries 10– in coastal and marine
				Beach nourishment and grooming	10– in estuaries 8– in coastal and marine
				Recreational Fishing – Hand gathering	8– in coastal and marine
				Charter activities – whale and dolphin watching	6– in coastal and marine

Appendix F Method for Calculating Prioritisation Scores

Raw Estuarine Areas (Statewide)	Score	Raw Coast and Marine Waters (Statewide)	Score	Combined Environmental (Statewide)	Score
				Shipping – Small commercial vessels	6– in coastal and marine

## Appendix F Method for Calculating Prioritisation Scores

Table F2: Combined Environmental Priorities for the North Region

Raw Estuarine Areas (North Region)	Score	Raw Coast and Marine Waters (North Region)	Score	Combined Environmental (North Region)	Score
Agricultural diffuse source runoff	21	Climate Change (20yrs)	17	Agricultural diffuse source runoff (in estuaries)	21- in estuaries
Estuary entrance modifications	21	Commercial fishing - Ocean Trap and Line	7	Estuary entrance modifications (in estuaries)	21- in estuaries
Clearing riparian and adjacent habitat including wetland drainage	21	Commercial fishing - Ocean Trawl	7	Clearing riparian and adjacent habitat including wetland drainage (in estuaries)	21- in estuaries
Climate Change (20yrs)	15	Recreational fishing - Shore-based line and trap fishing	4	Climate Change (20yrs)	15 - in estuaries 17 – in coastal and marine
Urban stormwater discharge	15	Recreational fishing - Boat-based line and trap fishing	4	Urban stormwater discharge (in estuaries)	15 - in estuaries
Recreation and tourism -Boating and boating infrastructure	14	Commercial fishing – Ocean Haul	3	Recreation and tourism -Boating and boating infrastructure (in estuaries)	14 – in estuaries
Navigation & entrance management and modification, harbour maintenance, etc.	13	Recreation and tourism - Four wheel driving	3	Navigation & entrance management and modification, harbour maintenance, etc. (in estuaries)	13 - in estuaries
Modified Freshwater flows	13	Shipping - Small commercial vessels (ferries, charter boats, commercial fishing, whale watching etc.)	2	Modified Freshwater flows (in estuaries)	13 – in estuaries
Stock grazing of riparian and marine vegetation	12	Recreational fishing - Hand Gathering	2	Sewage effluent and septic runoff	12 – in estuaries 2 – in coastal and marine

## Appendix F Method for Calculating Prioritisation Scores

<b>Raw Estuarine Areas (North Region)</b>	<b>Score</b>	<b>Raw Coast and Marine Waters (North Region)</b>	<b>Score</b>	<b>Combined Environmental (North Region)</b>	<b>Score</b>
Sewage effluent and septic runoff	12	Sewage effluent and septic runoff	2	Stock grazing of riparian and marine vegetation (in estuaries)	12 – in estuaries
Recreation and tourism - Four wheel driving	8	Charter activities – whale and dolphin watching	2	Recreation and tourism - Four wheel driving	8 – in estuaries 3 – in coastal and marine
Foreshore development	8	Foreshore development	2	Foreshore development	8 – in estuaries 2 – in coastal and marine
Commercial fishing – Estuary General	7			Commercial fishing - Ocean Trap and Line	7 – in coastal and marine
Recreational fishing - Boat-based line and trap fishing	4			Commercial fishing - Ocean Trawl	7 – in coastal and marine
Recreational fishing - Shore-based line and trap fishing	4			Commercial fishing – Estuary General	7 – in estuaries
Recreational fishing - Hand Gathering	4			Recreational fishing - Shore-based line and trap fishing	4 – in estuaries 4 – in coastal and marine
Oyster Aquaculture	4			Recreational fishing - Boat-based line and trap fishing	4 – in estuaries 4 – in coastal and marine
Commercial fishing – Estuary Prawn Trawl	2			Recreational fishing - Hand Gathering	4 – in estuaries 2 – in coastal and marine
Charter activities – whale and dolphin watching	2			Oyster Aquaculture	4 in estuaries

Appendix F Method for Calculating Prioritisation Scores

Raw Estuarine Areas (North Region)	Score	Raw Coast and Marine Waters (North Region)	Score	Combined Environmental (North Region)	Score
Beach nourishment and grooming	2			Commercial fishing – Ocean Haul	3 – in coastal and marine
				Commercial fishing – Estuary Prawn Trawl	2 – in estuaries
				Charter activities – whale and dolphin watching	2 – in estuaries 2 – in coastal and marine
				Beach nourishment and grooming (in estuaries)	2 – in estuaries
				Shipping - Small commercial vessels (ferries, charter boats, commercial fishing, whale watching etc.) (in coast and marine)	2 – in coastal and marine

## Appendix F Method for Calculating Prioritisation Scores

Table F3 Combined Environmental Priorities for the Central Region

<b>Raw Estuarine Areas (Central Region)</b>	<b>Score</b>	<b>Raw Coastal and Marine (Central Region)</b>	<b>Score</b>	<b>Combined Environmental (Central Region)</b>	<b>Score</b>
Urban stormwater discharge	29	Climate change (20yrs)	15	Urban stormwater discharge	29 – in estuaries 7 – in coastal and marine
Estuary entrance modifications	21	Shipping - Large commercial vessels and associated port activities and industries (trade ships, cruise ships, etc.)	8	Estuary entrance modifications (in estuaries)	21- in estuaries
Recreational Boating - Boating and boating infrastructure	20	Foreshore development	8	Recreational Boating - Boating and boating infrastructure (in estuaries)	20 – in estuaries
Foreshore development	19	Urban stormwater discharge	7	Foreshore development	19 – in estuaries 8 – in coastal and marine
Agricultural diffuse source runoff	17	Commercial fishing - Ocean Trawl	6	Agricultural diffuse source runoff (in estuaries)	17 – in estuaries
Clearing riparian and adjacent habitat including wetland drainage	16	Recreation and tourism - Shark meshing of swimming beaches	6	Clearing riparian and adjacent habitat including wetland drainage (in estuaries)	16 – in estuaries 5 – in coastal and marine waters
Shipping - Large commercial vessels and associated port activities and industries (trade ships, cruise ships, etc.)	16	Sewage effluent and septic runoff	6	Shipping - Large commercial vessels and associated port activities and industries (trade ships, cruise ships, etc.)	16 – in estuaries 8 – coastal and marine
Climate Change (20yrs)	15	Clearing riparian and adjacent habitat including wetland drainage	5	Climate Change (20yrs)	15 – in estuaries 15 – coastal and marine
Sewage effluent and septic runoff	13	Commercial fishing - Ocean Trap and Line	4	Sewage effluent and septic runoff	13 – in estuaries 6 – in coastal and marine

## Appendix F Method for Calculating Prioritisation Scores

<b>Raw Estuarine Areas (Central Region)</b>	<b>Score</b>	<b>Raw Coastal and Marine (Central Region)</b>	<b>Score</b>	<b>Combined Environmental (Central Region)</b>	<b>Score</b>
Industrial discharges	13	Recreational fishing - Shore-based line and trap fishing	4	Industrial discharges (in estuaries)	13 – in estuaries
Navigation & entrance management and modification, harbour maintenance, etc.	13	Recreational fishing – Boat-based line and trap fishing	4	Navigation & entrance management and modification, harbour maintenance, etc.	13 – in estuaries 2 – in coastal and marine waters
Stock grazing of riparian and marine vegetation	12	Beach nourishment and grooming	4	Stock grazing of riparian and marine vegetation (in estuaries)	12 – in estuaries
Modified Freshwater flows - Extraction, artificial barriers to riverine and estuarine flow (e.g. dams, weirs, waterway crossings, floodgates), urban drainage, impervious surfaces; flood mitigation	10	Recreation and tourism – Four wheel driving	3	Modified Freshwater flows - Extraction, artificial barriers to riverine and estuarine flow (e.g. dams, weirs, waterway crossings, floodgates), urban drainage, impervious surfaces; flood mitigation (in estuaries)	10 – in estuaries
Small commercial vessels (ferries, charter boats, whale watching vessels, fishing vessels etc)	9	Estuary entrance modifications	3	Small commercial vessels (ferries, charter boats, whale watching vessels, fishing vessels etc) (in estuaries)	9 – in estuaries
Service infrastructure – pipes, cables trenching and boring	8	Shipping - Small commercial vessels (ferries, charter boats, commercial fishing, whale watching etc.)	2	Service infrastructure – pipes, cables trenching and boring (in estuaries)	8 – in estuaries
Recreation and tourism – Four wheel driving	8	Commercial fishing – Ocean Haul	2	Recreation and tourism – Four wheel driving	8 – in estuaries 3 – in coastal and marine waters
Beach nourishment and grooming	6	Commercial fishing – Sea urchin and turban shells	2	Beach nourishment and grooming	6 – in estuaries 4 – in coastal and marine waters
Thermal discharges	6	Recreational fishing – Hand gathering	2	Thermal discharges (in estuaries)	6 – in estuaries
Commercial fishing – Estuary general	4	Charter activities – Charter whale and dolphin watching	2	Commercial fishing - Ocean Trawl	6 – in coastal and marine waters

## Appendix F Method for Calculating Prioritisation Scores

<b>Raw Estuarine Areas (Central Region)</b>	<b>Score</b>	<b>Raw Coastal and Marine (Central Region)</b>	<b>Score</b>	<b>Combined Environmental (Central Region)</b>	<b>Score</b>
Recreational fishing – Shore-based line and trap fishing	4	Recreation and tourism – Swimming, surfing, dog walking etc	2	Recreation and tourism - Shark meshing of swimming beaches	6 – in coastal and marine waters
Recreational fishing – Boat-based line and trap fishing	4	Navigation & entrance management and modification, harbour maintenance, etc.	2	Commercial fishing – Estuary general (in estuaries)	4 – in estuaries
Recreational fishing – Hand gathering	4			Recreational fishing – Shore-based line and trap fishing	4 – in estuaries 4 – in coastal and marine waters
Oyster aquaculture	4			Recreational fishing – Boat-based line and trap fishing	4 – in estuaries 4 – in coastal and marine waters
Mining and extractive industries	4			Recreational fishing – Hand gathering	4 – in estuaries 2 – in coastal and marine waters
				Oyster aquaculture (in estuaries)	4 – in estuaries
				Mining and extractive industries (in estuaries)	4 – in estuaries
				Commercial fishing - Ocean Trap and Line (in coastal and marine waters)	4 – in coastal and marine waters
				Estuary entrance modifications (in coastal and marine waters)	3 – in coastal and marine waters
				Shipping - Small commercial vessels (ferries, charter boats, commercial fishing, whale watching etc.) (in coastal and marine waters)	2 – in coastal and marine waters

Appendix F Method for Calculating Prioritisation Scores

Raw Estuarine Areas (Central Region)	Score	Raw Coastal and Marine (Central Region)	Score	Combined Environmental (Central Region)	Score
				Commercial fishing – Ocean Haul (in coastal and marine waters)	2 – in coastal and marine waters
				Commercial fishing – Sea urchin and turban shells (in coastal and marine waters)	2 – in coastal and marine waters
				Charter activities – Charter whale and dolphin watching (in coastal and marine waters)	2 – in coastal and marine waters
				Recreation and tourism – Swimming, surfing, dog walking etc (in coastal and marine waters)	2 – in coastal and marine waters

## Appendix F Method for Calculating Prioritisation Scores

Table F4: Combined Environmental Priorities for the South Region

Raw Estuarine Areas (South Region)	Score	Raw Coast and Marine Waters (South Region)	Score	Combined Environmental (South Region)	Score
Agricultural diffuse source runoff	21	Climate change (20yrs)	15	Estuary entrance modifications	21 – in estuaries 3 – in coastal and marine
Estuary entrance modifications	21	Commercial fishing - Ocean Haul	4	Agricultural diffuse source runoff (in estuaries)	21 – in estuaries
Climate Change (20yrs)	15	Recreational fishing - Boat-based line and trap fishing	4	Climate Change (20yrs)	15- in estuaries 15- in coastal and marine
Clearing riparian and adjacent habitat including wetland drainage	15	Estuary entrance modifications + Breakwaters	3	Urban stormwater discharge	15 – in estuaries 2 – in coastal and marine
Urban stormwater discharge	15	Shipping - Small commercial vessels (ferries, charter boats, commercial fishing, whalewatching etc.)	2	Clearing riparian and adjacent habitat including wetland drainage (in estuaries)	15 – in estuaries
Recreation and tourism -Boating and boating infrastructure	14	Commercial fishing - Ocean Trap and Line	2	Recreation and tourism -Boating and boating infrastructure (in estuaries)	14 – in estuaries
Navigation & entrance management and modification, harbour maintenance, etc.	13	Commercial fishing – Sea urchin and turban shells	2	Navigation & entrance management and modification, harbour maintenance, dredging etc. (in estuaries)	13 – in estuaries
Stock grazing of riparian and marine vegetation	12	Commercial fishing - Abalone	2	Stock grazing of riparian and marine vegetation (in estuaries)	12 – in estuaries
Sewage effluent and septic runoff	12	Recreational fishing - Shore-based line and trap fishing	2	Sewage effluent and septic runoff (in estuaries)	12 – in estuaries

## Appendix F Method for Calculating Prioritisation Scores

<b>Raw Estuarine Areas (South Region)</b>	<b>Score</b>	<b>Raw Coast and Marine Waters (South Region)</b>	<b>Score</b>	<b>Combined Environmental (South Region)</b>	<b>Score</b>
Modified Freshwater flows - Extraction, artificial barriers to riverine and estuarine flow (e.g. dams, weirs, waterway crossings, floodgates), urban drainage, impervious surfaces; flood mitigation	10	Recreational fishing - Hand Gathering	2	Modified Freshwater flows - Extraction, artificial barriers to riverine and estuarine flow (e.g. dams, weirs, waterway crossings, floodgates), urban drainage, impervious surfaces; flood mitigation (in estuaries)	10 – in estuaries
Recreation and Tourism – four wheel driving	8	Charter activities – Whale and dolphin watching	2	Recreation and Tourism – four wheel driving (in estuaries)	8 – in estuaries
Foreshore development	8	Urban stormwater discharge	2	Foreshore development	8 – in estuaries 2 – in coastal and marine waters
Commercial fishing – Estuary General	5	Foreshore development	2	Commercial fishing – Estuary General	5 – in estuaries
Oyster aquaculture	4	Beach nourishment and grooming	2	Oyster aquaculture (in estuaries)	4 – in estuaries
Shipping – Large commercial	2			Recreational fishing - Boat-based line and trap fishing	2 – in estuaries 4 – in coastal and marine waters
Recreational fishing – Boat-based line and trap fishing	2			Commercial fishing - Ocean Haul	4 – in coastal and marine waters
Recreational fishing – Shore-based line and trap fishing	2			Shipping – Large commercial (in estuaries)	2 – in estuaries
Beach nourishment and grooming	2			Recreational fishing – Shore-based line and trap fishing	2 – in estuaries 2 – in coastal and marine waters

Appendix F Method for Calculating Prioritisation Scores

Raw Estuarine Areas (South Region)	Score	Raw Coast and Marine Waters (South Region)	Score	Combined Environmental (South Region)	Score
				Beach nourishment and grooming	2 – in estuaries 2 – in coastal and marine waters
				Commercial fishing – Abalone (in coastal and marine waters)	2 – in coastal and marine waters
				Commercial fishing – Sea urchin and turban shells (in coastal and marine waters)	2 – in coastal and marine waters
				Recreational fishing - Hand Gathering (in coastal and marine waters)	2 – in coastal and marine waters
				Charter activities – Whale and dolphin watching (in coastal and marine waters)	2 – in coastal and marine waters
				Shipping - Small commercial vessels (ferries, charter boats, commercial fishing, whalewatching etc.)	2– in coastal and marine waters
				Commercial fishing - Ocean Trap and Line	2– in coastal and marine waters



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