

“Where will our knowledge take you?”



# New South Wales Marine Estate Threat and Risk Assessment Report Final Report

August 2017

# 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 approach aims to maximise 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.

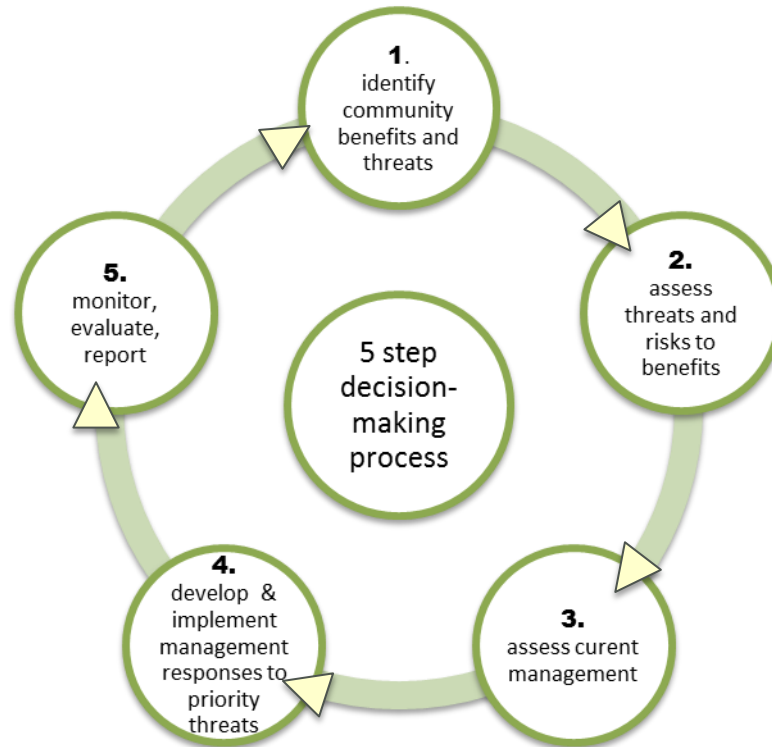
Essentially, the TARA seeks to identify how various activities may affect environmental assets or social or economic benefits that accrue from the marine estate. A risk assessment process (in accordance with AS/NZS ISO 31000:2009) is embedded within the TARA process, and is used to assess the risk of 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 responses at a statewide scale, as well as regional and local scales. The latter primarily being addressed through new marine park management plans, which will commence 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**

*Original source: Managing the NSW Marine Estate: Purpose, Underpinning Principles and Priority Setting (MEMA) November 2013*

### 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 marine 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).

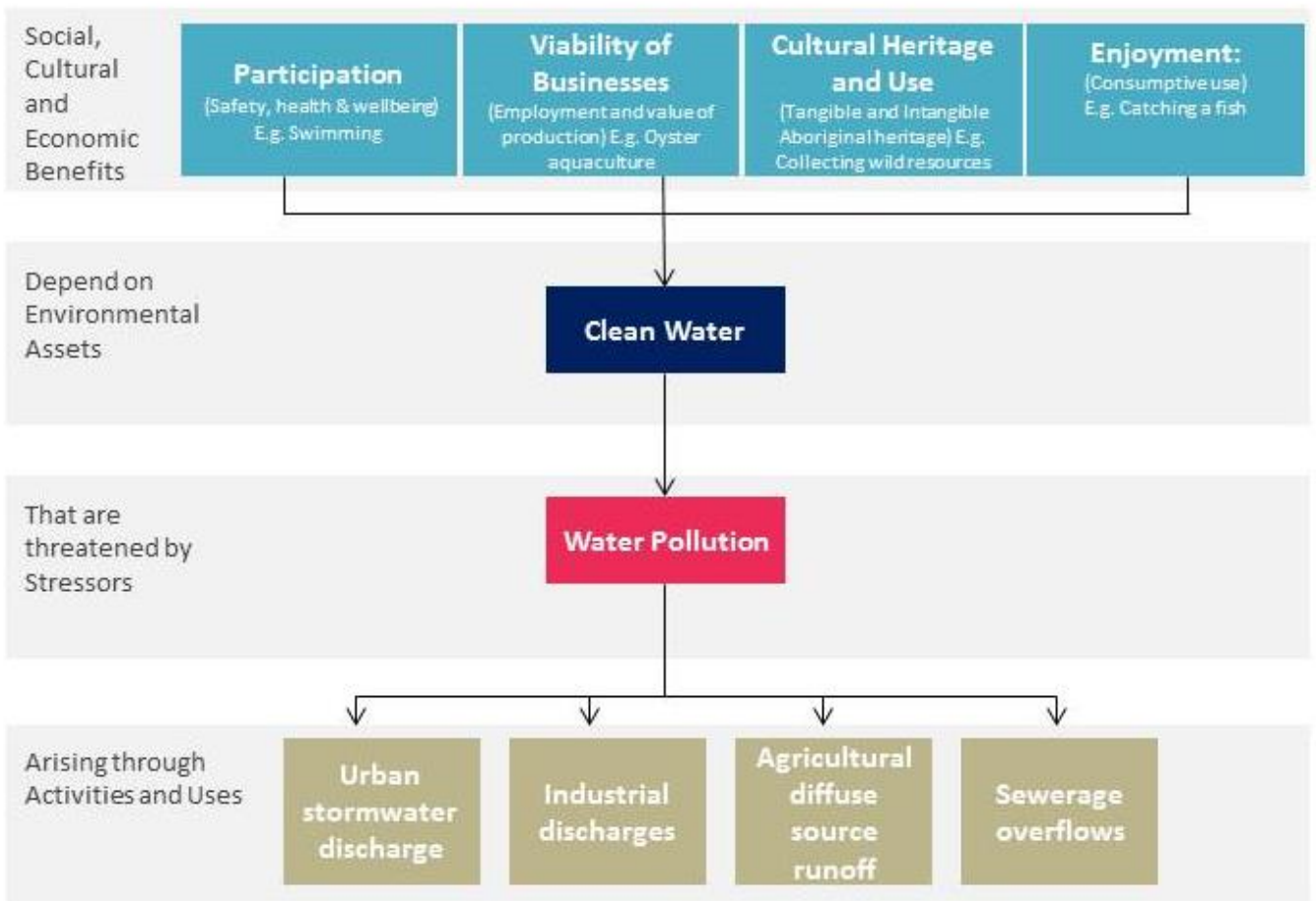


Figure ES-1-2 Example of the relationship between social and economic benefits, environmental assets, stressors and activities and uses

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, Cultural and Economic Benefits (in descending order of significance)
<ul style="list-style-type: none"> <li>• Urban stormwater discharge</li> <li>• Estuary entrance modifications</li> <li>• Agricultural diffuse source runoff (in estuaries)</li> <li>• Clearing riparian and adjacent habitat including wetland drainage</li> <li>• Climate change stressors 20 year timeframe (sea level rise, altered storm/cyclone activity, flooding, climate and sea temperature rise, altered ocean currents and nutrient inputs)</li> <li>• Modified freshwater flows (in estuaries)</li> <li>• Foreshore development</li> <li>• Recreation- Boating and boating infrastructure (in estuaries)</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 (in estuaries)</li> <li>• Four wheel driving</li> <li>• Recreational fishing -boat-based line and trap fishing</li> <li>• Passive recreational use</li> <li>• Recreational fishing-shore-based line and trap fishing</li> <li>• Beach nourishment and grooming</li> <li>• Commercial fishing -ocean trawl (in coast and marine waters)</li> <li>• Commercial fishing - ocean trap and line (in coast and marine waters)</li> <li>• Commercial fishing- estuary general (in estuaries)</li> <li>• Deliberate introduction of plants and animals (e.g. foxes, Bitou bush)</li> <li>• Shipping- small commercial vessels</li> <li>• Oyster aquaculture (in estuaries)</li> <li>• Commercial fishing-ocean haul (in coastal and marine waters)</li> <li>• Recreational fishing- hand gathering</li> </ul>	<ul style="list-style-type: none"> <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>• Inadequate social and economic information</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>• Reductions in abundances of species and trophic levels</li> <li>• Anti-social behaviour and unsafe practices</li> <li>• Climate change stressors 20 year time frame (sea level rise, altered storm/cyclone activity, flooding, climate and sea temperature rise, altered ocean currents and nutrient inputs)</li> <li>• Loss of public access (either by private development or Government area closures)</li> <li>• Inadequate, inefficient regulation, over-regulation (agencies)</li> <li>• Pests and diseases</li> <li>• Sediment contamination</li> <li>• Overcrowding / congestion</li> <li>• Conflict over resource access and use</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 or decline of marine industries</li> <li>• Seafood contamination</li> <li>• Modified hydrology/hydraulics and flow regime</li> <li>• Water pollution on environmental values - septic runoff, point source pollution and sewage overflows (such as outfalls, STPs, etc.) and</li> <li>• Wildlife disturbance (Shorebirds, Turtles,</li> </ul>



**Statewide TARA Assessment (Step 2 of the 5-step Decision Making Process)**

<ul style="list-style-type: none"> <li>Whale and dolphin watching</li> </ul>	<p>Whales) by dog walkers, 4WD, marine vessels, etc.</p> <ul style="list-style-type: none"> <li>Lack of community awareness of the marine estate, associated threats and benefits, regulations and opportunities for participation</li> <li>Lack of or ineffective community engagement or participation in governance</li> <li>Other water pollution/contamination affecting human health and safety</li> <li>Excessive or illegal extraction</li> </ul>
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**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 marine 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 five 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.
- Aboriginal cultural heritage and use was a particularly vulnerable benefit category and was considered to be at moderate or high risk across the state for all but one threat.
- Climate change at a 50 year timeframe 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.
- 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.
- The conservation, enjoyment and use of marine historic heritage provides social and economic benefits to the NSW community. However the threats to these benefits were not assessed as part of the social and economic TARA. This issue was identified during the consultation period as a potential policy gap. While some current government reforms are likely to benefit the protection and management of marine historic heritage, it is still important to acknowledge the benefits of marine historic heritage and the threats to which it is exposed. It is recommended that a 'watching brief' be kept on threats to marine historic heritage and that risk levels are assessed as part of the TARA's five-year check-up/review process.

### **Risk Evaluation Process**

Building on the lessons learned from the Hawkesbury Shelf marine 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:

- Aboriginal Cultural Heritage and Use
- 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).
- Threatened species protected under the Biodiversity Conservation Act 2016.
- 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.

### **Consultation on Draft Statewide TARA Report**

The NSW Marine Estate Threat and Risk Assessment Draft Report (draft Statewide TARA) and a range of supporting material was released to the marine estate website for public feedback on 18 January 2017 and concluded 30 April 2017.

Feedback and evidence gathered during the engagement period is reported on in the separate MEMA report, 'Community and Stakeholder Engagement Report' (MEMA, 2017) and has been considered and assessed to finalise the Statewide TARA.

The feedback and evidence gathered during the engagement period have led MEMA agencies to re-assess and, in some cases, change some of the risk levels that were presented in the draft Statewide TARA. In addition, risks to Aboriginal cultural heritage (as part of the Social and Economic TARA) and risks to threatened species under the NSW Biodiversity Conservation Act (as part of the Environmental TARA) have been identified as cumulative risk issues for further consideration.

A full list of the changes to risk levels between the Draft and Final Statewide TARA are included in the Community and Stakeholder Engagement Report (MEMA, 2017).

### **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 approach aims to maximise 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.

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

<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>

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 MEMA at both the State wide and Hawkesbury Shelf marine bioregional scales (MEMA 2015b).

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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 1-1, 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 regions, 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.

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

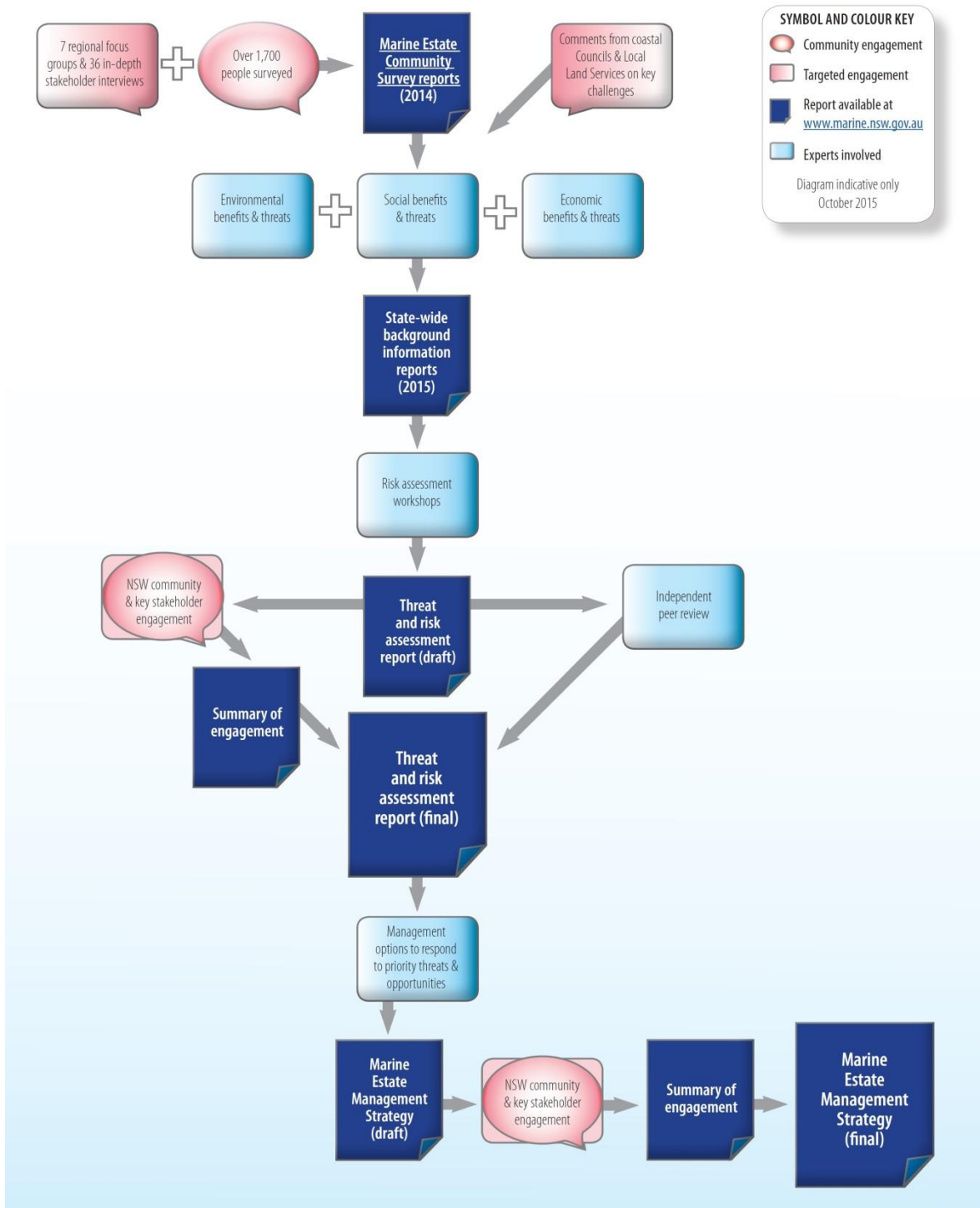


Figure 1-1 Key Steps in the Statewide Decision Making Process

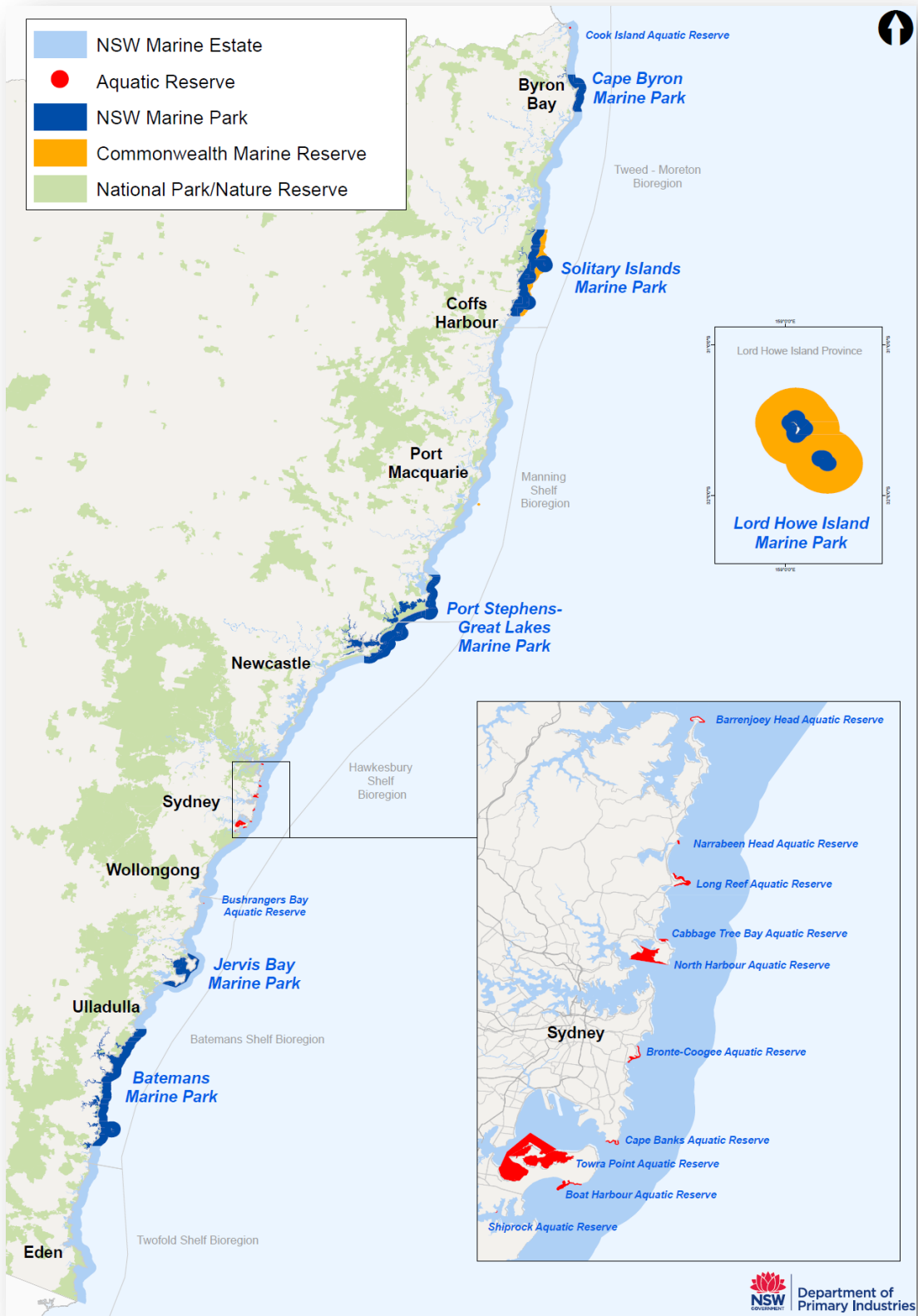


Figure 1-2 Planning Area for the Statewide Assessment

## 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, cultural 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 inform an understanding of 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 (including cultural) 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, cultural 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, cultural 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:** This environmental asset relates specifically to the physio-chemical attributes of the water column (e.g. nutrients, turbidity, salinity). For the purpose of this assessment, safety aspects are not considered, because these relate more to issues of public health than to marine biodiversity conservation
- **Habitats and Assemblages:** This category includes a range of environmental assets, principally the species that that dominate the habitat forming component of the seafloor, such as seagrass and mangroves, but also specific habitats generally contain distinct assemblages of biota, such as shallow reefs. The animals and plants that are typically associated with each habitat type are also assessed as a component of this category. The fish assemblage category differs in that it only relates to the specific stressors of harvest and bycatch of fish species. This habitat and associated assemblage category also includes planktonic assemblages that occur within the water column habitat.
- **Threatened and protected species:** This category relates to marine species listed as threatened or protected under the NSW Biodiversity Conservation Act or the Fisheries Management Act.

*\*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 Biodiversity Conservation Act 2016* [such as cetaceans, turtles, shorebirds, and other marine megafauna] (BCA Act). More detailed information on specific species is included in the environmental background report (MEMA, 2016).

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### 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]’)
- **Cultural heritage & use benefits** (which includes both ‘Tangible and intangible Aboriginal Heritage [traditions, practices, knowledge, places, items, sources of food, spiritual values]’).

#### *Economic*

- **Intrinsic & bequest** (e.g. the value of knowing that there are healthy and sustainable ecosystems in the marine estate, even without visiting or experiencing those ecosystems)
- **Viability of businesses** (e.g. the ability of tourism operators or commercial fishers to operate, be profitable and employ people)
- **Direct economic values** (e.g. when a recreational fisher goes fishing, they get consumer surplus which is equal to the ‘value’ of their experience minus the cost of the equipment, fishing licence and travel required to go fishing)

## 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, cultural 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

## Methods

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);
- 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, cultural 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.

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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'.
- 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.
- Schneirer, 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 Threat and Risk Assessment – 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.

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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, Incidental bycatch
	Ocean Trawl	Reduction in abundances of species and trophic levels. Incidental catch of species of conservation concern, Physical disturbance, Incidental bycatch
	Ocean Haul	Reduction in abundances of species and trophic levels, Incidental catch of species of conservation concern, Incidental bycatch
	Sea urchin and turban shells	Reduction in abundances of species and trophic level
	Lobster	Reduction in abundances of species and trophic level
	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, Incidental catch of species of conservation concern
	Estuary Prawn Trawl	Reduction in abundances of species and trophic levels, Incidental bycatch, Incidental catch of species of conservation concern
Charter fishing	Line fishing	Physical disturbance, Reduction in abundances of species and trophic levels, 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, Incidental catch of species of conservation concern
	Boat-based line and trap fishing	Physical disturbance, Reduction in abundances of species and trophic levels, Incidental bycatch, Wildlife disturbance, Incidental catch of species of conservation concern
	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

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Activity Category	Specific Activity	Key Stressors
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
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
	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)
	Deliberate introduction of plants and animals (e.g. foxes, Bitou bush)	Physical disturbance, wildlife disturbance
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
	Sea level rise	Physical disturbance
Extreme storm events	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.

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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 – septic runoff, 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) and impacts to ecological health 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 species and trophic levels</li> <li>• Pests/diseases</li> <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.



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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.

**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</li> </ul> <p><i>Note: the majority of impacts will be in this category</i></p>
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>

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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:

- Off-leash dogs on designated beaches can disturb shorebirds, nesting turtles and other species of concern in a local area, which influences regional and statewide level threat levels;
- Thermal pollution for Lake Macquarie and Lake Illawarra in the Central region (in relation to point sources of water pollution);
- legal use of four wheel drives on selected beaches in the central and northern regions

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).

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

## Methods

### 2.9 Priority Threats

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.

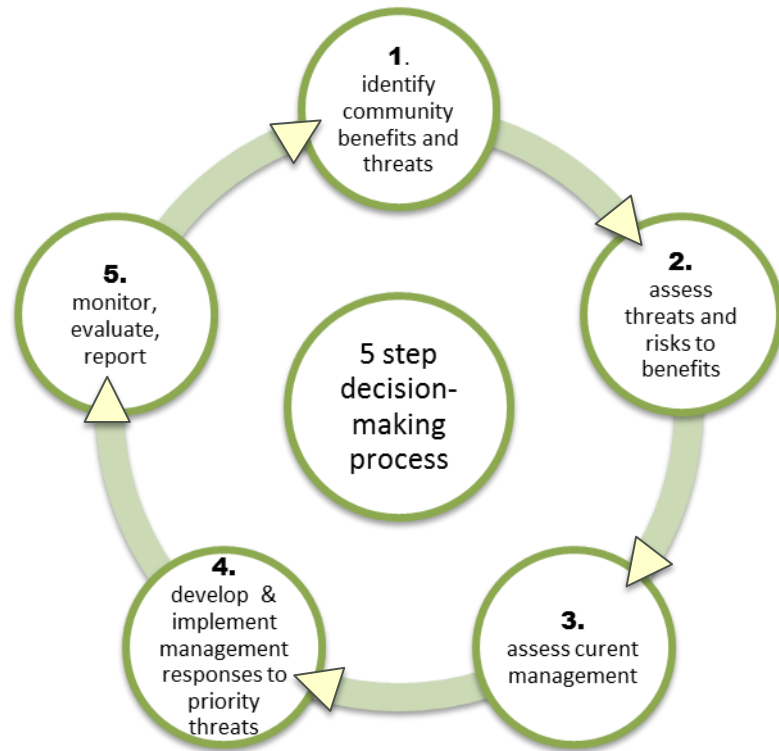
In this context, assignment of a 'High' or 'Moderate' risk level is a trigger for further examination of the threat to an asset or benefit but will not necessarily lead to a change to current management or regulations. In some cases, it will not be feasible, practical or possible to manage all threats 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.



Original source: *Managing the NSW Marine Estate: Purpose, Underpinning Principles and Priority Setting (MEMA) November 2013*

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

Table 2-6 Example of a Generic Risk Tolerance Table

Risk Levels	Description	Likely Management Action
Minimal	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.
Low	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.
Moderate	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.
High	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 based on an inferred level of evidence available to support the risk rating generally represent knowledge gaps for consideration in future stages of the process. 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. Further work to address these knowledge gaps will form an important part of the ongoing work for MEMA in coming years.

## Methods

### 2.11 MEMA Technical 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.

A validation workshop was held in July 2016 to address recommendations made by MEEKP as part of their evaluation of the social and economic TARA (refer Section 6 of this report). The outcomes of this workshop included better articulation of the definitions for stressors for the social and economic TARA, revisions to the likelihood and consequence tables for social and economic benefits and revisions to the risk matrix and risk levels including consideration of new or additional evidence.

Following the release of the draft Statewide TARA in early 2017, three TARA technical teams (across environmental issues, Aboriginal cultural heritage issues and social and economic issues) led by officers from the MEMA agencies were established to review and analyse submissions and feedback on the draft Statewide TARA

A workshop for each technical team was held and independently facilitated in early June 2017 to assess whether the evidence provided during stakeholder engagement warranted a change in risk levels, and proposed changes between the draft and final Statewide TARA documented (refer to Section 2.12).

Other feedback on the TARA process was also noted at the technical workshops. Comments regarding knowledge gaps and key studies have been used to inform development of a Marine Integrated Monitoring Program.

### 2.12 Consultation on Draft Statewide TARA Report

The NSW Marine Estate Threat and Risk Assessment Draft Report (draft Statewide TARA) and a range of supporting material was released to the marine estate website for public feedback on 18 January 2017 and concluded 30 April 2017.

Given the distribution of stakeholders across NSW, the complexity of the draft Statewide TARA and feedback from the previous Hawkesbury engagement process, an interactive web based tool ([www.marine.nsw.gov.au](http://www.marine.nsw.gov.au)) was established to allow users to navigate, interrogate and provide feedback on the draft Statewide TARA. The TARA interactive tool was the primary method for the public to submit their feedback. Stakeholders and the community were able to provide specific comments and evidence on individual risk levels or submit general feedback on the draft Statewide TARA.

Over 70 individuals or organisations submitted over 150 unique entries on specific risk levels or general feedback through the TARA tool. In addition to the TARA interactive tool over 55 unique submissions were received by individuals or organisations to the marine estate email address. Included in this last figure were two campaign email submissions which generated over 1,500 support emails to the email address.

## Methods

To assist stakeholders make submissions, MEMA organised a series of six targeted workshops in February 2017 in Ballina, Coffs Harbour, Newcastle, Sydney, Kiama and Narooma to inform and engage with key stakeholders about the draft Statewide TARA. These sessions provided the invited key stakeholders with the opportunity to identify omissions or inaccuracies within the draft Statewide TARA report, to review the evidence base used, give additional evidence to inform the finalisation of the TARA report and provide local and regional examples where available. A workshop report was produced summarising the feedback obtained.

Ten Aboriginal stakeholder workshops were also held in March 2017 at Newcastle, Byron Bay, Coffs Harbour, Wollongong, Nowra, Ulladulla, Port Macquarie, Bega and two in Sydney. An independent Aboriginal consultancy was involved in identifying key bodies and knowledge holders and conducted the workshops. A detailed Aboriginal stakeholder workshop report was produced summarising the feedback obtained.

Feedback and evidence gathered during the engagement period including as part of the stakeholder and Aboriginal stakeholder workshops is reported on in the separate MEMA report, 'Community and Stakeholder Engagement Report' (MEMA, 2017) and has been considered and assessed to finalise the Statewide TARA.

The feedback and evidence gathered during the engagement period have led MEMA agencies to re-assess and, in some cases, change some of the risk levels that were presented in the draft Statewide TARA. Some of these changes include:

### For the Environmental TARA -

- Changes to risk levels related to commercial fishing
- Changes to risk levels to species protected under the NSW Biodiversity Conservation Act (including cetaceans, birds and marine reptiles) across multiple threat activities
- Changes to risk levels related to bather protection (shark meshing)
- Changes to risk levels related to modified freshwater flows
- Changes to risk levels related to climate change

### For the Social and Economic TARA -

- Changes to risk levels related to resource use conflicts
- Changes to risk levels related to various aspects of water pollution
- Changes to risk levels related to seafood contamination/safety
- Changes to risk levels related to Aboriginal cultural heritage (including a decision to combine tangible and intangible cultural heritage benefit classes) across multiple threat activities
- Changes to risk levels related to climate change

In addition, risks to Aboriginal cultural heritage (as part of the Social, Cultural and Economic TARA) and risks to threatened species under the NSW Biodiversity Conservation Act (as part of the Environmental TARA) have been identified as being cumulative risk issues for further consideration based on the high incidence of moderate and high risks to these benefits.



## Methods

For more detail on changes to risk levels following consultation on the Draft Statewide TARA refer to the Community and Stakeholder Engagement Report (MEMA, 2017).

### 2.13 Limitations

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

- The information on threats and benefits, and current management arrangements that were used to estimate risk levels have been derived directly from the background evidence provided to 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.
- 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.
- Lastly, it should be noted that the threat and risk assessment has been completed based on an assessment of the effectiveness of the current regulations and management regimes for addressing the threats identified. This may introduce some bias relating to specific threats 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.

## 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 marine 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' and 'estuaries' matrices for the environmental component of the TARA are contained in Appendix C of this report, which also contains a details of the stressors relating to the risks for the low, moderate and high risks as compiled by the MEMA agencies and independent experts. The full evidence supporting these justifications is presented in the Background Environmental Information report (MEMA 2016).

### 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' (orange) and 'High' (red) 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 marine 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). These summary graphs only include 20 year climate change.

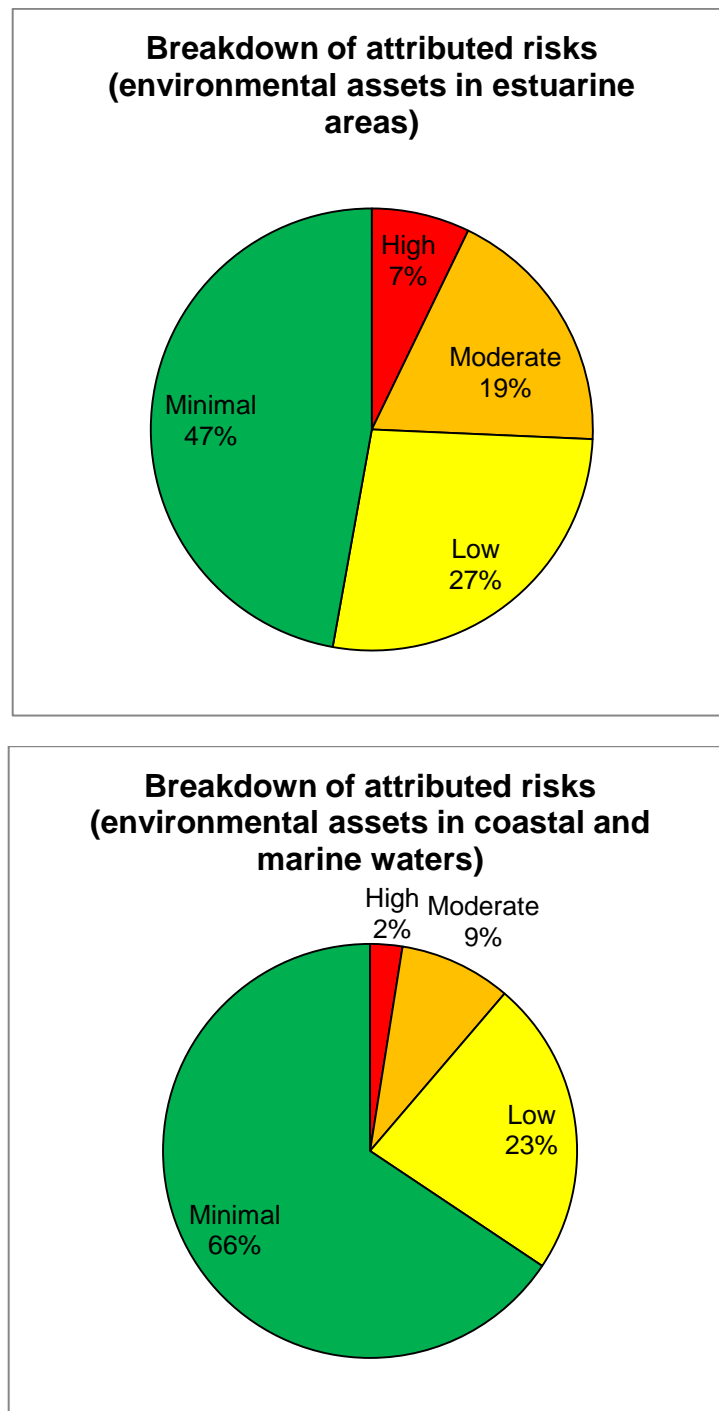


Figure 3-1 Distribution of risk levels for threats to the coastal and marine waters and estuaries

### 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). Also note that the 20 year climate change risks are included, however the 50 year climate changes risks are not.

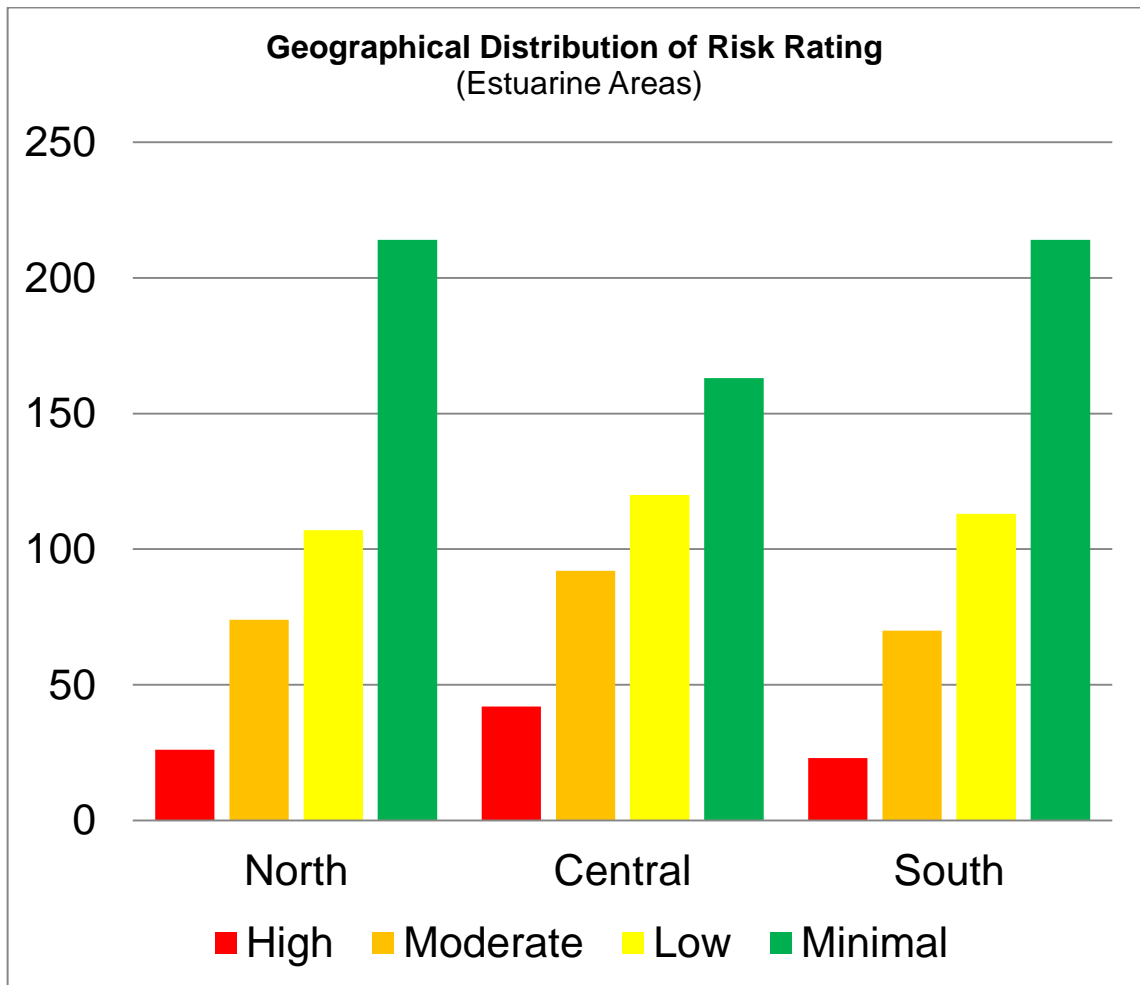


Figure 3-2 Geographical Distribution of Environmental Risk Attributions for Threats in the Estuarine Areas

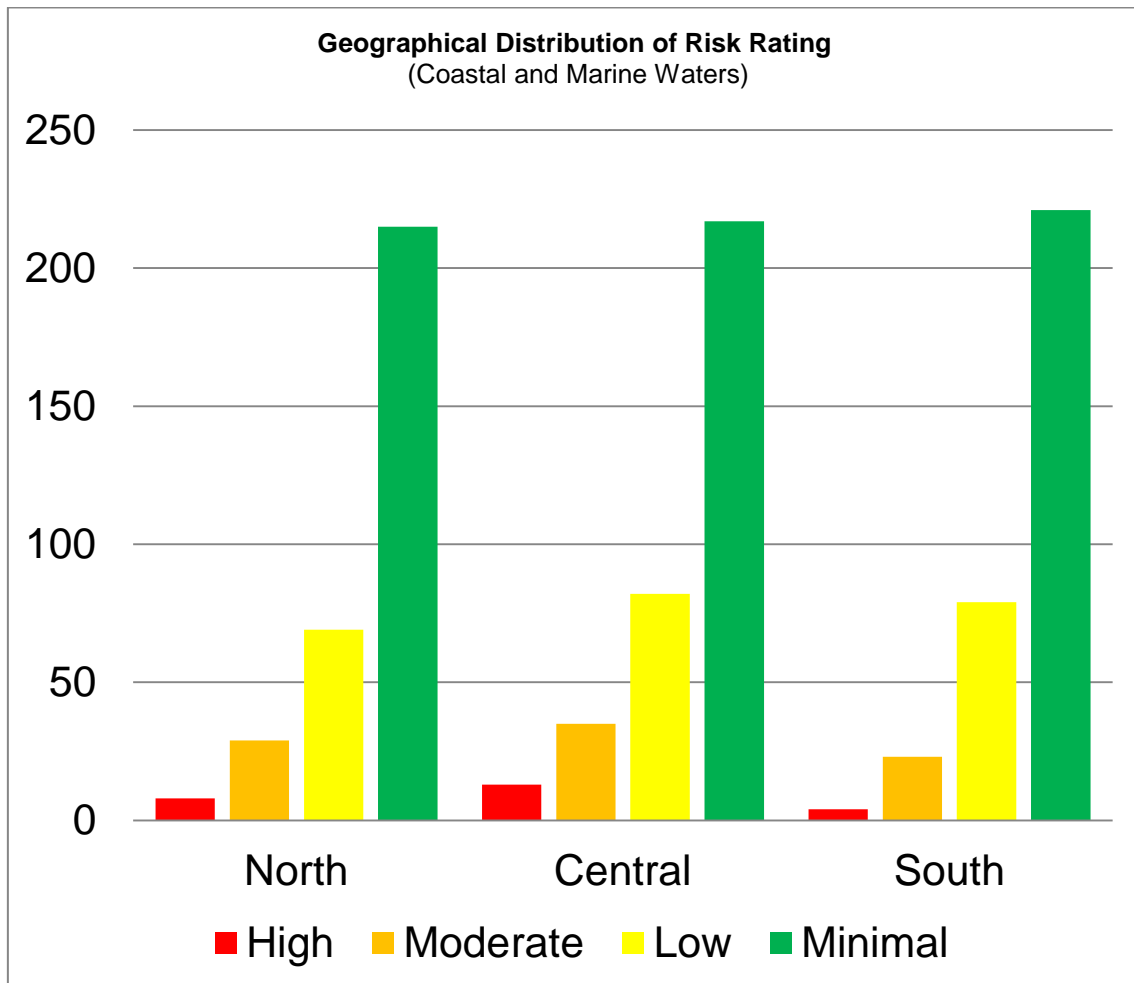


Figure 3-3 Geographical Distribution of Environmental Risk Attributions for threats in the Coastal and Marine Waters Area

### 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

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 total 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 and a brief reference to the evidence supporting risk levels are given in Table 3-1.

Table 3-1 Moderate and High Threats to Environmental Assets

Use, Activity or Stressor (Threats)	Environmental Assets in Estuaries and Coastal and Marine that are at 'High' risk from the use/activity/stressor	Environmental Assets in Estuaries and Coastal and Marine that are at 'Moderate' risk from the use/activity/stressor	Summary of Key Stressors
<p><b>Shipping</b> (includes Large and Small Commercial Vessels)</p>	<p><b>Estuarine</b></p> <ul style="list-style-type: none"> <li>● Mangrove(Central only)</li> </ul> <p><b>Coastal and Marine</b></p> <ul style="list-style-type: none"> <li>● Deep Soft Sediments (Central only)</li> <li>● Species protected under BCA (Central only)</li> </ul>	<p><b>Estuarine</b></p> <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 BCA (Central and South only)</li> </ul> <p><b>Coastal and Marine</b></p> <ul style="list-style-type: none"> <li>● Deep Reefs (Central only)</li> <li>● Species protected under BCA (North and South only)</li> </ul>	<ul style="list-style-type: none"> <li>• Water pollution – toxic contaminants through antifouling paint and oil spills; sediment resuspension</li> <li>• Physical disturbance through vessels strike</li> <li>• Physical disturbance through anchor damage</li> <li>• Wildlife disturbance (shorebirds, turtles, wales)</li> <li>• Marine debris</li> </ul>
<p><b>Commercial Fishing</b> (includes estuary general, estuary prawn trawl, ocean trap and line, ocean trawl, ocean haul, sea urchin and turban shells, abalone)</p>	<p><b>Coastal and Marine</b></p> <ul style="list-style-type: none"> <li>● Fish Assemblages (harvest and bycatch) (North only)</li> <li>● Species protected under FMA (North only)</li> </ul>	<p><b>Estuarine</b></p> <ul style="list-style-type: none"> <li>● Species Protected under BCA (North and Central)</li> <li>● Fish Assemblages (harvest and bycatch)</li> <li>● Shallow and Soft Sediments</li> <li>● Species protected under FMA (North and South only)</li> </ul> <p><b>Coastal and Marine</b></p> <ul style="list-style-type: none"> <li>● Beaches (North and South only)</li> <li>● Deep Soft Sediments</li> <li>● Fish Assemblages (harvest and bycatch) (Central and South only)</li> <li>● Species protected under FMA (Central and South only)</li> <li>● Species protected under BCA (North and Central only)</li> </ul>	<ul style="list-style-type: none"> <li>• Reduction in abundances of species and trophic levels</li> <li>• Bycatch</li> <li>• Incidental catch of species of conservation concern</li> <li>• Physical disturbance through use of trawl gear</li> <li>• Wildlife disturbance (shorebirds, turtles, wales)</li> <li>• Physical disturbance through interaction with fishing gears</li> <li>• Marine debris</li> <li>• Ghost fishing</li> </ul>
<p><b>Recreational Fishing</b> (includes shore-based line and trap fishing, boat-based line and trap fishing, hand gathering)</p>	<p>Nil</p>	<p><b>Estuarine</b></p> <ul style="list-style-type: none"> <li>● Fish Assemblages (harvest and bycatch)</li> <li>● Species protected under BCA (North and Central only)</li> </ul> <p><b>Coastal and Marine</b></p> <ul style="list-style-type: none"> <li>● Fish Assemblages (harvest and</li> </ul>	<ul style="list-style-type: none"> <li>• Reduction in abundances of species and trophic levels</li> <li>• Bycatch</li> <li>• Incidental catch of species of conservation concern</li> <li>• Wildlife disturbance (shorebirds, turtles, wales)</li> <li>• Physical disturbance through interaction with fishing gears</li> <li>• Marine debris</li> <li>• Ghost fishing</li> </ul>



Findings of the Environmental Threat and Risk Assessment

Use, Activity or Stressor (Threats)	Environmental Assets in Estuaries and Coastal and Marine that are at 'High' risk from the use/activity/stressor	Environmental Assets in Estuaries and Coastal and Marine that are at 'Moderate' risk from the use/activity/stressor	Summary of Key Stressors
		bycatch) • Species protected under FMA	
<b>Boating and Boating Infrastructure</b>	<b>Estuarine</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 (<i>Posidonia</i>)</li> </ul>	<b>Estuarine</b> <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 BCA</li> </ul>	<ul style="list-style-type: none"> <li>• Water pollution – toxic contaminants through antifouling paint and oil spills</li> <li>• Physical disturbance resulting from propellers, anchoring, moorings, shoreline infrastructure, sediment re-suspension and shading from boats/jetties resulting in light limitation</li> <li>• Wildlife disturbance through noise disturbance, vessel strike</li> <li>• Marine debris</li> <li>• Bank erosion</li> </ul>
<b>Recreation and tourism</b> (includes passive use, snorkelling and diving, 4WD, charter activities and shark control measures)	<b>Coastal and Marine</b> <ul style="list-style-type: none"> <li>• Beaches (North and Central only)</li> <li>• Species protected under BCA (North and Central only)</li> <li>• Species protected under FMA (Central only)</li> </ul>	<b>Estuarine</b> <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 BCA</li> </ul> <b>Coastal and Marine</b> <ul style="list-style-type: none"> <li>• Rocky shores (Central only)</li> <li>• Species protected under BCA (South only)</li> </ul>	<ul style="list-style-type: none"> <li>• Physical disturbance resulting from compaction</li> <li>• Water pollution – toxic contaminants through antifouling paint and oil spills</li> <li>• Wildlife disturbance through noise disturbance, vessel strike</li> <li>• Marine debris</li> <li>• Bank erosion</li> </ul>
<b>Foreshore / urban development</b> (includes beach nourishment and grooming)	<b>Estuarine</b> <ul style="list-style-type: none"> <li>• Beach and mudflats (Central only)</li> <li>• Saltmarsh (Central only)</li> <li>• Shallow and soft sediments (Central only)</li> <li>• Species Protected under BCA (Central only)</li> </ul> <b>Coastal and Marine</b> <ul style="list-style-type: none"> <li>• Beaches (Central only)</li> <li>• Species protected under BCA (Central only)</li> </ul>	<b>Estuarine</b> <ul style="list-style-type: none"> <li>• Seagrass (Central only)</li> <li>• Mangrove</li> <li>• Saltmarsh (North and South only)</li> <li>• Beaches and mudflats (North and South only)</li> <li>• Rocky shores (Central only)</li> <li>• Species and Populations Protected under FMA</li> <li>• Species Protected under BCA (North and South only)</li> </ul> <b>Coastal and Marine</b> <ul style="list-style-type: none"> <li>• Beaches (North and South only)</li> <li>• Rocky Shores (Central only)</li> <li>• Species protected under BCA (North and South only)</li> </ul>	<ul style="list-style-type: none"> <li>• Water pollution – toxic contaminants through antifouling paint and oil spills; sediment resuspension</li> <li>• Physical disturbance resulting from grooming, shoreline infrastructure, sediment re-suspension and shading resulting in light limitation, sediment deposition</li> <li>• Wildlife disturbance through pollution and habitat loss</li> <li>• Marine debris</li> </ul>
<b>Water pollution and sediment contamination</b>	<b>Estuarine</b>	<b>Estuarine</b>	<ul style="list-style-type: none"> <li>• Water pollution –through nutrients and organic matter, toxic contaminants; sediment resuspension, pathogens</li> </ul>

Findings of the Environmental Threat and Risk Assessment

Use, Activity or Stressor (Threats)	Environmental Assets in Estuaries and Coastal and Marine that are at 'High' risk from the use/activity/stressor	Environmental Assets in Estuaries and Coastal and Marine that are at 'Moderate' risk from the use/activity/stressor	Summary of Key Stressors
(includes urban stormwater, agricultural runoff, industrial discharges, sewage effluent and thermal discharges)	<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 (Central only)</li> <li>● Rocky Shores (Central only)</li> <li>● Planktonic Assemblages</li> <li>● Species and Populations Protected under FMA</li> <li>● Species Protected under BCA (Central only)</li> </ul> <p><b>Coastal and Marine</b></p> <ul style="list-style-type: none"> <li>● Species protected under BCA (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> <li>● Shallow soft sediments</li> <li>● Rocky Shores (South only)</li> <li>● Subtidal Reefs (South and North only)</li> <li>● Species Protected under BCA (North and South only)</li> </ul> <p><b>Coastal and Marine</b></p> <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>● Sedimentation</li> <li>● Marine debris (including microplastics)</li> </ul>
<p><b>Clearing, dredging and excavation activities</b></p> <p>(includes vegetation clearing, dredging, service infrastructure, mining and extraction and cattle grazing)</p>	<p><b>Estuarine</b></p> <ul style="list-style-type: none"> <li>● Estuarine Waters</li> <li>● Saltmarsh</li> <li>● Seagrass</li> <li>● Mangroves</li> <li>● Shallow soft sediments</li> <li>● Species and Populations Protected under FMA</li> <li>● Species Protected under BCA (Central only)</li> </ul> <p><b>Coastal and Marine</b></p> <ul style="list-style-type: none"> <li>● Species protected under BCA (Central only)</li> </ul>	<p><b>Estuarine</b></p> <ul style="list-style-type: none"> <li>● Beach and Mudflats</li> <li>● Planktonic Assemblages</li> <li>● Species Protected under BCA (North and South only)</li> <li>● Subtidal reefs (Central only)</li> </ul> <p><b>Coastal and Marine</b></p> <ul style="list-style-type: none"> <li>● Beaches (Central)</li> <li>● Deep soft sediments (Central only)</li> </ul>	<ul style="list-style-type: none"> <li>● Water pollution – contamination through nutrients, toxicants; sediment resuspension, acid sulfate soils</li> <li>● Sedimentation</li> <li>● Physical disturbance resulting from sediment re-suspension and shading resulting in light limitation, sediment deposition, trampling and grazing, habitat removal</li> <li>● Changes to tidal flow velocity and patterns</li> <li>● Wildlife disturbance</li> </ul>
<p><b>Estuary openings/modified freshwater flows</b></p> <p>(includes hydrological modifications/estuary entrance/modified freshwater flows)</p>	<p><b>Estuarine</b></p> <ul style="list-style-type: none"> <li>● Estuarine Waters</li> <li>● Saltmarsh</li> <li>● Mangrove (North only)</li> <li>● Seagrass</li> <li>● Species and Populations Protected under FMA</li> </ul> <p><b>Coastal and Marine</b></p> <ul style="list-style-type: none"> <li>● Beaches</li> </ul>	<p><b>Estuarine</b></p> <ul style="list-style-type: none"> <li>● Mangroves</li> <li>● Beaches and mudflats</li> <li>● Shallow and soft sediments</li> <li>● Planktonic Assemblages</li> <li>● Species Protected under BCA</li> </ul> <p><b>Coastal and Marine</b></p> <ul style="list-style-type: none"> <li>● Species protected under BCA</li> </ul>	<ul style="list-style-type: none"> <li>● Water pollution – contamination through acid sulfate soils</li> <li>● Sedimentation</li> <li>● Physical disturbance resulting from sediment re-suspension, habitat loss</li> <li>● Sedimentation</li> <li>● Changes to tidal flow and tidal prism</li> <li>● Wildlife disturbance</li> </ul>

Findings of the Environmental Threat and Risk Assessment

Use, Activity or Stressor (Threats)	Environmental Assets in Estuaries and Coastal and Marine that are at 'High' risk from the use/activity/stressor	Environmental Assets in Estuaries and Coastal and Marine that are at 'Moderate' risk from the use/activity/stressor	Summary of Key Stressors
<p><b>Deliberate introduction of plants and animals</b> (e.g. foxes, bitou bush)</p>	<p><b>Estuarine</b></p> <ul style="list-style-type: none"> <li>● Species Protected under BCA</li> </ul> <p><b>Coastal and Marine</b></p> <ul style="list-style-type: none"> <li>● Species protected under BCA</li> </ul>	<p>Nil</p>	<ul style="list-style-type: none"> <li>• Physical disturbance</li> <li>• Wildlife disturbance</li> </ul>
<p><b>Aquaculture</b> (includes Oyster Aquaculture)</p>	<p>Nil</p>	<p><b>Estuarine</b></p> <ul style="list-style-type: none"> <li>● Seagrass</li> <li>● Species and Populations Protected under FMA (<i>Posidonia</i>)</li> </ul>	<ul style="list-style-type: none"> <li>• Physical disturbance resulting from propellers, sediment re-suspension and shading resulting in light limitation</li> </ul>
<p><b>Climate Change</b> (includes all climate change components based on a 20 year projection of impacts only)</p>	<p><b>Estuarine</b></p> <ul style="list-style-type: none"> <li>● Species protected under BCA</li> </ul> <p><b>Coastal and Marine</b></p> <ul style="list-style-type: none"> <li>● Species protected under BCA</li> </ul>	<p><b>Estuarine</b></p> <ul style="list-style-type: none"> <li>● Estuarine Waters (North and Central only)</li> <li>● Saltmarsh</li> <li>● Planktonic Assemblages</li> <li>● Species and Populations Protected under FMA</li> </ul> <p><b>Coastal and Marine</b></p> <ul style="list-style-type: none"> <li>● Ocean Waters (North only)</li> <li>● Beaches (Central only)</li> <li>● Rocky shores (North only)</li> <li>● Shallow reefs</li> <li>● Planktonic Assemblages</li> </ul>	<ul style="list-style-type: none"> <li>• Physical disturbance, wildlife disturbance, marine debris, water pollution and reduction in abundances of species and trophic levels due to climate change components of altered ocean currents and nutrient inputs, ocean acidification, climate and sea temperature rise, sea level rise and altered storm and cyclone activity</li> </ul>

The priority risks at a Statewide level for estuaries in ranked order are shown in Table 3-2.

**Table 3-2 Moderate and High (Priority) Threats to Estuaries Statewide**

Ranked Priority Threats to Estuaries - Statewide
<ul style="list-style-type: none"> <li>• Agricultural diffuse source runoff</li> <li>• Urban stormwater discharge</li> <li>• Estuary entrance modifications + breakwaters</li> <li>• Clearing riparian and adjacent habitat including wetland drainage</li> <li>• Modified freshwater flows</li> <li>• Recreation - boating and boating infrastructure</li> <li>• Navigation &amp; entrance management and modification, harbour maintenance etc.</li> <li>• Foreshore development</li> <li>• Sewage effluent and septic runoff</li> <li>• Stock grazing of riparian and marine vegetation</li> <li>• Climate Change 20 years</li> <li>• Four wheel driving</li> <li>• Shipping - Large commercial vessels and associated port activities and industries (trade ships, cruise ships, etc.)</li> <li>• Commercial fishing - estuary general</li> <li>• Oyster aquaculture</li> <li>• Passive recreational use</li> <li>• Beach nourishment and grooming</li> <li>• Recreational fishing - shore-based line and trap fishing</li> <li>• Recreational boat-based line and trap fishing</li> <li>• Deliberate introduction of plants and animals (e.g. foxes, bitou bush)</li> <li>• Pipelines, cables, trenching and boring</li> <li>• Shipping -small commercial vessels (ferries, charter boats etc.)</li> <li>• Recreational fishing- hand gathering</li> <li>• Whale and dolphin watching</li> <li>• Oil, gas, minerals, sand, aggregate, coal mining</li> <li>• Commercial fishing – estuary prawn trawl</li> </ul>

The priority threats at a Statewide level for Coastal and Marine Waters 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 20 year timeframe</li> <li>• Commercial fishing - ocean trawl</li> <li>• Foreshore development</li> <li>• Estuary entrance modifications + breakwaters</li> <li>• Commercial fishing - ocean trap and line</li> <li>• Recreational boat-based line and trap fishing</li> <li>• Urban stormwater discharge</li> <li>• Recreational fishing - shore-based line and trap fishing</li> <li>• Passive recreational use</li> <li>• Commercial fishing -ocean haul</li> <li>• Deliberate introduction of plants and animals (e.g. foxes, Bitou bush)</li> <li>• Beach nourishment and grooming</li> <li>• Shipping - small commercial vessels (ferries, charter boats etc.)</li> <li>• Recreational fishing - hand gathering</li> <li>• Whale and dolphin watching</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 3-4). 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 MEMA's 5-step 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.

Table 3-4 Combined Moderate and High (Priority) Threats to Environmental Assets Statewide

Ranked Priority Threats to Environmental Assets - Statewide
<ul style="list-style-type: none"> <li>• Urban stormwater discharge</li> <li>• Estuary entrance modifications</li> <li>• Agricultural diffuse source runoff (in estuaries)</li> <li>• Clearing riparian and adjacent habitat including wetland drainage</li> <li>• Climate change stressors 20 year timeframe (sea level rise, altered storm/cyclone activity, flooding, climate and sea temperature rise, altered ocean currents and nutrient inputs)</li> <li>• Modified freshwater flows (in estuaries)</li> <li>• Foreshore development</li> <li>• Recreation- Boating and boating infrastructure (in estuaries)</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 (in estuaries)</li> <li>• Four wheel driving</li> <li>• Recreational fishing -boat-based line and trap fishing</li> <li>• Passive recreational use</li> <li>• Recreational fishing-shore-based line and trap fishing</li> <li>• Beach nourishment and grooming</li> <li>• Commercial fishing -ocean trawl (in coast and marine waters)</li> <li>• Commercial fishing - ocean trap and line (in coast and marine waters)</li> <li>• Commercial fishing- estuary general (in estuaries)</li> <li>• Deliberate introduction of plants and animals (e.g. foxes, Bitou bush)</li> <li>• Shipping- small commercial vessels</li> <li>• Oyster aquaculture (in estuaries)</li> <li>• Commercial fishing-ocean haul (in coastal and marine waters)</li> <li>• Recreational fishing- hand gathering</li> <li>• Whale and dolphin watching</li> </ul>

### 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 3-5, with detailed data in Appendix F.

## Findings of the Environmental Threat and Risk Assessment

Table 3-5 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>• Estuary entrance modifications</li> <li>• Clearing riparian and adjacent habitat including wetland drainage (in estuaries)</li> <li>• Agricultural diffuse source runoff (in estuaries)</li> <li>• Climate Change (20yrs)</li> <li>• Urban stormwater discharge (in estuaries)</li> <li>• Modified Freshwater flows (in estuaries)</li> <li>• Recreation and tourism -Boating and boating infrastructure (in estuaries)</li> <li>• Recreation and tourism - Four wheel driving</li> <li>• Foreshore development</li> <li>• Navigation &amp; entrance management and modification, harbour maintenance, etc. (in estuaries)</li> <li>• Sewage effluent and septic runoff</li> <li>• Stock grazing of riparian and marine vegetation (in estuaries)</li> <li>• Commercial fishing - Ocean Trawl (in coastal and marine)</li> <li>• Recreational fishing - Shore-based line and trap fishing</li> <li>• Recreational fishing - Boat-based line and trap fishing</li> <li>• Commercial fishing - Ocean Trap and Line (in coastal and marine)</li> <li>• Commercial fishing – Estuary General (in estuaries)</li> <li>• Passive recreational use</li> <li>• Deliberate introduction of plants and animals (e.g. foxes, bitou bush)</li> <li>• Recreational fishing - Hand Gathering</li> <li>• Oyster Aquaculture (in estuaries)</li> </ul>	<ul style="list-style-type: none"> <li>• Urban stormwater discharge</li> <li>• Foreshore development</li> <li>• Estuary entrance modifications (in estuaries)</li> <li>• Shipping - Large commercial vessels and associated port activities and industries (trade ships, cruise ships, etc.)</li> <li>• Agricultural diffuse source runoff (in estuaries)</li> <li>• Clearing riparian and adjacent habitat including wetland drainage</li> <li>• Climate change 20 years</li> <li>• Recreational Boating - Boating and boating infrastructure (in estuaries)</li> <li>• Sewage effluent and septic runoff</li> <li>• Navigation &amp; entrance management and modification, harbour maintenance, etc.</li> <li>• Modified Freshwater flows - Modified freshwater flows (in estuaries)</li> <li>• Industrial discharges (in estuaries)</li> <li>• Recreation and tourism - Four wheel driving</li> <li>• Stock grazing of riparian and marine vegetation (in estuaries)</li> <li>• Small commercial vessels (ferries, charter boats, whale watching vessels, fishing vessels etc) (in estuaries)</li> <li>• Beach nourishment and grooming</li> <li>• Service infrastructure - pipes, cables trenching and boring (in estuaries)</li> <li>• Recreational fishing - Shore-based line and trap fishing</li> <li>• Recreational fishing - Boat-based line and trap fishing</li> </ul>	<ul style="list-style-type: none"> <li>• Agricultural diffuse source runoff (in estuaries)</li> <li>• Estuary entrance modifications</li> <li>• Urban stormwater discharge</li> <li>• Modified Freshwater flows - Modified freshwater flows (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>• Foreshore development</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>• Recreation and Tourism – four wheel driving (in estuaries)</li> <li>• Recreational fishing - Boat-based line and trap fishing</li> <li>• Deliberate introduction of plants and animals(e.g. foxes, bitou bush)</li> <li>• Passive Recreational Use</li> <li>• Commercial fishing – Estuary General</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>• Charter activities – Whale and dolphin watching</li> <li>• Commercial fishing - Ocean Trap and Line</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
<ul style="list-style-type: none"> <li>Commercial fishing – Ocean Haul (in coastal and marine)</li> <li>Charter activities – whale and dolphin watching</li> <li>Beach nourishment and grooming</li> <li>Shipping - Small commercial (in coast and marine)</li> <li>Commercial Fishing – Estuary Prawn Trawl (in estuaries)</li> </ul>	<ul style="list-style-type: none"> <li>Recreation and tourism - Passive recreational Use</li> <li>Thermal discharges (in estuaries)</li> <li>Commercial fishing - Ocean Trawl</li> <li>Recreation and tourism - Shark control measures</li> <li>Commercial fishing - Estuary general (in estuaries)</li> <li>Oyster aquaculture (in estuaries)</li> <li>Recreational fishing - Hand gathering</li> <li>Mining and extractive industries (in estuaries)</li> <li>Commercial fishing - Ocean Trap and Line (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> </ul>	<ul style="list-style-type: none"> <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>Shipping - Small commercial</li> <li>Shipping – Large commercial (in estuaries)</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 trophic levels of fish assemblages from recreational and commercial fishing
- Many climate change stressors for both 20 and 50 year projections
- Dredging, aquaculture, mining activities, service infrastructure and some fishing methods on threatened and protected marine mammals, seabirds and reptiles.

- Urban stormwater discharge on several environmental assets
- Point discharges and sewage effluent on several environmental assets

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

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### 4.1 Introduction

For the Statewide social, cultural 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, cultural and economic benefits derived from the marine estate with the social, cultural 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 (which includes both Tangible and Intangible Aboriginal Cultural Heritage [historic objects, places, items, and source of food traditions, practices, knowledge, spiritual values]).

#### Cultural

- Cultural heritage & use benefits (which includes both Tangible and Intangible Aboriginal Cultural Heritage [historic objects, places, items, and source of food 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'

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

- 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, cultural and economic uses and activities at a Statewide level was prepared by MEMA agencies based on the data collected from the original Social, Cultural 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.

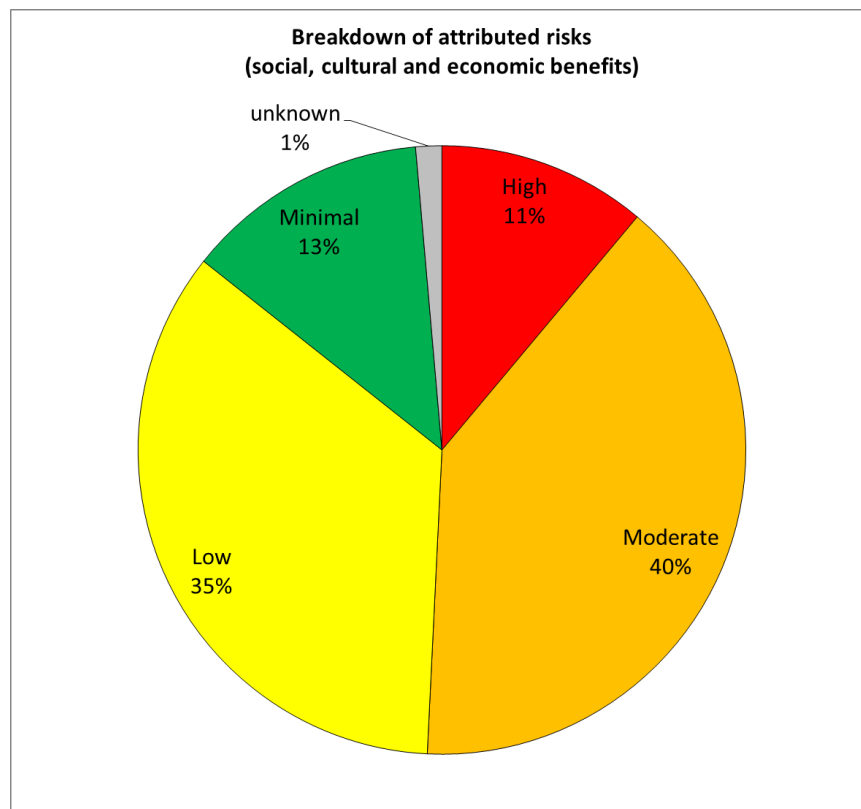
The amended summary of evidence underpinning the risk levels is contained in Appendix D of this report.

## 4.2 Summary of Key Threats – Social, Cultural and Economic

### 4.2.1 High and Moderate Risks

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

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, Cultural and Economic Benefits**

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

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

- 72 instances where the risk of the threat being realised was identified as a 'High' risk;
- 257 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. As discussed below in Section 4.2.3, these tallies only include the risk attributions for climate change for a 20 year timeframe.

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, cultural 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 threats to all benefit categories from sediment contamination were consistently higher in the Central region than for the North and South). This information is also presented in Table 4-3.

### 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.

It is anticipated, as with the 20 year assessment that impacts of climate change on Intrinsic & bequest values, Employment & value of production, and Individual enjoyment value (consumer surplus) will increase over time. In particular, significant impacts can be expected where climate change impacts upon business assets and access to the marine environment, and where climate change affects the distribution, abundance, breeding cycles and migrations of marine plants and animals that people rely on for food, income and enjoyment. However, different economic uses of the marine estate will experience different impacts, and economic adjustment strategies are expected to seek to minimise losses and identify new opportunities. Therefore, impacts on economic benefits cannot be predicted over a long term time frame with the same certainty as environmental impacts. Economic modelling is not available to support the determination of risk ratings for economic uses of the marine estate over a 50-year time-frame. Risk ratings to economic benefits are therefore not provided for the 50-year time-frame. However, where scores are required to support the calculation of total risk, scores for the 20-year time-frame are used.

**Findings of the Social, Cultural and Economic Threat and Risk Assessment****4.2.4 Statewide Priority Threats**

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, cultural 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 combined 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, cultural and economic benefits across the state (in descending order – although some consecutive risks have equal scores) are presented in Table 4-1:

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

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

Ranked Priority Threats to Social, Cultural and Economic Benefits - Statewide
<ul style="list-style-type: none"> <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>• Inadequate social and economic information</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>• Reductions in abundances of species and trophic levels</li> <li>• Anti-social behaviour and unsafe practices</li> <li>• Climate change stressors 20 years (sea level rise, altered storm/cyclone activity, flooding, climate and sea temperature rise, altered ocean currents and nutrient inputs)</li> <li>• Loss of public access (either by private development or Government area closures)</li> <li>• Inadequate, inefficient regulation, over-regulation (agencies)</li> <li>• Pests and diseases</li> <li>• Sediment contamination (toxicants in sediment)</li> <li>• Overcrowding / congestion</li> <li>• Conflict over resource access and use</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 or decline of marine industries</li> <li>• Seafood contamination</li> <li>• Modified hydrology/hydraulics and flow regime</li> <li>• Water pollution on environmental values - septic runoff, point source pollution and sewage overflows (such as outfalls, STPs, etc.)</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>• Lack of or ineffective community engagement or participation in governance</li> <li>• Other water pollution/contamination affecting human health and safety (such as toxic algal blooms, <i>e. coli</i> concentrations, etc.)</li> <li>• Excessive or illegal extraction</li> </ul>

Findings of the Social, Cultural and Economic Threat and Risk Assessment

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

Use, Activity or Stressor (Threats)	Social, Cultural and Economic benefits of the marine estate that are at 'High' risk from the use/activity/stressor	Social, Cultural and Economic benefits of the marine estate that are at 'Moderate' risk from the use/activity/stressor	Summary of Evidence
<b>Conflict over resource access and use</b>	<ul style="list-style-type: none"> <li>● Tangible &amp; Intangible Aboriginal cultural heritage</li> </ul>	<ul style="list-style-type: none"> <li>● Participation: Safety, health and wellbeing</li> <li>● Participation: Socialising and sense of community</li> </ul>	<ul style="list-style-type: none"> <li>● Tangible and intangible Aboriginal cultural heritage is impacted by conflict over resource access and use. This is largely a result of conflict between recreational, commercial and cultural fishing sectors</li> <li>● Risk to tangible and intangible Aboriginal cultural heritage relates to equitable resource allocation and particularly to community attitudes and beliefs around which sectors should be prioritised in resource allocation exercises. Aspirations around improved cultural fishing rights are likely to be resisted by other sectors and conflict will increase as these rights are pursued.</li> <li>● 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.).</li> <li>● Numerous concerns about and examples of conflict over resource use and access, such as illegal camping in parks and headlands in the marine estate, kite surfing, power boats used by dive operators, and tension between the local community and tourists.</li> </ul>
<b>Antisocial behaviour and unsafe practices</b>	<ul style="list-style-type: none"> <li>● Tangible &amp; Intangible Aboriginal cultural heritage</li> </ul>	<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>● 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>● Tangible &amp; Intangible Aboriginal cultural heritage</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> <li>● Overcrowding/congestion can impact on tangible and intangible Aboriginal cultural heritage due to more competition of food resources, and increased access to and degradation of important cultural sites.</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>● Tangible &amp; Intangible Aboriginal cultural heritage</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> <li>● Decline in marine industry viability particularly professional fishing and aquaculture may impact the ability of Aboriginal people to maintain traditional connections and employment in these industries.</li> </ul>
<b>Excessive or illegal</b>		<ul style="list-style-type: none"> <li>● Tangible &amp; Intangible Aboriginal</li> </ul>	<ul style="list-style-type: none"> <li>● Excessive or illegal extraction can impact on tangible and intangible Aboriginal heritage by causing a reduction in natural resources. e.g.</li> </ul>



Findings of the Social, Cultural and Economic Threat and Risk Assessment

Use, Activity or Stressor (Threats)	Social, Cultural and Economic benefits of the marine estate that are at 'High' risk from the use/activity/stressor	Social, Cultural and Economic benefits of the marine estate that are at 'Moderate' risk from the use/activity/stressor	Summary of Evidence
extraction		cultural heritage • Viability of businesses (South only)	transfer of traditional knowledge, ability to conduct cultural significant ceremonies or events involving seafood consumption. • 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). For instance, there have been numerous instances of illegal abalone takes on the NSW South Coast which have impacted the profitability of commercial operators. As a result, moderate impacts are considered likely in the Southern Region as a result of illegal extraction.
Water Pollution (on Environmental Values – septic runoff, point source pollution and sewage overflows, outfalls, STP's etc)		• Enjoyment: Enjoying the biodiversity and beauty of the marine estate • Tangible & Intangible Aboriginal cultural heritage • Viability of businesses (North and South only)	• Loss of amenity associated with pollution from septic runoff, point source pollution and sewage overflows 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. • Septic runoff consistent with the environmental TARA has been the major contributor to the risk and the impacts are likely to be localised. This particularly occurs in estuaries that contain adjacent septic systems. • Water pollution can impact on tangible Aboriginal cultural heritage such as source of food and can also cause damage to places associated with cultural practices and traditions.
Water Pollution (on Environmental Values- urban stormwater discharge)	• Tangible & Intangible Aboriginal cultural heritage	• Participation: Safety, health & wellbeing • Participation: Socialising and sense of community • Enjoyment: Enjoying the biodiversity and beauty of the marine estate • Enjoyment: Consumptive use • Intrinsic & bequest values • Viability of businesses • Direct Values	• 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). • Impacts on consumptive use from stormwater discharge relates mostly to impacts on seafood quality (especially aquaculture), scientific reference sites and participation in marine tourism • Water pollution can also cause damage to places associated with cultural practices and traditions • Local Businesses that are dependent on the marine estate for their viability, such as commercial fishers and tourist operators, may experience major impacts on production, and therefore on employment, due to events such as closures and fish kills.
Water Pollution (on Environmental Values- agricultural diffuse runoff)	• Tangible & Intangible Aboriginal cultural heritage	• Participation: Safety, health & wellbeing • Participation: Socialising and sense of community • Enjoyment: Enjoying the biodiversity and beauty of the marine estate • Enjoyment: Consumptive use • Intrinsic & bequest values • Viability of businesses • Direct Values	• The environmental TARA found that agricultural sources had major impacts almost certain due to elevated nutrients, sediments, potential contaminants and turbidity, and sedimentation. • 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. • Water pollution can also cause damage to places associated with cultural practices and traditions
Water Pollution (on	• Tangible & Intangible	• Participation: Safety, health &	• The environmental TARA considered marine debris and littering from a range of sources and references evidence of microplastics, marine

Findings of the Social, Cultural and Economic Threat and Risk Assessment

Use, Activity or Stressor (Threats)	Social, Cultural and Economic benefits of the marine estate that are at 'High' risk from the use/activity/stressor	Social, Cultural and Economic benefits of the marine estate that are at 'Moderate' risk from the use/activity/stressor	Summary of Evidence
<i>Environmental Values- litter, solid waste, marine debris and microplastics)</i>	Aboriginal cultural heritage	wellbeing • Participation: Socialising and sense of community • Enjoyment: Enjoying the biodiversity and beauty of the marine estate • Enjoyment: Consumptive use • Intrinsic & bequest values • Viability of businesses • Direct Values	debris and other contaminants impacting marine fauna. • 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). • Water pollution can also cause damage to places associated with cultural practices and traditions Impact on businesses that that are dependent on the marine estate for their viability, such as commercial fishers and tourist operators, • Litter in oceans and seas is an aesthetic problem, incurs considerable costs to clean and can have severe impacts on marine organisms and habitats.
<b>Wildlife disturbance</b> (shorebirds, turtles, whales and impacts to ecological health by dog walkers, 4WD, marine vessels, etc.)	• Tangible & Intangible Aboriginal cultural heritage	• Enjoyment: Enjoying the biodiversity and beauty of the marine estate	• Impacts on people's relationship with the coast (e.g. loss of appeal due to decline in wildlife) will also impact social connections. • Wildlife interactions can impact on both tangible and intangible Aboriginal cultural heritage as a lack of or changing wildlife interactions can impact on spiritual connections such as totemic species.
<b>Habitat (physical) disturbance</b> (Including foreshore development, commercial and recreational fishing methods, vessel moorings and anchors, four wheel driving, mining and beach grooming)	• Tangible & Intangible Aboriginal cultural heritage	• Enjoyment: Enjoying the biodiversity and beauty of the marine estate • Enjoyment: Consumptive use	• Impacts to enjoyment due to depletion of fish stocks through overfishing and wildlife connectivity. • Physical disturbance limits 'undisturbed' control sites required for scientific research and education. • Preference for undisturbed sites for tourism/ charter activities such as snorkelling and diving. • 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. • Habitat (physical disturbance) from human activity such as dredging, fishing, boat anchors and other human activities that can cause damage to heritage sites and to places associated with cultural practices and traditions and to totemic or culturally significant species.
<b>Reductions in abundances of species and trophic levels</b> (Including commercial, recreational and charter fishing)	• Enjoyment: Consumptive Use • Tangible & Intangible Aboriginal cultural heritage	• Enjoyment: Enjoying the biodiversity and beauty of the marine estate • Intrinsic & bequest values • Viability of businesses	• Evidence suggests a loss of enjoyment for visitors accessing locally caught seafood, including as a tourism product associated with coastal holidays. • Enjoyment at risk following depletion of fish stocks. • 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). • 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.
<b>Pests/diseases</b> (Including shipping, aquaculture and the aquarium trade)	Nil	• Participation: Safety, health & wellbeing • Enjoyment: Consumptive use • Tangible & Intangible Aboriginal cultural heritage • Viability of businesses	• 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 • 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. • 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 • Pests/diseases may impact on tourism operators, commercial fishers and aquaculture producers where impacts on habitats and marine life may be significant. A recent example includes the outbreak of white spot disease in the Queensland prawn industry.

Findings of the Social, Cultural and Economic Threat and Risk Assessment

	Use, Activity or Stressor (Threats)	Social, Cultural and Economic benefits of the marine estate that are at 'High' risk from the use/activity/stressor	Social, Cultural and Economic benefits of the marine estate that are at 'Moderate' risk from the use/activity/stressor	Summary of Evidence
	<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> <li>• Tangible &amp; Intangible Aboriginal cultural heritage</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> <li>• The stressor modified freshwater flows can impact on Aboriginal cultural heritage by negatively affecting fish stocks.</li> </ul>
	<b>Sediment contamination</b> <i>(toxicants in sediment; dioxins in Sydney Harbour, Cooks River)</i>	<ul style="list-style-type: none"> <li>• Tangible &amp; Intangible Aboriginal cultural heritage</li> </ul>	<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> <li>• Sediment contamination can impact on Aboriginal cultural heritage as environmental degradation can impact on spiritual connections</li> </ul>
	<b>Climate change (20yrs)</b>	<ul style="list-style-type: none"> <li>• Tangible &amp; Intangible Aboriginal cultural heritage</li> </ul>	<ul style="list-style-type: none"> <li>• Enjoyment: Enjoying the biodiversity and beauty of the marine estate</li> <li>• Enjoyment: Consumptive use</li> <li>• Viability of businesses</li> <li>• Direct Values</li> </ul>	<ul style="list-style-type: none"> <li>• Climate change stressors such as sea level rise and increased sea temperatures 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> <li>• In the near future (now to 2031) it is predicted that increases in heavy rainfall events are expected to increase the likelihood of flooding along urban streams. The effects of increased flood incidence include poor water quality with impacts on beach use.</li> <li>• Decrease in primary production leading to further emigration from rural towns, where agriculture is the dominant industry, leading to multiple flow-on effects including health and community cohesion impacts.</li> <li>• The consequences of damage and loss associated with increased frequency and severity of storm and erosion events include implications for socialisation and sense of community.</li> <li>• The effects of increased flood incidence on private property, loss of crops and livestock, nutrient runoff, standing water following flood and sedimentation in rivers and drainage systems include poor water quality with impacts on terrestrial, aquatic and marine coastal ecosystems, commercial (e.g. oyster production) and recreational fishing and beach use.</li> </ul>

Findings of the Social, Cultural and Economic Threat and Risk Assessment

	Use, Activity or Stressor (Threats)	Social, Cultural and Economic benefits of the marine estate that are at 'High' risk from the use/activity/stressor	Social, Cultural and Economic benefits of the marine estate that are at 'Moderate' risk from the use/activity/stressor	Summary of Evidence
	<b>Climate change</b> (50yrs)	<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>● Tangible &amp; Intangible Aboriginal cultural heritage</li> </ul>		<ul style="list-style-type: none"> <li>● Climate change stressors such as sea level rise and increased sea temperatures 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>● 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> <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> </ul>
Governance of the marine estate	<b>Inadequate, inefficient regulation, overregulation</b> (agencies)	<ul style="list-style-type: none"> <li>● Tangible &amp; Intangible Aboriginal cultural heritage</li> </ul>	<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>● Viability of businesses</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>	<ul style="list-style-type: none"> <li>● Tangible &amp; Intangible Aboriginal cultural 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</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, regulations and opportunities for participation</b>	<ul style="list-style-type: none"> <li>● Tangible &amp; Intangible Aboriginal cultural heritage</li> </ul>	<ul style="list-style-type: none"> <li>● Enjoyment: Enjoying the biodiversity and beauty of the marine estate</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> <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>

Findings of the Social, Cultural and Economic Threat and Risk Assessment

	Use, Activity or Stressor (Threats)	Social, Cultural and Economic benefits of the marine estate that are at 'High' risk from the use/activity/stressor	Social, Cultural and Economic benefits of the marine estate that are at 'Moderate' risk from the use/activity/stressor	Summary of Evidence
	<b>Lack of compliance with regulations (by users) or lack of compliance effort (by agencies)</b>	<ul style="list-style-type: none"> <li>● Tangible &amp; Intangible Aboriginal cultural heritage</li> </ul>	<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> <li>● 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.</li> </ul>
Public Safety	<b>Wildlife interactions</b>	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>
	<b>Seafood contamination</b>	<ul style="list-style-type: none"> <li>● Tangible &amp; Intangible Aboriginal cultural heritage</li> </ul>	<ul style="list-style-type: none"> <li>● Participation: Safety, health &amp; wellbeing (Central only)</li> <li>● Enjoyment: Consumptive use</li> <li>● Viability of businesses (Central only)</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> <li>● Aboriginal people frequently eat wild pipis, oysters and other shellfish that are known to be vulnerable to contamination issues.</li> </ul>
	<b>Other water pollution/contamination affecting human health and safety (such as toxic algal blooms, e coli etc.)</b>	<ul style="list-style-type: none"> <li>● Tangible &amp; Intangible Aboriginal cultural heritage</li> </ul>		<ul style="list-style-type: none"> <li>● Pollution or contamination impacts the ability of Aboriginal communities to make use of important sites or participate in important cultural practises</li> </ul>
Knowledge Gaps	<b>Inadequate social and economic information</b>	<ul style="list-style-type: none"> <li>● Tangible &amp; Intangible Aboriginal cultural heritage</li> </ul>	<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>● 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>

Findings of the Social, Cultural and Economic Threat and Risk Assessment

	Use, Activity or Stressor (Threats)	Social, Cultural and Economic benefits of the marine estate that are at 'High' risk from the use/activity/stressor	Social, Cultural and Economic benefits of the marine estate that are at 'Moderate' risk from the use/activity/stressor	Summary of Evidence
Lack of access availability	<p><b>Limited or lack of access infrastructure to the marine estate</b></p>		<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>• Tangible &amp; Intangible Aboriginal cultural heritage</li> <li>• Viability of businesses</li> <li>• Direct Values (Central only)</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> <li>• Lack of access to infrastructure is impacting tangible and intangible cultural heritage values. Without access to affordable boats and/or cars there is a lack of access to important cultural sites, totemic species and traditional food resources</li> </ul>
	<p><b>Loss of public access (either by private development or government closures)</b></p>	<ul style="list-style-type: none"> <li>• Tangible &amp; Intangible Aboriginal cultural heritage</li> </ul>	<ul style="list-style-type: none"> <li>• Participation: Safety, health and wellbeing</li> <li>• Enjoyment: Consumptive use</li> <li>• Intrinsic &amp; bequest values</li> <li>• Viability of businesses (North and South only)</li> </ul>	<ul style="list-style-type: none"> <li>• 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. 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.</li> <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>• Mental health impacts for people in the fishing industry resulting from a number of stressors including area closures. These impacts include stress and anxiety on fishers and their families.</li> </ul>

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

#### 4.2.5 Regional Priority Threats

The priority order of 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 threats for each of the three regions of the state are given in Table 4-3.

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

Threats to Social, Cultural and Economic Benefits for the North region	Threats to Social, Cultural and Economic Benefits for the Central Region	Threats to Social, Cultural and Economic Benefits for the South Region
<ul style="list-style-type: none"> <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>Inadequate social and economic information</li> <li>Lack of compliance with regulations (by users) or lack of compliance effort (by agencies)</li> <li>Reductions in abundances of species and trophic levels</li> <li>Limited or lack of access infrastructure to the marine estate</li> <li>Anti-social behaviour and unsafe practices</li> <li>Climate change stressors 20 years</li> <li>Loss of public access (either by private development or Government area closures)</li> <li>Inadequate, inefficient regulation, over-regulation (agencies)</li> </ul>	<ul style="list-style-type: none"> <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>Sediment contamination (toxicants in sediment; dioxins in Sydney Harbour, Cooks River)</li> <li>Inadequate social and economic information</li> <li>Anti-social behaviour and unsafe practices</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>Reductions in abundances of species and trophic levels</li> <li>Climate change stressors 20 years</li> <li>Inadequate, inefficient regulation, over-regulation</li> </ul>	<ul style="list-style-type: none"> <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>Inadequate social and economic information</li> <li>Lack of compliance with regulations (by users) or lack of compliance effort (by agencies)</li> <li>Reductions in abundances of species and trophic levels</li> <li>Limited or lack of access infrastructure to the marine estate</li> <li>Climate change stressors 20 years</li> <li>Loss of public access (either by private development or Government area closures)</li> <li>Anti-social behaviour and unsafe practices</li> <li>Inadequate, inefficient regulation, over-regulation (agencies)</li> </ul>

Findings of the Social, Cultural and Economic Threat and Risk Assessment

Threats to Social, Cultural and Economic Benefits for the North region	Threats to Social, Cultural and Economic Benefits for the Central Region	Threats to Social, Cultural and Economic Benefits for the South Region
<ul style="list-style-type: none"> <li>• Loss or decline of marine industries</li> <li>• Pests and diseases</li> <li>• Conflict over resource access and use</li> <li>• Habitat (physical) disturbance</li> <li>• Overcrowding / congestion</li> <li>• Water pollution on environmental values - septic runoff, point source pollution and sewage overflows (such as outfalls, STPs, etc.) and</li> <li>• Modified hydrology/hydraulics and f regime</li> <li>• Wildlife disturbance (shorebirds, turtles, whales) and impacts to ecological health 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>• Sediment contamination</li> <li>• Lack of or ineffective community engagement or participation in governance</li> <li>• Other water pollution/contamination affecting human health and safety</li> <li>• Excessive or illegal extraction</li> <li>• Wildlife interactions (e.g. shark bite, jellyfish, boat striking a whale)</li> </ul>	<p>(agencies)</p> <ul style="list-style-type: none"> <li>• Overcrowding / congestion</li> <li>• Seafood contamination</li> <li>• Loss of public access (either by private development or Government area closures)</li> <li>• Pests and diseases</li> <li>• Conflict over resource access and use</li> <li>• Habitat (physical) disturbance</li> <li>• Modified hydrology/hydraulics and f regime</li> <li>• Wildlife disturbance (shorebirds, turtles, whales) and impacts to ecological health 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>• Water pollution on environmental values - septic runoff, point source pollution and sewage overflows (such as outfalls, STPs, etc.) and</li> <li>• Lack of or ineffective community engagement or participation in governance</li> <li>• Other water pollution/contamination affecting human health and</li> <li>• Excessive or illegal extraction</li> </ul>	<ul style="list-style-type: none"> <li>• Loss or decline of marine industries</li> <li>• Pests and diseases</li> <li>• Conflict over resource access and use</li> <li>• Habitat (physical) disturbance</li> <li>• Overcrowding / congestion</li> <li>• Water pollution on environmental values - septic runoff, point source pollution and sewage overflows (such as outfalls, STPs, etc.) and</li> <li>• Modified hydrology/hydraulics and f regime</li> <li>• Wildlife disturbance (shorebirds, turtles, whales) and impacts to ecological health 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>• Excessive or illegal extraction</li> <li>• Sediment contamination (</li> <li>• Lack of or ineffective community engagement or participation in governance</li> <li>• Other water pollution/contamination affecting human health and safety</li> </ul>

4.2.6 Key Knowledge Gaps

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



**Findings of the Social, Cultural and Economic Threat and Risk Assessment**

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.

The conservation, enjoyment and use of marine historic heritage provides social, cultural and economic benefits to the NSW community. However the threats to these benefits were not assessed as part of the social and economic TARA. This issue was identified during the consultation period as a potential policy gap. While some current government reforms are likely to benefit the protection and management of marine historic heritage, it is still important to acknowledge the benefits of marine historic heritage and the threats to which it is exposed. It is recommended that a 'watching brief' be kept on threats to marine historic heritage and that risk levels are assessed as part of the TARA's five-year health check (refer to Section 6).

The following knowledge gaps, based on inferred confidence ratings, have been identified for the social, cultural and economic TARA.

- Resource use conflict (in particular overcrowding/congestion, loss or decline of marine industries),
- Environmental (in particular wildlife disturbance, pests and diseases, modified hydrology/hydraulics and flow regime, sediment contamination and climate change)
- Governance of the marine estate (in particular lack of community awareness of the marine estate)
- Public safety (in particular wildlife interactions, seafood contamination, other water pollution/contamination affecting human health and safety)
- Critical knowledge gaps (inadequate social and economic information)
- Loss of public access availability (in particular, limited or lack of access infrastructure to the marine estate, loss of public access)

## 5 Integrating the Environmental, Social, Cultural and Economic Assessments

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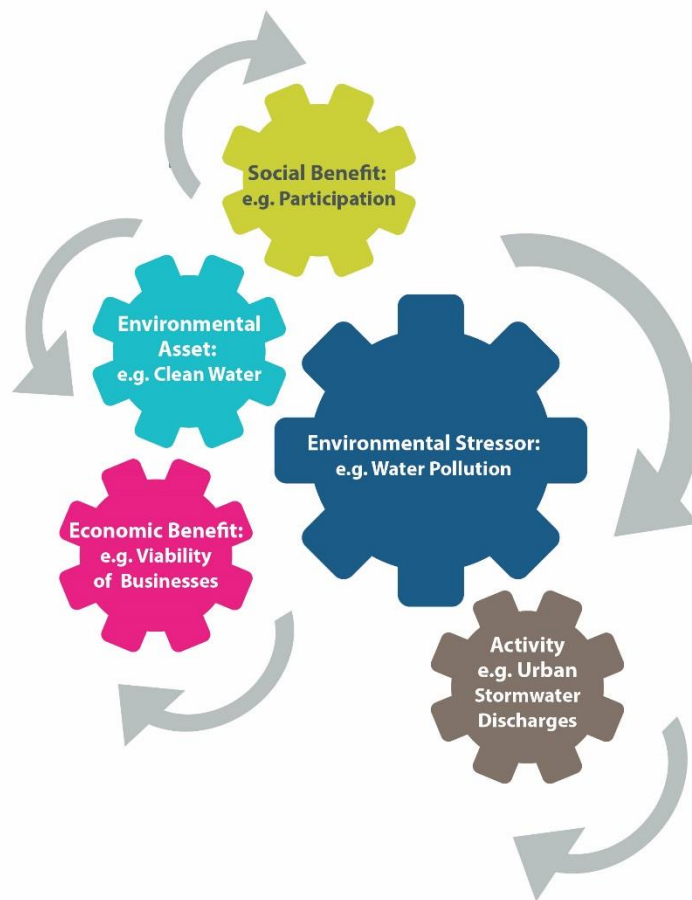
### 5.1 Linkages between the Assessments

It is recognised by the TARA process that many of the environmental, social, cultural 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, cultural and economic uses of the marine estate which, in turn, provide social, cultural 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, cultural 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, cultural and economic benefits (such as participation and enjoyment of them marine estate as key social values).



**Figure 5-1 The Social, Cultural 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, Cultural 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, cultural 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, Cultural 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, cultural and economic benefits of the marine estate.

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

Integrating the Environmental, Social, Cultural and Economic Assessments

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’.

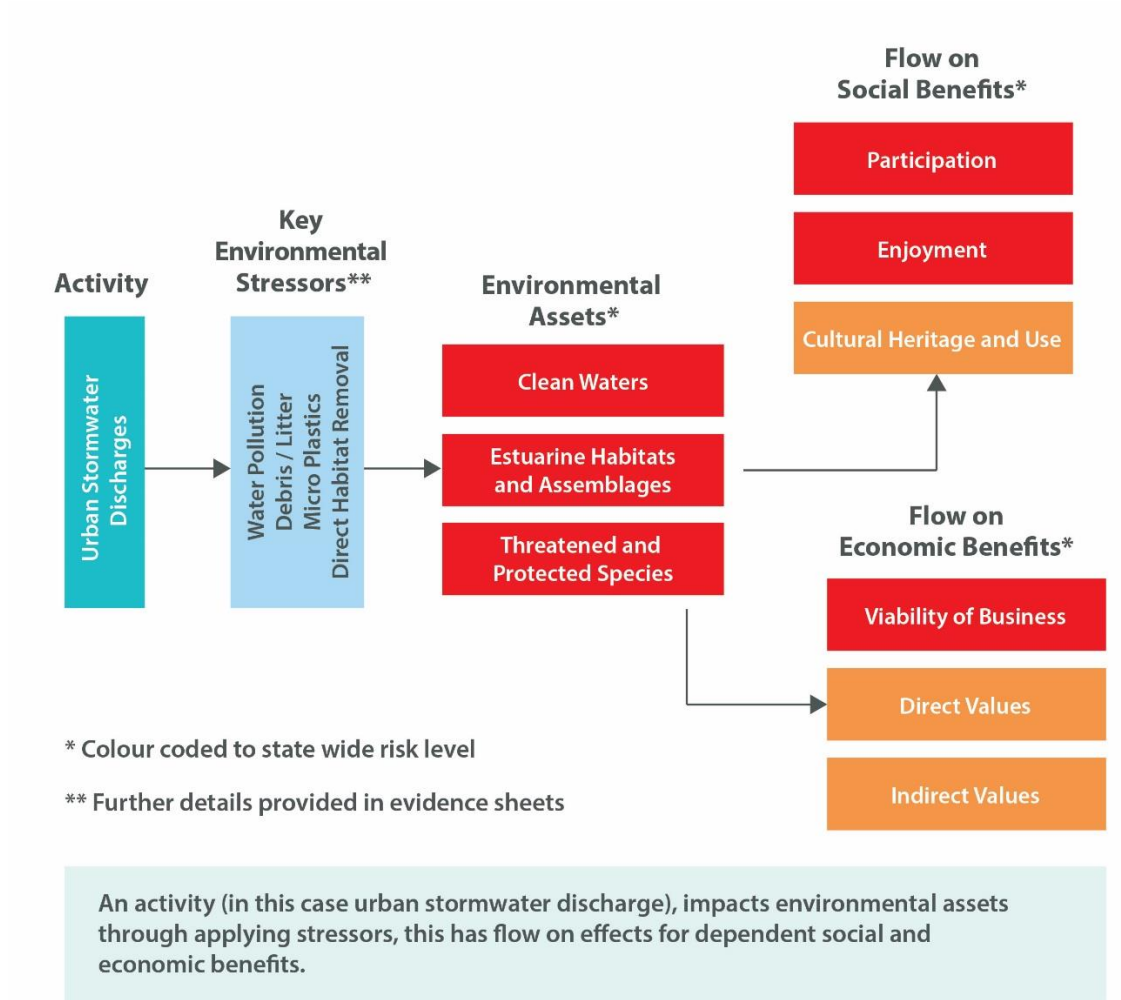


Figure 5-2 Relationship between Activities, Stressors, Environmental Assets and flow on Social and Economic Benefits

Integrating the Environmental, Social, Cultural and Economic Assessments

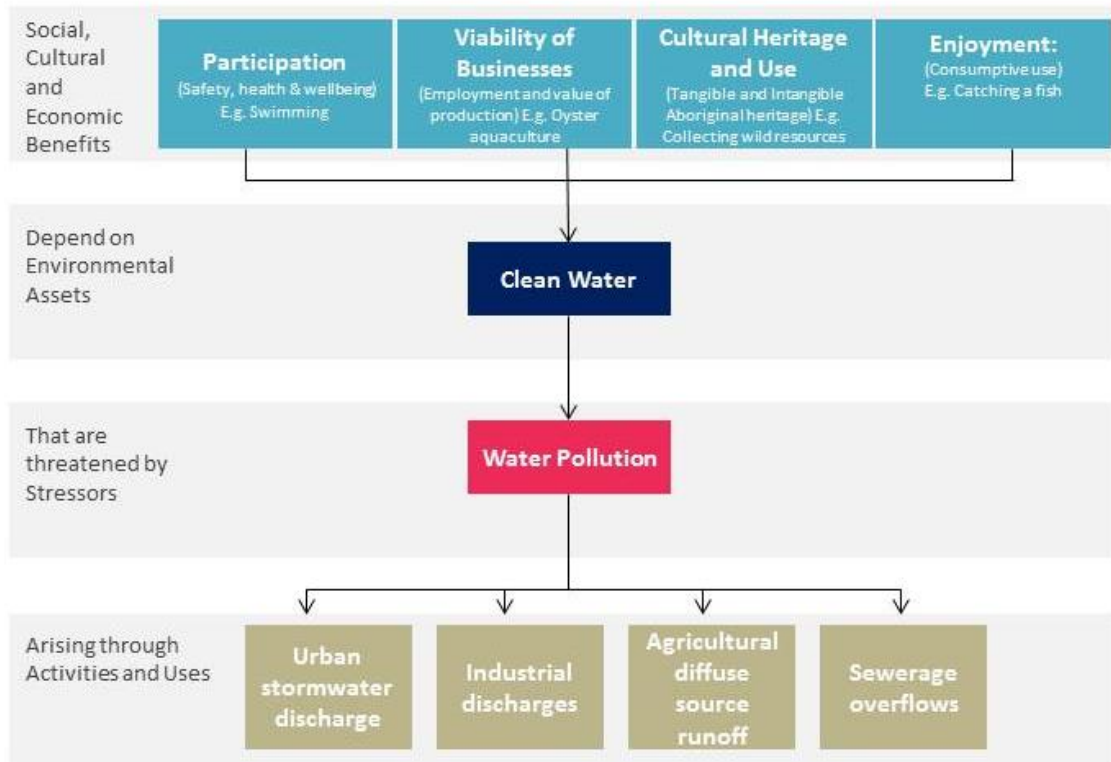


Figure 5-3 Social, cultural and Economic Benefit Dependencies and Threats

As discussed in Section 1, The outputs of the TARA will be used as a key input to inform the development of management responses at a Statewide scale, as well as regional and local scales. The latter primarily being addressed through new marine park management plans, which will commence with the Solitary Islands and Batemans Marine Park. 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, Cultural 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, Cultural 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, Cultural and Economic Benefits - Statewide	Shared Priority Threats across Assets and Benefits Statewide
<ul style="list-style-type: none"> <li>• Urban stormwater discharge</li> <li>• Estuary entrance modifications</li> <li>• Agricultural diffuse source runoff (in estuaries)</li> <li>• Clearing riparian and adjacent habitat including wetland drainage</li> <li>• Climate change stressors 20 year timeframe (sea level rise, altered storm/cyclone activity, flooding, climate and sea temperature rise, altered ocean currents and nutrient inputs)</li> <li>• Modified freshwater flows (in estuaries)</li> <li>• Foreshore development</li> <li>• Recreation- Boating and boating infrastructure (in estuaries)</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 (in estuaries)</li> <li>• Four wheel driving</li> <li>• Recreational fishing -boat-based line and trap fishing</li> <li>• Passive recreational use</li> <li>• Recreational fishing-shore-based line and trap fishing</li> <li>• Beach nourishment and grooming</li> <li>• Commercial fishing -ocean trawl (in coast and marine waters)</li> <li>• Commercial fishing - ocean trap and line (in coast and marine waters)</li> <li>• Commercial fishing- estuary general (in estuaries)</li> <li>• Deliberate introduction of plants and animals (e.g. foxes, Bitou bush)</li> <li>• Shipping- small commercial vessels</li> <li>• Oyster aquaculture (in estuaries)</li> <li>• Commercial fishing-ocean haul (in coastal and marine waters)</li> <li>• Recreational fishing- hand gathering</li> <li>• Whale and dolphin watching</li> </ul>	<ul style="list-style-type: none"> <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>• Inadequate social and economic information</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>• Reductions in abundances of species and trophic levels</li> <li>• Anti-social behaviour and unsafe practices</li> <li>• Climate change stressors 20 year time frame (sea level rise, altered storm/cyclone activity, flooding, climate and sea temperature rise, altered ocean currents and nutrient inputs)</li> <li>• Loss of public access (either by private development or Government area closures)</li> <li>• Inadequate, inefficient regulation, over-regulation (agencies)</li> <li>• Pests and diseases</li> <li>• Sediment contamination</li> <li>• Overcrowding / congestion</li> <li>• Conflict over resource access and use</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 or decline of marine industries</li> <li>• Seafood contamination</li> <li>• Modified hydrology/hydraulics and flow regime</li> <li>• Water pollution on environmental values - septic runoff, point source pollution and sewage overflows (such as outfalls, STPs, etc.) and</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>• Lack of or ineffective community engagement or participation in governance</li> <li>• Other water pollution/contamination affecting human health and safety</li> <li>• Excessive or illegal extraction</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, cultural 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 for the North Region

Ranked Priority Threats to Environmental Assets for the North Region	Ranked Priority Threats to Social, Cultural 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>• Estuary entrance modifications</li> <li>• Clearing riparian and adjacent habitat including wetland drainage (in estuaries)</li> <li>• Agricultural diffuse source runoff (in estuaries)</li> <li>• Climate Change (20yrs)</li> <li>• Urban stormwater discharge (in estuaries)</li> <li>• Modified Freshwater flows (in estuaries)</li> <li>• Recreation and tourism -Boating and boating infrastructure (in estuaries)</li> <li>• Recreation and tourism - Four wheel driving</li> <li>• Foreshore development</li> <li>• Navigation &amp; entrance management and modification, harbour maintenance, etc. (in estuaries)</li> <li>• Sewage effluent and septic runoff</li> <li>• Stock grazing of riparian and marine vegetation (in estuaries)</li> <li>• Commercial fishing - Ocean Trawl (in coastal and marine)</li> <li>• Recreational fishing - Shore-based line and trap fishing</li> <li>• Recreational fishing - Boat-based line and trap fishing</li> <li>• Commercial fishing - Ocean Trap and Line (in coastal and marine)</li> <li>• Commercial fishing - Estuary General (in estuaries)</li> <li>• Passive recreational use</li> <li>• Deliberate introduction of plants and animals (e.g. foxes, bitou bush)</li> <li>• Recreational fishing - Hand Gathering</li> <li>• Oyster Aquaculture (in estuaries)</li> <li>• Commercial fishing - Ocean Haul (in coastal and marine)</li> <li>• Charter activities - whale and dolphin watching</li> <li>• Beach nourishment and grooming</li> <li>• Shipping - Small commercial (in coast and marine)</li> <li>• Commercial Fishing - Estuary Prawn Trawl (in estuaries)</li> </ul>	<ul style="list-style-type: none"> <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>• Inadequate social and economic information</li> <li>• Lack of compliance with regulations (by users) or lack of compliance effort (by agencies)</li> <li>• Reductions in abundances of species and trophic levels</li> <li>• Limited or lack of access infrastructure to the marine estate</li> <li>• Anti-social behaviour and unsafe practices</li> <li>• Climate change stressors 20 years</li> <li>• Loss of public access (either by private development or Government area closures)</li> <li>• Inadequate, inefficient regulation, over-regulation (agencies)</li> <li>• Loss or decline of marine industries</li> <li>• Pests and diseases</li> <li>• Conflict over resource access and use</li> <li>• Habitat (physical) disturbance</li> <li>• Overcrowding / congestion</li> <li>• Water pollution on environmental values - septic runoff, point source pollution and sewage overflows (such as outfalls, STPs, etc.) and</li> <li>• Modified hydrology/hydraulics and f regime</li> <li>• Wildlife disturbance (shorebirds, turtles, whales) and impacts to ecological health 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>• Sediment contamination</li> <li>• Lack of or ineffective community engagement or participation in governance</li> <li>• Other water pollution/contamination affecting human health and safety</li> <li>• Excessive or illegal extraction</li> <li>• Wildlife interactions (e.g. shark bite, jellyfish, boat striking a whale)</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, cultural 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 for the Central Region

Ranked Priority Threats to Environmental Assets for the Central Region	Ranked Priority Threats to Social, Cultural 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>• Foreshore development</li> <li>• Estuary entrance modifications (in estuaries)</li> <li>• Shipping - Large commercial vessels and associated port activities and industries (trade ships, cruise ships, etc.)</li> <li>• Agricultural diffuse source runoff (in estuaries)</li> <li>• Clearing riparian and adjacent habitat including wetland drainage</li> <li>• Climate change 20 years</li> <li>• Recreational Boating - Boating and boating infrastructure (in estuaries)</li> <li>• Sewage effluent and septic runoff</li> <li>• Navigation &amp; entrance management and modification, harbour maintenance, etc.</li> <li>• Modified Freshwater flows - Modified freshwater flows (in estuaries)</li> <li>• Industrial discharges (in estuaries)</li> <li>• Recreation and tourism – Four wheel driving</li> <li>• Stock grazing of riparian and marine vegetation (in estuaries)</li> <li>• Small commercial vessels (ferries, charter boats, whale watching vessels, fishing vessels etc) (in estuaries)</li> <li>• Beach nourishment and grooming</li> <li>• Service infrastructure – pipes, cables trenching and boring (in estuaries)</li> <li>• Recreational fishing – Shore-based line and trap fishing</li> <li>• Recreational fishing – Boat-based line and trap fishing</li> <li>• Recreation and tourism – Passive recreational Use</li> <li>• Thermal discharges (in estuaries)</li> <li>• Commercial fishing - Ocean Trawl</li> <li>• Recreation and tourism - Shark control measures</li> <li>• Commercial fishing – Estuary general (in estuaries)</li> <li>• Oyster aquaculture (in estuaries)</li> <li>• Recreational fishing – Hand gathering</li> <li>• Mining and extractive industries (in estuaries)</li> <li>• Commercial fishing - Ocean Trap and Line (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> </ul>	<ul style="list-style-type: none"> <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>• Sediment contamination (toxicants in sediment; dioxins in Sydney Harbour, Cooks River)</li> <li>• Inadequate social and economic information</li> <li>• Anti-social behaviour and unsafe practices</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>• Reductions in abundances of species and trophic levels</li> <li>• Climate change stressors 20 years</li> <li>• Inadequate, inefficient regulation, over-regulation (agencies)</li> <li>• Overcrowding / congestion</li> <li>• Seafood contamination</li> <li>• Loss of public access (either by private development or Government area closures)</li> <li>• Pests and diseases</li> <li>• Conflict over resource access and use</li> <li>• Habitat (physical) disturbance</li> <li>• Modified hydrology/hydraulics and f regime</li> <li>• Wildlife disturbance (shorebirds, turtles, whales) and impacts to ecological health 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>• Water pollution on environmental values - septic runoff, point source pollution and sewage overflows (such as outfalls, STPs, etc) and</li> <li>• Lack of or ineffective community engagement or participation in governance</li> <li>• Other water pollution/contamination affecting human health and</li> <li>• Excessive or illegal extraction</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, cultural 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 for the South Region

Ranked Priority Threats to Environmental Assets for the South Region	Ranked Priority Threats to Social, Cultural 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>• Agricultural diffuse source runoff (in estuaries)</li> <li>• Estuary entrance modifications</li> <li>• Urban stormwater discharge</li> <li>• Modified Freshwater flows - Modified freshwater flows (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>• Foreshore development</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>• Recreation and Tourism – four wheel driving (in estuaries)</li> <li>• Recreational fishing - Boat-based line and trap fishing</li> <li>• Deliberate introduction of plants and animals (e.g. foxes, bitou bush)</li> <li>• Passive Recreational Use</li> <li>• Commercial fishing – Estuary General</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>• Charter activities – Whale and dolphin watching</li> <li>• Commercial fishing - Ocean Trap and Line</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>• Shipping - Small commercial</li> <li>• Shipping – Large commercial (in estuaries)</li> </ul>	<ul style="list-style-type: none"> <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>• Inadequate social and economic information</li> <li>• Lack of compliance with regulations (by users) or lack of compliance effort (by agencies)</li> <li>• Reductions in abundances of species and trophic levels</li> <li>• Limited or lack of access infrastructure to the marine estate</li> <li>• Climate change stressors 20 years</li> <li>• Loss of public access (either by private development or Government area closures)</li> <li>• Anti-social behaviour and unsafe practices</li> <li>• Inadequate, inefficient regulation, over-regulation (agencies)</li> <li>• Loss or decline of marine industries</li> <li>• Pests and diseases</li> <li>• Conflict over resource access and use</li> <li>• Habitat (physical) disturbance</li> <li>• Overcrowding / congestion</li> <li>• Water pollution on environmental values - septic runoff, point source pollution and sewage overflows (such as outfalls, STPs, etc.) and</li> <li>• Modified hydrology/hydraulics and regime</li> <li>• Wildlife disturbance (shorebirds, turtles, whales) and impacts to ecological health 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>• Excessive or illegal extraction</li> <li>• Sediment contamination (</li> <li>• Lack of or ineffective community engagement or participation in governance</li> <li>• Other water pollution/contamination affecting human health and safety</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, cultural and economic TARAs. Other threats will overlap between the two TARA priority lists however they are not directly equivalent.</i></p>

## 6 MEEKP Evaluation Process

### 6.1 Risk Evaluation Process

Building on the lessons learned from the Hawkesbury Shelf marine bioregion TARA pilot project, a formal risk evaluation process was undertaken at the conclusion of the Statewide TARA by the Marine Estate Expert Knowledge Panel (MEEKP) as part of a full day workshop undertaken on 26 May 2016 (refer Appendix B).

Consistent with ISO 31000 (see Figure 6-1), this risk evaluation was undertaken following the initial risk identification and risk analysis (consequence vs likelihood) workshops undertaken by the agencies and independent experts – with the completed risk assessment tables and associated evidence tables used as the basis for the evaluation.

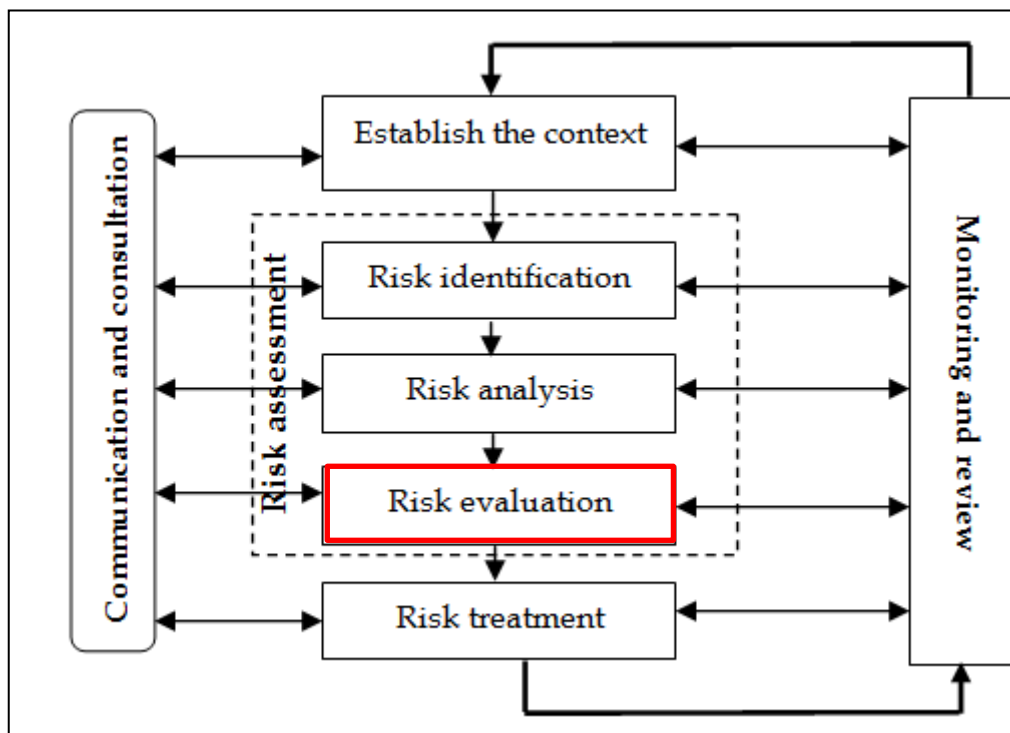


Figure 6-1 Risk Evaluation within the Risk Assessment Process (ISO 31000)

In a general sense (and consistent with best practice risk assessment), the overarching aims of the risk evaluation process was to re-affirm the judgements made during the risk analysis, to assess the prioritisation of the risks (in particular those threats that had received a ‘high’ or ‘moderate’ risk rating out of the initial TARA outputs) and to identify those threats for which more detailed analysis was recommended.

More specifically, the risk evaluation workshop sought to address the following matters that MEEKP recommended be further considered as part of the Statewide TARA process:

- **Historic threats and shifted baselines (legacy issues)** – review 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, cultural and

economic benefits to further change, and to determine if some assets or benefits were at some form of ecological and/or social, cultural 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, Cultural 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, cultural 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).

### 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
- Aboriginal cultural heritage and use
- Threatened species protected under the Biodiversity Conservation Act 2016

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.

## 8 References

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## 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 <b>at a Statewide scale</b>,</p> <p>or</p> <p>catastrophic impacts 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 MEMA Agency and MEEKP Technical Workshops

Workshop Date	Details
August 2015	Technical Workshop for the Environmental TARA – Hawkesbury Shelf marine bioregion
August 2015	Technical Workshop for the Social, Cultural and Economic TARA - Hawkesbury Shelf marine bioregion and Draft Statewide Assessment
Feb 2016	Technical Workshop for the Environmental TARA – Draft Statewide Assessment
May 2016	Evaluation Workshop for the Draft Statewide Assessment – Marine Estate Expert Knowledge Panel (MEEKP)
July 2016	Additional (Verification) Workshop for the Social, Cultural and Economic TARA – Draft Statewide Assessment
June 2017	Technical Workshop for Aboriginal Cultural Heritage aspects of the Social, Cultural and Economic TARA – Final Statewide Assessment
June 2017	Technical Workshop for Social and Economic aspects of the Social, Cultural and Economic TARA - Final Statewide Assessment
June 2017	Technical Workshop for the Environmental TARA – Final Statewide Assessment

## Appendix C Environmental Risk Matrices and Evidence

Estuaries	Clean waters			Estuarine Habitats and Assemblages															Threatened and Protected Species																	
	Estuarine waters			Saltmarsh			Mangrove			Seagrass			Beach and Mudflats			Shallow Soft Sediments			Rocky Shores			Subtidal Reefs			Planktonic Assemblages			Fish assemblages (harvest and bycatch)			Species and communities protected under FMA	Species protected under BCA				
Resource use		Region			North			Central			South			North			Central			South			North			Central			South			North	Central		South	
Shipping	Large commercial vessels and associated port activities and industries (trade ships, cruise ships, etc.)	Low	Moderate	Low	Minimal	Moderate	Minimal	Moderate	Minimal	Moderate	Minimal	Moderate	Minimal	Moderate	Minimal	Moderate	Minimal	Moderate	Minimal	Moderate	Minimal	Moderate	Minimal	Moderate	Minimal	Moderate	Minimal	Moderate	Minimal	Moderate	Minimal	Moderate	Minimal	Moderate		
	Small commercial vessels (ferries, charter boats etc.)	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low		
Commercial fishing	Estuary General	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal		
	Estuary Prawn Trawl	Low	Minimal	N/A	Minimal	Minimal	N/A	Minimal	Minimal	N/A	Low	Low	N/A	Low	Low	N/A	Low	Low	N/A	Low	Low	N/A	Low	Low	N/A	Low	Low	N/A	Low	Low	N/A	Low	Low	N/A		
Charter fishing	Line fishing	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal		
Recreational fishing	Shore-based line and trap fishing	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low			
	Boat-based line and trap fishing	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low			
	Spearfishing	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
	Hand gathering	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low		
	Fish stocking (prawns, other species)	N/A	Minimal	Minimal	N/A	Minimal	Minimal	Minimal	N/A	N/A	Minimal	Minimal	Minimal	Minimal	N/A	N/A	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	
Aboriginal Cultural Fishing (permitted or part of native title rights)	Line fishing, spearfishing, hand gathering, traditional fishing methods, related cultural traditions	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal		
Charter activities	Whale and dolphin watching	Minimal	Minimal	Minimal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
Aquaculture	Oyster aquaculture	Low	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low		
Aquaculture	Mussel farms	N/A	N/A	Minimal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
Aquaculture	Prawn farms	Low	N/A	N/A	Minimal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
Bait and aquarium trade	Imported baits, imported fish and other aquatic species	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal		
Research and education	Collecting, sampling and tagging	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal		
Recreation and tourism	Boating and boating infrastructure	Moderate	Moderate	Moderate	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low			
	Snorkelling and diving, and other rec use	Minimal	Minimal	Minimal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
	Passive recreational use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	
Four wheel driving	Four wheel driving	Low	Low	Low	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	Moderate	Moderate	Moderate		
	Deadging (including Placement)	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low		
Modified freshwater flows	Extraction, artificial barriers to riverine and estuarine flow (e.g. dams, weirs, waterway crossings, floodgates), urban drainage, impervious surfaces, flood mitigation	High	High	High	High	High	High	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		
Mining and extractive industries	Oil, gas, minerals, sand, aggregate, coal mining	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal		
Service infrastructure	Pipelines, cables, trenching and boring	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	
Land-based impacts		Urban stormwater discharge			High			High			High			Moderate			Moderate			Moderate			Moderate			Moderate			Moderate	Moderate		Moderate				
Foreshore development		Low			Low			Low			Moderate			High			Moderate			Moderate			Moderate			Moderate			Moderate	Moderate		Moderate				
Beach nourishment and grooming		Minimal			Low			Minimal			Minimal			Low			Moderate			Low			Low			Low			Minimal			N/A	N/A		N/A	
Clearing riparian and adjacent habitat including wetland drainage		High			High			High			High			High			High			High			High			High			High			High	High		High	
Agricultural diffuse source runoff		High			High			High			High			High			High			High			High			High			High			High	High		High	
Stock grazing of riparian and marine vegetation		Low			Low			Low			High			High			High			High			High			High			High			High	High		High	

Shaded Cells indicate local scale risks (Moderate and High risks only)



Coastal and marine waters		Clean waters			Marine Habitats and Associated Biota												Threatened and Protected Species																				
		Ocean waters			Beaches			Shallow soft sediments			Deep soft sediments			Rocky Shores			Shallow Reefs			Deep Reefs			Planktonic Assemblages			Fish Assemblages (harvest and bycatch)			Species and communities protected under FMA			Species protected under BCA					
Resource Use		Region																																			
		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	North	Central	South	North	Central	South	North	Central	South
Shipping	Large commercial vessels and associated port activities and industries (trade ships, cruise ships, etc.)	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal
	Small commercial vessels (ferries, charter boats etc.)	Low	Low	Low	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal
Commercial fishing	Ocean Trap and Line	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
	Ocean Trawl	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
	Ocean Haul	Minimal	Minimal	Minimal	Moderate	Moderate	Moderate	Minimal	Minimal	Minimal	Moderate	Moderate	Moderate	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
	Sea urchin and turban shells	Minimal	Minimal	Minimal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Lobster	Minimal	Minimal	Minimal	NA	NA	NA	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Abalone	Minimal	Minimal	Minimal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Charter fishing	Line fishing	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
	Shore-based line and trap fishing	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
	Boat-based line and trap fishing	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
	Spearfishing	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Recreational fishing	Hand Gathering	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
	Aboriginal Cultural fishing (including permitted as well as native title rights)	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Charter activities	Whale and dolphin watching	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Aquaculture	Fish farming	NA	NA	Minimal	NA	NA	NA	Minimal	Minimal	Minimal	Low	NA	NA	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Raft and aquarism trade	Imported bait, imported fish and other aquatic sp.	Minimal	Minimal	Minimal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Research and education	Collecting, sampling and tagging	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Recreation and tourism	Boating and boating infrastructure	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
	Snorkelling and diving	Minimal	Minimal	Minimal	NA	NA	NA	NA	NA	NA	NA	NA	NA	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
	Passive recreational use	Minimal	Minimal	Minimal	Low	Moderate	Low	NA	NA	NA	NA	NA	NA	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
	Four wheel driving	Minimal	Minimal	NA	High	High	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Shark control measures	NA	NA	NA	Minimal	Minimal	Minimal	NA	NA	NA	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Druiding (includes placement)	Navigation & entrance management and modification, harbour maintenance etc.	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Moderate	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Modified freshwater flows	Extraction, artificial barriers to estuarine flow	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Mining and extractive industries	Oil, gas, minerals, sand, aggregate, mining coal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Service infrastructure	Pipelines, cables, trenching and boring	NA	Low	NA	NA	NA	NA	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Land-based impacts																																					
Landuse intensification	Urban stormwater discharge	Low	Low	Low	Moderate	Moderate	Moderate	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
	Freeshore development	Minimal	Minimal	Minimal	Moderate	High	Moderate	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
	Beach nourishment and grooming	NA	NA	NA	Moderate	Moderate	Moderate	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
	Clearing riparian and adjacent habitat including wetland drainage	Minimal	Minimal	Minimal	Low	Moderate	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal

Shaded Cells indicate local scale threats (moderate and high only)



## Appendix C Environmental Risk Matrices and Evidence

## Statewide Risk Assessment – Estuaries

## Estuarine waters

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 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.	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.	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.	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.	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.	A	L:
	Prawn farms	North	Low	minor	likely	<b>Water pollution</b> – due to sediment re-suspension, with impacts minor at a local scale.	A	L
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	A	L: marinas, mooring areas in larger 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
						would occur due to the amount of vessel activity in the identified 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.	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.	A	L: Many large estuaries
Modified freshwater flows	Extraction, artificial barriers to riverine and estuarine flow (e.g. dams, weirs, waterway crossings, floodgates)	All	High	major	almost certain	<b>Water pollution</b> – major impacts likely to occur from acid sulfate soils leaching and reducing pH which were considered almost certain to occur.	L	R: Numerous estuaries, particularly Tweed, Brunswick, Macleay, Richmond, Clarence, Macleay, Manning, Hunter, Shoalhaven
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.	L	L
Service infrastructure	Pipelines, cables, trenching and boring	Central	low	minor	likely	<b>Water pollution</b> - minor impacts likely due to suspended sediments.	L	L: Botany Bay
<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.	A	R: Central -majority of estuaries have urban runoff L: North and south - specific estuaries with urban runoff

## 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	low	minor	almost certain	<b>Water pollution</b> - minor impacts almost certain from combined stressors of toxic contaminants, nutrients and suspended sediments.	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.	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.	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.	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 nutrients via defecation.	A	R: all estuaries where grazing occurs
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.	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.	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	A	L: Lake Mac, Lake Illawarra

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
						and changing dissolved oxygen within the affected system.		
	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.	A	L: Restricted to estuaries with specific discharges
		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 contaminants, primarily from overflows, except from the Hunter and Hawkesbury.	A	R: Hunter River, Lake Macquarie, Sydney Harbour, Tuggerah, Hawkesbury
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.	A	R: occurs in a majority of estuaries
<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.	L	R: Mainly drowned river valleys
	Climate and sea temp. rise	North Central	moderate	moderate	likely	<b>Elevated temperatures</b> - moderate effects on water quality due to increased temperatures.	L	R: Mainly wave dominated estuaries
		South	low	minor	likely	<b>Elevated temperatures</b> - minor water quality effects due to reduced temperature increases in the south.	I	R: Mainly wave dominated estuaries
	Ocean acidification	All	low	minor	likely	<b>Increased acidity</b> - minor water quality effects likely.	I	R: Mainly wave dominated estuaries and drowned 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
								valleys
	Altered storm/cyclone activity	North	moderate	moderate	likely	<b>Physical disturbance</b> - intensity of storms will result in re-suspending sediments.	L	R: Mainly drowned river valleys
	Altered storm/cyclone activity (including flooding, storm surge, inundation)	Central South	low	minor	likely	<b>Physical disturbance</b> - intensity of storms will result in re-suspending sediments, and vegetation death causes decreasing water quality (limited to coastal lagoons).	L	R: Drowned river valleys, 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.	L	R: Drowned river valleys
		Central South	low	moderate	possible	<b>Nutrient changes</b> - moderate effects on water quality possible due to changing nutrient inputs.	L	R: Drowned river valleys
	Climate and sea temp. rise	North	high	major	likely	<b>Elevated temperatures</b> - major effects on water quality due to increased temperatures.	L	R: wave dominated estuaries
		Central South	moderate	moderate	likely	<b>Elevated temperatures</b> - moderate water quality effects likely, mainly in drowned river valleys.	I	R: wave dominated estuaries
	Ocean acidification	All	moderate	moderate	likely	<b>Increased acidity</b> - moderate water quality effects, mainly in drowned river valleys.	I	R: Drowned river valleys
	Altered storm/cyclone activity (including flooding, storm surge, inundation)	North	high	major	likely	<b>Physical disturbance</b> - intensity of storms re-suspending sediments and increasing catchment runoff.	I	R: Drowned river valleys, coastal lagoons and wave dominated
		Central South	moderate	moderate	likely	<b>Physical disturbance</b> - intensity of storms re-suspending sediments and increasing catchment runoff.	I	R: Drowned river valleys

## 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.	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.	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.	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.	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, although some illegal activity. Major impacts possible in localised areas.	A	L: Stockton-Hunter, and in other regions, particularly coastal lagoons
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.	L	L: Most large estuaries, particularly Hunter River

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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
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.	A	R: 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 likely due to physical disturbance.	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.	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.	A	R: All estuaries (where present)
	Foreshore development	Central	high	major	likely	<b>Physical disturbance</b> – major impacts likely due to direct habitat removal and destruction in some areas. Development of foreshore historically meant removing/infilling of saltmarsh. Likely under current management.	A	R: majority of estuaries
		North South	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.	A	L: 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
	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.	A	R: majority of 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.	A	R: 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.	L	R: Restricted to estuaries with agricultural catchments
	Stock grazing of riparian and marine vegetation	All	high	major	almost certain	<b>Physical disturbance, water pollution</b> – major impacts considered almost certain from the physical disturbance from trampling and grazing and nutrients via defecation.	A	R: all estuaries where grazing occurs
	Deliberate introduction of animals and plants (e.g. foxes, dogs, cats, bitou bush)	All	low	minor	likely	<b>Physical disturbance</b> – minor impacts likely from pests that result in habitat changes and encroachment.	A	R
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	L	L: estuaries where discharges occur

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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
						impact biota. Only possible under current management.		
	Sewage effluent and septic runoff	All	low	moderate	possible	<b>Water pollution</b> – moderate impacts from elevated nutrients and sediments, and lowered salinity would affect biota, but considered possible under current management.	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.	A	R: All estuaries (where present)
<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> - experimental studies show response and expected change is greater than thresholds. Resilient systems	I	R
	Ocean acidification	All	low	minor	likely	<b>Increased acidity</b> - experimental studies show response and expected pH change is greater than thresholds.	I	R
	Altered storm/cyclone activity (including flooding, storm surge, inundation)	All	low	moderate	possible	<b>Physical disturbance</b> - tolerant of abiotic stress, but increased nutrient and sediment runoff may be result in moderate impacts. - Increased nutrient and sediment runoff may be significant, with moderate impacts possible.	I	R
	Sea level rise	All	moderate	moderate	almost certain	<b>Physical disturbance</b> – habitat almost certain to be inundated, limited chances to expand range.	A	R
<b>Climate change</b>	<b>50 years</b>							



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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
	Climate and sea temperature rise	North	high	major	likely	<b>Elevated temperatures</b> - experimental studies show response and expected change is greater than thresholds. Resilient systems	I	R
		Central South	moderate	moderate	likely	<b>Elevated temperatures</b> - experimental studies show response and expected change is greater than thresholds. Resilient systems	I	R
	Ocean acidification	All	moderate	moderate	likely	<b>Increased acidity</b> - experimental studies show response and expected pH change is greater than thresholds.	I	R
	Altered storm/cyclone activity (including flooding, storm surge, inundation)	All	moderate	moderate	likely	<b>Physical disturbance</b> - tolerant of abiotic stress, but increased nutrient and sediment runoff may be significant. 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> - habitat will be inundated, limited chances to expand range, with major impacts almost certain.	L	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.	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.	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.	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.	L	R
Recreational fishing	Shore-based line and trap fishing	All	low	minor	likely	<b>Physical disturbance</b> –minor impacts are likely due to shore-based activities.	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.	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.	A	L
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	L	R: Most large estuaries, particularly Hunter River Hawkesbury

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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
						stressors from the activity (e.g. fuel spills, physical disturbance) and the moderate resilience of the habitat to these impacts.		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.	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.	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 inundation regimes which results in prevention of inundation by floodgates and very broad overall impacts.	A	L
Mining and extractive industries	Oil, gas, minerals, sand, aggregate, coal mining	Central	Low	minor	likely	<b>Physical disturbance</b> – only minor impacts considered likely.	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.	A	R: most estuaries
<b>Land-based impacts</b>								
Landuse Intensification	Urban stormwater discharge	All	moderate	moderate	likely	<b>Water pollution, marine debris</b> – moderate impacts considered likely due to	L	R: Central Estuaries with mangroves near

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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
						increased nutrients, contaminants and sediments and reduced salinities which impact biota in mangroves.		urban areas L: North and south with mangroves in urban areas
	Foreshore development	All	moderate	moderate	likely	<b>Physical disturbance</b> – moderate impacts likely due to direct habitat removal and destruction in some areas. Development of foreshore historically meant removing/infilling of mangroves. Possible under current management.	L	R : Central – in majority of estuaries with mangroves L: North and south – restricted to estuaries with mangroves in urban areas
	Clearing riparian and adjacent habitat including wetland drainage	North Central	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 likely, especially in rural catchments.	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.	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 on associated biota. Surface water carries nutrients and is likely to enter mangroves via overland flow.	L	R: Restricted to estuaries with agricultural catchments

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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
	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.	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 contaminant concentrations negatively impact biota. Only possible under current management.	L	L: estuaries where discharges occur
	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.	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.	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							
	Climate and sea temperature rise	All	low	moderate	possible	<b>Elevated temperatures</b> - resilient systems, though moderate effects possible.	I	R
	Ocean acidification	All	low	minor	likely	<b>Increased acidity</b> - minor impact on molluscs and other calcifying organisms likely.	I	R
	Sea level rise	All	low	minor	almost certain	<b>Physical disturbance</b> – increased water levels will result in landward expansion, but may not be able to expand in some	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
						estuaries.		
<b>Climate change</b>	<b>50 year</b>							
	Climate and sea temperature rise	All	moderate	moderate	likely	<b>Elevated temperatures</b> - resilient systems, though moderate effects likely.	I	R
	Ocean acidification	All	moderate	moderate	likely	<b>Increased acidity</b> - moderate impact on molluscs and other calcifying organisms likely.	I	R
	Altered storm/cyclone activity (including 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
	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 occur.	A	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.	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.	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.	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.	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 re-suspension were considered likely to occur from this activity at a local scale under current management arrangements, and only at a local scale.	L	L: Estuaries where prawn trawling occurs
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 but in many estuaries.	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	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
						scale. It was considered possible that this level of impact would occur from this activity under current management arrangements.		
	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.	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 light limitation. Low resilience of components of the habitat to these impacts (i.e. <i>Posidonia</i> ).	A	L – Central: principally in Brisbane Waters. North : principally Port Stephens and Wallis Lake. South: estuaries where activity occurs
Bait and aquarium trade	Imported baits, imported fish and other aquatic species	All	low	minor	likely	<b>Pests and disease</b> – minor impacts expected to be likely on biota associated with seagrass	L	L
Recreation and tourism	Boating and boating infrastructure	All	high	major	almost certain	<b>Physical disturbance, water pollution, antifouling</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.	A	R: all estuaries where recreational boating and related infrastructure 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
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	moderate	moderate	likely	<b>Changes to tidal flow and patterns</b> – moderate impacts likely through changed water table and inundation regimes and broad overall impacts.	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.	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 likely, but pulsed impacts at time of construction and mostly highly localised. Removal of <i>Posidonia</i> leads to damage.	L	R: Botany Bay, Lake Macquarie, 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.	A	L
		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.	A	R: All estuaries and some coastal lagoons
	Foreshore development	All	low	moderate	possible	<b>Physical disturbance, changes to tidal flow velocity and patterns</b> – moderate	A	R: All estuaries where nearshore 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
						impacts possible due to direct habitat removal and destruction in some areas. Development of foreshore historically meant removing/ infilling of some seagrass areas.		(including ), in particularly 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.	A	L: some estuaries
		Central	moderate	moderate	likely	<b>Physical disturbance</b> – moderate impacts likely 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.	A	R: most estuaries, particularly Tuggerah Lakes
	Clearing riparian and adjacent habitat including wetland drainage	North South	moderate	moderate	likely	<b>Physical disturbance, changes to tidal flow velocity and patterns</b> – moderate 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.	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.	L	R: Estuaries with seagrass
	Agricultural diffuse source runoff	North South	High	major	almost certain	<b>Water pollution, sedimentation</b> – major impacts on both seagrass and associated	A	R: Restricted to estuaries with

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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
						biota almost certain due to elevated nutrients, sediments, potential contaminants and turbidity, and sedimentation.		agricultural catchments
		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.	A	R: Estuaries with seagrass and agriculture catchment, e.g. Hawkesbury, Hunter, Tuggerah, Lake Macquarie.
	Stock grazing of riparian and marine vegetation	All	high	major	likely	<b>Physical disturbance, water pollution, sedimentation</b> – major impacts considered likely from the physical disturbance from trampling and due to elevated nutrients, sediment / turbidity caused by stock grazing on adjacent riparian or marine vegetation.	A	R: all estuaries where grazing 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.	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.	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	L	R: Central - majority of 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
						runoff carries microplastics. Occurs primarily as overflows, with major impacts possible.		L: North, south: restricted to estuaries with urban development
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 other modifications.	A	R: Lake Mac, Tuggerah, Brisbane Waters, Botany Bay, Hacking, Illawarra, coastal lagoons and other regional estuaries.
<b>Climate change</b>	<b>20 Years</b> - See section 6.3.1 for further details on climate change							
	Climate and sea temp rise	North	low	moderate	possible	<b>Elevated temperatures</b> - seagrass species likely to be sensitive to increases in temp. Moderate impacts possible in time frame.	I	R
	Ocean acidification	All	low	moderate	possible	<b>Increased acidity</b> - seagrass and associated organisms sensitive to pH changes. Moderate changes possible in time frame.	L	R
	Altered storm/cyclones (including flooding, storm surge, inundation)	All	low	moderate	possible	<b>Physical disturbance</b> - sensitive to decreased salinity ( <i>Zostera</i> ), and wave action. However, moderate changes possible in time frame. Also increased turbidity, decreased water depth.	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
<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

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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
	Ocean acidification	All	moderate	moderate	likely	<b>Increased acidity</b> - seagrass and associated organisms sensitive to pH changes. Moderate changes likely in time frame.	I	R
	Altered storm/cyclones (including flooding, storm surge, inundation)	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

## 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.	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.	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.	A	L: Upper Parramatta River
		North South	low	minor	likely	<b>Physical disturbance</b> –minor impacts were considered likely due to physical disturbance and oil spills from vessel traffic.	L	R
Commercial fishing	Estuary General	Central	low	moderate	possible	<b>Physical disturbance</b> - moderate impacts possible at local scale.	I	L: Port Hacking
Recreational fishing	Shore-based line and trap fishing	All	low	minor	likely	<b>Physical disturbance</b> - minor impacts were considered likely due to trampling at a local scale.	L	R: activity occurs in a majority of estuaries
	Hand gathering	All	low	moderate	possible	<b>Physical disturbance</b> – moderate impacts were considered possible at a local scale	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
						from trampling during bait gathering, particularly of nippers.		
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.	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.	A	R: Higher impacts in Hawkesbury, Georges, Lake Macquarie, Hunter River, Sydney Harbour, Port Hacking, Pittwater, Brisbane Water
		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.	A	R: Estuaries where boating and infrastructure occurs
	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	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
						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.		
	Passive recreational use	All	moderate	moderate	likely	<b>Physical disturbance</b> - impact was considered moderate, 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. It was considered likely that this level of impact would occur, but only at a local scale where the activity occurs and where access is highest.	L	R: Central – occurs in a majority of estuaries in the region  L: North and south – localised to estuaries that have high levels of recreational use
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 opening of coastal lagoons changes habitats, exposes beaches and mudflats.	L	L: Most large estuaries, particularly Hunter River and Botany Bay
Modified freshwater flows	Extraction, artificial barriers to riverine and estuarine flow (e.g. dams, weirs,	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	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
	floodgates)					overall impacts.		
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.	L	L
Service infrastructure	Pipelines, cables, trenching and boring	Central	low	moderate	possible	<b>Physical disturbance, sedimentation and water pollution</b> – moderate impacts possible, but pulsed impacts at time of construction and mostly highly localised.	L	L: Highly modified estuaries
<b>Land-based impacts</b>								
Land-use Intensification	Urban stormwater discharge	Central	high	major	almost certain	<b>Water pollution, marine debris</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.	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.	A	L: occurs in estuaries with urban development
	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 foreshore historically meant removing/infilling of habitat. Impacts almost certain under current management.	A	R: all estuaries with sandy/muddy shorelines
		North South	moderate	moderate	almost certain	<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.	A	L: estuaries with developed foreshores
	Beach nourishment and	All	moderate	moderate	likely	<b>Physical disturbance</b> - moderate impacts	I,L	R (Central): 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
	grooming					were considered likely at a local scale due to deposition of sediment on estuary beaches changing habitat structure.		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.	L	R: occurs in a majority of estuaries
		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.	I	R: Estuaries with mudflats
	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.	A	R: Estuaries with agriculture catchments
	Deliberate introduction of animals and plants (e.g. foxes, dogs, cats, bitou bush)	All	low	minor	likely	<b>Physical disturbance</b> – minor impacts likely from pests that result in habitat changes and encroachment.	A	R
Point Discharges	Industrial discharges	Central	moderate	moderate	almost certain	<b>Water pollution</b> – moderate impacts almost certain due to elevated nutrients and sediments. Increased nutrient loads and contaminant concentrations negatively	L	R: Estuaries with industrial discharges and landuse, e.g. Hunter, Hawkesbury,

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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
						impact biota. This level of impact almost certain, with contribution from legacy pollution.		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.	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.	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.	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 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.	L	R: Hunter, Tuggerah, Illawarra
<b>Climate change</b>	<b>20 Years</b>							

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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
	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.	L	R
	Altered storm/cyclone activity (including flooding, storm surge, inundation)	All	low	minor	likely	<b>Physical disturbance</b> -beaches with limited capacity to move due to infrastructure etc., particularly in conjunction with higher sea levels, so minor impacts are likely.	I	R
	Sea level rise	All	low	minor	likely	<b>Physical disturbance</b> - some minor impacts likely if intertidal flats become submerged.	A	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.	I	R
	Altered storm/cyclone activity (including flooding, storm surge, inundation)	All	low	minor	likely	<b>Physical disturbance</b> -beaches with limited capacity to move due to infrastructure etc., particularly in conjunction with higher sea levels, so minor impacts are likely.	I	R
	Sea level rise	All	moderate	moderate	likely	<b>Physical disturbance</b> - some impact of intertidal flats become submerged, with moderate impacts likely.	A	R

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## 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.	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.	L	L: principally Sydney Harbour, Hawkesbury
		North 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 level of this activity in the identified areas.	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.	L	L: In estuaries where commercial fishing occurs
	Estuary Prawn Trawl	North Central	low	minor	likely	<b>Physical disturbance</b> –minor impacts were considered likely due to physical disturbance, including sediment resuspension and the moderate resilience of the habitat, and the level of this activity.	L	L: North: Clarence River and Lake Wooloweyah only. Central: Hunter and Hawkesbury
Recreational	Shore-based line and	All	low	minor	likely	<b>Physical disturbance</b> - minor 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
fishing	trap fishing					were considered likely at a local scale.		
	Boat-based line and trap fishing	All	low	minor	likely	<b>Physical disturbance</b> - minor impacts were considered likely at a local scale.	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.	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).	A	R: Higher impacts in Hawkesbury, Georges, Lake Macquarie, Hunter River, Sydney Harbour, Port Hacking, Pittwater, Brisbane Water
		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. 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 activity at this local scale.	L	R – Most estuaries
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.	A	L: Wherever dredging 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
Modified freshwater flows	Extraction, artificial barriers to riverine and estuarine flow (e.g. dams, weirs, floodgates)	All	moderate	moderate	likely	<b>Changes to tidal flow and patterns</b> – moderate impacts were considered likely through changed water table and inundation regimes results in very broad overall impacts which impact associated biota.	L	R Tweed, Richmond, Clarence, Macleay, Manning, Hunter, Shoalhaven
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.	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.	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.	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.	A	L
	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.	A	R: 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.	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
						Impacts almost certain under current management.		
	Beach nourishment and grooming	All	low	moderate	possible	<b>Physical disturbance</b> - moderate impacts were considered possible due to deposition of sediment in estuary changing habitat structure.	A	R: all estuaries with urban development
	Clearing riparian and adjacent habitat including wetland drainage	All	moderate	moderate	Almost certain	<b>Water pollution, changes to tidal flow velocity and patterns</b> – moderate impacts on associated biota almost certain to occur from acid sulfate soils leaching and reducing pH. Also due to altering water tables and connectivity, with impacts local, especially in rural catchments.	A	R: Tweed, Richmond, Clarence, Macleay, Manning, Hunter Shoalhaven
	Agricultural diffuse source runoff	North South	high	major	likely	<b>Water pollution</b> – major impacts due to elevated nutrients, sediments and potential contaminants. This level of impacts likely to occur.	A	R: Restricted to estuaries with agricultural catchments
		Central	moderate	major	possible	<b>Water pollution</b> - Enriches natural habitats in systems with nutrients, organic carbon from agricultural catchments. Agricultural runoff delivers nutrient enriched sediment, with major impacts considered possible.	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.	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.	A	L: Macquarie, Illawarra
	Sewage effluent and septic runoff	All	moderate	major	possible	<b>Water pollution</b> – major impacts from elevated nutrients, sediments and	I	Hawkesbury 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
						contaminants affect biota. Occurs primarily from septic runoff, although some local scale sewage, with moderate impacts possible in estuaries with high levels of septic.		
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, impacts habitat and alters currents.	A	L: Estuaries where dredging occurs, where shoreline development occurs
<b>Climate change</b>	<b>20 Years</b> - See section 6.3.1 for further details on climate change							
	Ocean acidification	All	low	moderate	likely	<b>Increased acidity</b> - larger pH changes may affect sensitive organisms such as echinoderms and molluscs, with minor impacts likely.	I	R
<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	moderate	moderate	likely	<b>Increased acidity</b> - larger pH changes may affect sensitive organisms such as echinoderms and molluscs, with moderate 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	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
						morphology, hence minor impacts are almost certain.		

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.	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.	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.	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.	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.	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 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.	A	L
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	L	R: All estuaries, but particularly Lake Macquarie, Hawkesbury River, Sydney Harbour,

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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
						through infrastructure, fuel spills) and the low resilience of components of the habitat to these impacts.		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).	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.	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.	L	L
<b>Land-based impacts</b>								
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.	I	R: 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.	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	L	L: Limited to estuaries with sizeable rocky shore habitats where development has occurred

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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.		
	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.	L	R
	Agricultural diffuse source runoff	Central South	moderate	moderate	likely	<b>Water pollution</b> – moderate impacts due to elevated nutrients, sediments and potential contaminants. This level of impact was considered likely to occur.	I	R: Hunter, Hawkesbury, Macquarie, Illawarra, Batemans Bay and other south locations
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 management.	I	L: All with industrial inputs
	Thermal discharges	Central	low	minor	likely	<b>Thermal pollution</b> –minor impacts were considered likely due to elevated water temperatures and associated biota impacts.	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.	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.	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
<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, with moderate impacts considered possible	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 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 (including flooding, storm surge, inundation)	All	low	minor	likely	<b>Physical disturbance</b> - rocky shore biota with limited capacity to move due to infrastructure etc., particularly in conjunction with higher sea levels, so minor impacts are possible.	I	R
	Sea level rise	All	moderate	moderate	almost certain	<b>Physical disturbance</b> - sea level rise could change depths over rocky reefs in estuaries, with moderate impacts considered almost certain	L	R

## Appendix C Environmental Risk Matrices and Evidence

## Subtidal reefs

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 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.	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.	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.	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.	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.	L	L
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	I	L: Several large estuaries, particularly Sydney Harbour and Hawkesbury River

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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
						moderate resilience of components of the habitat to these impacts.		
		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.	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.	L	L
Dredging	Navigation & entrance management and modification, harbour maintenance etc.	North South	low	minor	likely	<b>Water pollution</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 scale. See section 6.1.10 for further details.	A	L: Wherever dredging occurs
		Central	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. Physical disturbances and removal in generally small areas for discrete projects such as jetties, marinas. Likely to occur at a local scale.	L	L: Botany Bay, 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
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.	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.	L	L
<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 impact was considered to be likely.	L	R: 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.	L	L:
	Clearing riparian and adjacent habitat including wetland drainage	North South	moderate	moderate	likely	<b>Water pollution, changes to tidal flow velocity and patterns</b> –moderate impacts were considered likely on associated biota due to altering water tables and connectivity. Impacts from acid sulfate soils leaching and reducing pH which were considered likely to occur. Removal/clearing of adjacent habitats under current management is still likely, especially in rural catchments.	L	R:
		Central	low	moderate	possible	<b>Water pollution, changes to tidal flow velocity and patterns</b> – moderate impacts were considered possible due to altering water tables and connectivity. And water	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
						pollution.		
	Agricultural diffuse source runoff	Central South	moderate	moderate	likely	<b>Water pollution</b> – moderate impacts due to elevated nutrients, sediments and potential contaminants which impact biota. This level of impact was considered likely to occur.	L	R: Estuaries with agriculture in catchment
		North	low	moderate	possible	<b>Water pollution</b> - moderate impacts due to elevated nutrients, sediments and potential contaminants which impact biota namely remnant natural shellfish reefs. This level of impact was considered possible to occur.	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.	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.	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.	L	L
<b>Climate</b>	<b>20 Years</b> - See section 6.3.1 for further details on climate change							

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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>change</b>								
	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
	Ocean acidification	All	low	minor	likely	<b>Increased acidity</b> -larger pH changes may affect sensitive organisms such as echinoderms and molluscs, with minor impacts likely.	L	R
	Altered storm/cyclone activity (including flooding, storm surge, inundation)	All	low	minor	likely	<b>Physical disturbance</b> - reef biota with limited capacity to move, so minor impacts are possible.	I	R
<b>Climate change</b>								
<b>50 Years</b>								
	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
	Altered storm/cyclone activity (including flooding, storm surge,	All	moderate	moderate	likely	<b>Physical disturbance</b> - sensitive to disturbance and increased wave action. Moderate impacts likely in time frame.	I	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)							
	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

## 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.	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.	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.	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.	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	likely	<b>Water pollution</b> – moderate impacts considered likely to occur from acid sulfate soils leaching and reducing pH..	L	R: Shoalhaven, Hunter, Manning, Clarence, Richmond, Macleay, Tweed
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.	L	L
<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	A	L: estuaries where there is 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
						from combined stressors of toxic contaminants, nutrients, suspended sediments, marine debris and microplastics. Nutrients are present as bioavailable dissolved inorganic forms.		
		Central	high	major	likely	<b>Water pollution, marine debris (including microplastics)</b> – major impacts likely from combined stressors of toxic contaminants, nutrients, suspended sediments, marine debris and microplastics. Nutrients are present as bioavailable dissolved inorganic forms.	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 sedimentation, nutrification, acid runoff and blackwater events after floods. Moderate impacts likely to occur, although local impacts isolated to affected areas only.	A	R: Hunter, Hawkes, Port Jackson, Botany Bay, Lake Illawarra, Shoalhaven, Manning, Macleay, Clarence, Richmond, Tweed, Coastal lagoons
	Agricultural diffuse source runoff	North South	high	major	likely	<b>Water pollution</b> - major impacts likely from combined stressors of nutrients, suspended sediments, and potentially toxic contaminants.	A	R: all estuaries with agriculture in catchment
	Agricultural diffuse source runoff	Central	moderate	moderate	likely	<b>Water pollution</b> - moderate impacts considered likely from combined stressors of nutrients, suspended sediments, and potentially toxic contaminants.	A	Restricted to estuaries with agricultural catchments. E.g. 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.	A	R: all estuaries where grazing occurs
Point Discharges	Industrial discharges	Central	moderate	moderate	likely	<b>Water pollution</b> - moderate impacts likely from combined stressors of nutrients, and potentially toxic contaminants and a highly	A	L: Estuaries with industrial discharges and industrial landuse, e.g. Hunter, Lake

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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
						localised scale.		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.	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.	A	R: Lake Mac, Hawkes, Hunter, Tuggerah, Lake Illawarra, coastal lagoons
<b>Climate change</b>	<b>20 Years</b> - See section 6.3.1 for further details on climate change							
	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.	L	R
	Ocean acidification	All	moderate	moderate	likely	<b>Increased acidity</b> - only small pH changes in short time frame, with colicophores, pteropods vulnerable. Moderate impacts likely.	L	R
<b>Climate change</b>	<b>50 Years</b>							

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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
Climate change	Altered ocean currents & 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.	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
	Altered storm/cyclone activity (including flooding, storm surge, inundation)	All	low	minor	likely	<b>Physical disturbance</b> - sensitive to disturbance and increased wave action. Minor impacts likely in time frame.	I	R



## Appendix C Environmental Risk Matrices and Evidence

## Fish assemblages (harvest and bycatch stressors only)

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)	All	moderate	moderate	likely	<b>Reduction in abundances of species and trophic levels, bycatch</b> – approx. 65% of recent statewide landings in the EG fishery are taken from the northern region, dominated by three species which makes up approx. 60% of landings, approx. 27% in the central region, and approx. 8% in the south (principally from one estuary), resulting in a moderate impacts at different spatial scales arising from harvest that is likely to occur. Impacts from bycatch of fish assemblages in the EG fishery is considered to be moderate.	L	North, Central: R - in large number of estuaries in the region, but risk will vary depending on estuary characteristics and fishing pressure.  South: L -
	Estuary Prawn Trawl (EPT)	North Central	moderate	moderate	likely	<b>Reduction in abundances of species and trophic levels, bycatch</b> – approx. 40% of recent statewide landings are taken from the northern region, and approx. 60% from the central region, dominated by school prawns, and this was considered to result in a moderate consequence arising from harvest that is likely to occur. In addition, impacts from bycatch of fish assemblages associated with the EPT fishery is considered to be moderate.	L	North: L - Clarence River and Lake Wolloweyah  Central: L - Hunter and Hawkesbury estuaries.
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, bycatch</b> - the impact on harvested assemblages as a result of	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
						shore-based recreational fishing was considered moderate, and 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. Impacts from bycatch is considered to be moderate.		
	Boat-based line and trap fishing	All	moderate	moderate	likely	<b>Reduction in abundances of species and trophic levels, bycatch</b> - the impact on harvested assemblages as a result of boat-based recreational fishing was considered moderate, and 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. Impacts from bycatch is considered to be moderate.	L	R
	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.	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	L	L: restricted to specific locations where harvest of nippers occurs at a high level such as Tweed River, Port Hacking, as well as

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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
						prawns occurs in a number of estuaries.		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.	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.	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.	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.	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).	R	R
		Central	low	minor	likely	<b>Physical disturbance, Incidental catch of species of conservation concern</b> —only minor impacts considered likely related to impacts on <i>Posidonia</i> and saltmarsh and associated protected	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
						species (e.g. sygnathids).		
	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).	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.	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.	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.	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.	L	R
Bait and aquarium trade	Imported baits, imported fish and other aquatic species	All	low	minor	likely	<b>Pests and disease</b> – minor impacts expected to be likely on several species, including <i>Posidonia</i>	L	L
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 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	A	R: All estuaries, but particularly Lake Macquarie, Hawkesbury River, Sydney Harbour, Port Hacking

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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
						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.		
	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.	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.	L	L: All estuaries where dredging occurs
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.	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.	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
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.	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.	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.	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 foreshore historically meant removing/infilling of saltmarsh. Possible under current management.	A	R: 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 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.	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	A	R: all estuaries where clearing and drainage 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
Point Discharges						clearing, altering water tables and connectivity. Removal/clearing of adjacent habitats under current management is still possible, especially in rural catchments.		
	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.	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.	A	R: Estuaries with seagrass and agriculture catchment, e.g. Hawkesbury, Hunter, Tuggerah, 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.	A	R: all estuaries where grazing occurs
	Deliberate introduction of animals and plants (e.g. foxes, dogs, cats, bitou bush)	All	low	minor	likely	<b>Physical disturbance</b> – minor impacts likely from pests that result in habitat changes and encroachment.	A	R
	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.	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.	L	All 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
						Occurs primarily as overflows, with major impacts possible.		
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 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.	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	moderate	moderate	almost certain	<b>Physical disturbance</b> - saltmarsh likely to be inundated and limited chances to expand range. High chance of sea level rise with moderate impacts on saltmarsh almost certain.	L	R
	Altered storm/cyclone activity (including 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	North	high	major	likely	<b>Elevated temperatures</b> - likely impacts to be major on saltmarsh in this region	I	R
		Central South	moderate	moderate	likely	<b>Elevated temperatures</b> - experimental studies show response and expected change is greater than thresholds. Resilient systems with moderate impacts likely in these regions	I	R
	Ocean acidification	All	moderate	moderate	likely	<b>Increased acidity</b> - <i>Posidonia</i> likely to be sensitive to pH changes. Moderate impacts likely in time frame.	I	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 (including flooding, storm surge, tsunami, inundation)	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

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**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	moderate	likely	<b>Wildlife disturbance, physical disturbance, marine debris</b> - moderate consequence considered likely due to many individuals reported as struck by vessels in the region and a strong evidence base from Australian and international literature highlighting the risk of large commercial vessels to marine fauna. Evidence suggests a moderate risk to marine fauna from vessel strike, noise disturbance, and wildlife disturbance, and additional impacts from marine debris.	L	L: Main ports
		North	low	moderate	possible	<b>Wildlife disturbance, physical disturbance, marine debris</b> – moderate consequence considered possible due to less port activity in the north, but many individuals reported as struck by vessels in NSW and a strong evidence base from Australian and international literature highlighting the risk of large commercial vessels to marine fauna. Evidence suggests a moderate risk to marine fauna from vessel strike, noise disturbance, and wildlife disturbance, and additional impacts from marine debris.	L	L: Main ports
	Small commercial vessels (ferries, charter boats)	North South	low	moderate	possible	<b>Wildlife disturbance, physical disturbance, marine debris</b> - moderate consequence considered possible due to less vessel activity than in the central region, but many individuals reported as struck by vessels in NSW and a strong evidence base from Australian and international literature highlighting the risk	L	R: Majority of 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
						of commercial vessels to marine fauna. Evidence suggests a moderate risk to marine fauna from vessel strike, noise disturbance, and wildlife disturbance, and additional impacts from marine debris.		
		Central	moderate	moderate	likely	<b>Wildlife disturbance, physical disturbance, marine debris</b> - moderate consequence considered likely due to many individuals reported as struck by vessels in the region and a strong evidence base from Australian and international literature highlighting the risk of commercial vessels to marine fauna. Evidence suggests a moderate risk to marine fauna from vessel strike, noise disturbance, and wildlife disturbance, and additional impacts from marine debris.	L	R: Many large estuaries, particularly Sydney Harbour, Hawkesbury, Hunter, rivers and coastal lakes
Commercial fishing	Estuary General	North Central	moderate	moderate	likely	<b>Wildlife disturbance, catch of species of conservation concern, physical disturbance, marine debris, ghost fishing</b> – moderate consequence considered likely due to many individuals reported as entangled in fishing gear across NSW, evidence highlighting risk from gear types used in this fishery to marine fauna, and overlap between threatened species at risk and fishing activity. Wildlife are further impacted by disturbance and marine debris.	L	All estuaries where the activity occurs
		South	low	minor	likely	<b>Wildlife disturbance, catch of species of conservation concern, physical disturbance, marine debris, ghost fishing</b> – minor consequence considered likely due to less activity in the south	L	All estuaries where 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
						region, but many individuals reported as entangled in fishing gear in NSW, evidence highlighting risk from gear types used in this fishery to marine fauna, and overlap between threatened species at risk and fishing activity. Wildlife are further impacted by disturbance and marine debris.		
	Estuary Prawn Trawl	North Central	low	minor	likely	<b>Wildlife disturbance, catch of species of conservation concern, physical disturbance, marine debris, ghost fishing</b> - moderate consequence considered possible due to known impacts from gear types used in this fishery on marine fauna, reports of turtle and seal entanglements in the NSW EPTF, and overlap between threatened species at risk and fishing activity. Wildlife are further impacted by disturbance and marine debris.	I	L: All estuaries where the activity occurs
Charter fishing	Line fishing	All	low	minor	likely	<b>Wildlife disturbance, catch of species of conservation concern, physical disturbance, marine debris</b> – minor consequence considered likely due to reports of entangled wildlife in fishing gear across NSW, evidence highlighting risk from gear types used in charter fishing to marine fauna, and overlap between threatened species at risk and fishing activity, but uncertainty regarding the extent of interactions with the charter fishery. Wildlife are further impacted by disturbance and to a lesser extent marine debris from charter fishing.	I	All estuaries where 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
Recreational fishing	Shore-based line and trap fishing	North Central	moderate	moderate	likely	<b>Wildlife disturbance, catch of species of conservation concern, physical disturbance, marine debris</b> - moderate consequence considered likely due to many individuals reported as entangled and hooked in recreational fishing gear across NSW, evidence highlighting risk from gear types used in shore-based recreational fishing to marine fauna, and overlap between threatened species at risk and fishing activity. Wildlife disturbance is a key issue, particularly for threatened shorebirds when fishing access overlaps with important habitat areas. Wildlife are further impacted by marine debris from recreational fishing.	L	R
		South	low	moderate	possible	<b>Wildlife disturbance, catch of species of conservation concern, physical disturbance, marine debris</b> - moderate consequence considered possible due to many individuals reported as entangled and hooked in recreational fishing gear across NSW, evidence highlighting risk from gear types used in shore-based recreational fishing to marine fauna, and overlap between threatened species at risk and fishing activity. Wildlife disturbance is a key issue, particularly for threatened shorebirds when fishing access overlaps with important habitat areas. Less activity across the landscape in the south, however, disturbance to beach-nesting shorebirds such as endangered hooded plovers is an issue. Wildlife are further	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
						impacted by marine debris from recreational fishing.		
	Boat-based line and trap fishing	North Central	moderate	moderate	likely	<b>Wildlife disturbance, catch of species of conservation concern, physical disturbance, marine debris, ghost fishing</b> - moderate consequence considered likely due to many individuals reported as entangled and hooked in recreational fishing gear across NSW, evidence highlighting risk from gear types used in boat-based recreational fishing to marine fauna, and overlap between threatened species at risk and fishing activity. Entanglement of turtles in pots/traps is a key issue. Wildlife are further impacted by disturbance and marine debris.	L	R
		South	low	moderate	possible	<b>Wildlife disturbance, catch of species of conservation concern, physical disturbance, marine debris, ghost fishing</b> - moderate consequence considered possible due to many individuals reported as entangled and hooked in recreational fishing gear across NSW, evidence highlighting risk from gear types used in boat-based recreational fishing to marine fauna, and overlap between threatened species at risk and fishing activity; though some uncertainty regarding the extent of interactions in the south. Wildlife are further impacted by disturbance and marine debris.	L	R
	Hand gathering	All	Low	minor	likely	<b>Wildlife disturbance, physical disturbance, marine debris</b> - minor	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
						consequence considered likely due to disturbance to endangered shorebirds from hand-gathering. Disturbance at roosting, foraging, and nesting sites is a key threat to shorebirds in NSW. Displacement from foraging areas is a significant threat to endangered shorebirds such as beach-stone curlews, particularly during summer holiday periods.		
Charter activities	Whale and dolphin watching	North South	moderate	moderate	likely	<b>Wildlife disturbance, physical disturbance</b> – moderate consequence considered likely due to known impacts of charter activities on marine wildlife including displacement from or abandonment of habitat areas and disturbance to life-history behaviours. Disturbance from vessels may have potential impacts on population success, particularly in estuaries with high charter activity and populations of threatened species or resident dolphins.	L	L: All estuaries where activity occurs
		Central	low	minor	likely	<b>Wildlife disturbance, physical disturbance</b> – minor consequence considered likely due to known impacts of charter activities on marine wildlife including displacement from or abandonment of habitat areas and disturbance to life-history behaviours. Disturbance from vessels may have potential impacts on population success, particularly in estuaries with high charter activity and populations of threatened species or resident dolphins. The risk in the central region was rated as lower than the	L	L: All estuaries where 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
						north and south due to a lower density of vessels and uncertainty regarding the impacts of the activity in the region.		
Aquaculture	Oyster aquaculture	All	low	minor	likely	<b>Wildlife disturbance, physical disturbance</b> – minor consequence considered likely due to some wildlife disturbance and physical disturbance from people and vessels from aquaculture operations.	I	L: All estuaries where activity occurs
	Mussel farms	South	Low	minor	likely	<b>Wildlife disturbance, physical disturbance</b> – minor consequence considered likely due to some wildlife disturbance and physical disturbance from people and vessels from mussel farm operations.	I	L
Recreation and tourism	Boating and boating infrastructure	All	moderate	moderate	likely	<b>Physical disturbance, wildlife disturbance, marine debris</b> - moderate consequence considered likely due to many individuals reported as struck by vessels in the region and a strong evidence base highlighting the risk of vessels to marine fauna. Evidence suggests a moderate risk to marine fauna from vessel strike, noise disturbance, and wildlife disturbance, and additional impacts from marine debris.	L	R
	Passive recreational use including dog walking	All	moderate	moderate	likely	<b>Physical disturbance, wildlife disturbance, marine debris</b> – moderate consequence considered likely due to a strong evidence base on the threat of recreational activities, particularly domestic dogs, to wildlife. Evidence suggests a moderate risk to threatened shorebirds from domestic dogs including impacts on	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
						behaviour, breeding success, as well as direct mortalities. Wildlife are also impacted by marine debris and human disturbance including breaches of the marine mammal approach distance regulations.		
	Four-wheel driving	All	moderate	moderate	likely	<b>Physical disturbance, wildlife disturbance</b> – moderate consequence considered likely due to known impacts of four-wheel driving on nesting and foraging habitat for threatened shorebirds and nesting habitat for threatened turtles. Evidence suggests a moderate risk from four-wheel drives to endangered shorebirds at roost and feeding sites, with potential consequences on breeding success and migration capacity for affected populations.	L	L
Dredging	Navigation & entrance management, modification and maintenance	All	low	moderate	possible	<b>Physical disturbance, wildlife disturbance, water pollution, sedimentation</b> – moderate consequence considered possible due to known impacts of dredging activities on marine wildlife. Evidence suggests a moderate risk to wildlife population health from dredging operations including displacement from habitat areas, disturbance from noise, and degradation of habitats from dumping of dredge spoil and decreased water quality.	I	L: Ports/Estuaries
Modified freshwater flows	Extraction, artificial barriers to riverine and estuarine flow (e.g. dams, weirs, waterway crossings, floodgates)	All	moderate	moderate	likely	<b>Wildlife disturbance, physical disturbance, water pollution, changes to tidal flow velocity and patterns, sedimentation, reduction in abundances of species and trophic levels</b> – moderate consequence considered likely due to	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
						known impacts of the alteration of natural flow regimes on threatened shorebirds. Evidence suggests modified freshwater flows threaten the viability of shorebird populations through degradation and permanent loss of habitat, reductions in prey availability, and loss of connectivity between habitat areas used by shorebirds and their prey.		
Mining and extractive industries	Oil, gas, minerals, sand, aggregate, underground coal	All	low	minor	likely	<b>Water pollution</b> – minor consequence considered likely due to the impact of mine waste water and associated pollutants on marine wildlife health.	I	L
Service infrastructure	Pipelines, cables, trenching and boring	All	low	moderate	possible	<b>Wildlife disturbance, physical disturbance, water pollution</b> – moderate consequence considered possible due to impacts of trenching and boring activities on marine wildlife including disturbance and displacement of wildlife from noise and habitat modification, but uncertainty regarding the level of impact within NSW.	I	L: All estuaries where this activity occurs
<b>Land-based impacts</b>								
Landuse Intensification	Urban stormwater discharge	North South	moderate	moderate	likely	<b>Wildlife disturbance, physical disturbance, water pollution, marine debris</b> – moderate consequence considered likely due to known impacts of urban stormwater discharge and associated pollutants and debris on marine wildlife. Evidence suggests increases in pollution from stormwater discharge have moderate consequences for marine wildlife health, including increases in disease and direct mortalities.	I	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
		Central	high	major	likely	<b>Wildlife disturbance, physical disturbance, water pollution, marine debris</b> – moderate consequence considered likely due to known impacts of urban stormwater discharge and associated pollutants and debris on marine wildlife. Evidence suggests increases in pollution from stormwater discharge have major consequences for marine wildlife health, including increases in disease and direct mortalities. The threat of stormwater pollution is higher in the central region due to the higher, urbanised population.	L	R
	Foreshore development	North South	moderate	moderate	likely	<b>Wildlife disturbance, physical disturbance, marine debris</b> – moderate consequence considered likely due to the impact of foreshore development on marine wildlife including the replacement of coastal habitat with man-made structures. Habitat loss and degradation has significant impacts on marine wildlife with consequences for wildlife health, breeding success and subsequent population viability. Wildlife are further impacted by increased disturbance, marine debris, and alteration of resources.	L	L
		Central	high	major	almost certain	<b>Wildlife disturbance, physical disturbance, marine debris</b> – major consequence considered almost certain due to the impact of foreshore development on marine wildlife including the replacement of coastal habitat with man-made structures. Habitat loss and degradation has significant impacts on	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
						marine wildlife with consequences for wildlife health, breeding success and subsequent population viability. Wildlife are further impacted by increased disturbance, marine debris, and alteration of resources. Populations in the central region have a low resilience due to large-scale legacy impacts.		
	Beach nourishment and grooming	Central	moderate	moderate	likely	<b>Wildlife disturbance, physical disturbance</b> – moderate consequence considered likely due to impacts of beach nourishment and grooming on shorebirds through wildlife disturbance and physical disturbance to shore-based habitat including reductions in prey availability.	L	R
		North South	low	minor	likely	<b>Wildlife disturbance, physical disturbance</b> – minor consequence considered likely due to impacts of beach nourishment and grooming on shorebirds through wildlife disturbance and physical disturbance to shore-based habitat including reductions in prey availability. Impacts are lower in the north and south compared to the central region due to lower intensity of the activity.	L	R: Activity occurs in many locations along the coast from Tweed River, Cudgen creek
	Clearing riparian and adjacent habitat including wetland drainage	North South	moderate	moderate	likely	<b>Wildlife disturbance, physical disturbance</b> – moderate consequence considered likely due to permanent loss of shorebird habitat from clearing and wetland drainage with potential consequences for the viability of already threatened species.	L	R
		Central	high	major	likely	<b>Wildlife disturbance, physical disturbance</b> – major consequence considered likely due to permanent loss of	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
						shorebird habitat from clearing and wetland drainage with potential consequences for the viability of already threatened species. Populations in the central region have a low resilience due to large-scale legacy impacts.		
	Agricultural diffuse source runoff	All	moderate	moderate	likely	<b>Water pollution</b> – moderate consequence considered likely due to impacts from water pollution including increased nutrients and contaminants on marine wildlife health. Pollution associated with agricultural activities including algal blooms are linked to disease outbreaks and mortalities in wildlife populations including marine mammals, turtles, and birds.	L	R: Coffs Harbour blueberry region, sugar cane North Coast.
	Deliberate introduction of plants and animals (e.g. foxes, bitou bush)	All	high	major	Almost certain	<b>Physical disturbance, wildlife disturbance</b> – major consequence considered almost certain due to a strong evidence base outlining the impact of deliberately introduced pests such as foxes on the population viability of threatened shorebirds. Foxes have been linked to regional declines and localised extinctions of some shorebird and seabird species in NSW.	A	R
Point Discharges	Industrial discharges	Central	moderate	moderate	likely	<b>Water pollution</b> – moderate consequence considered likely due to elevated nutrients and increased contaminant concentrations, which have negative consequences for marine wildlife health. The impact of contaminants on wildlife can be through direct exposure and through bioaccumulation of toxins through the food web.	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
	Thermal discharges	Central	low	minor	likely	<b>Water pollution, physical disturbance</b> – minor consequence considered likely due to known issues of thermal discharges on marine wildlife including turtles experiencing thermal shock or getting caught in inlet canals of power stations. Additional impacts from loss of foraging habitat due to loss of seagrass.	I	L
	Sewage effluent and septic runoff	North South	low	moderate	possible	<b>Water pollution, marine debris</b> – moderate consequence considered possible due to impacts from water pollution including increased chemicals, microplastics, and pathogens (e.g. E. coli, toxoplasmosis) on marine wildlife health. Pollution associated with sewage is linked to disease outbreaks and mortalities in wildlife populations, though there is uncertainty regarding the level of impact in the north and south regions.	L	L
		Central	moderate	moderate	likely	<b>Water pollution, marine debris</b> – moderate consequence considered likely due to impacts from water pollution including increased chemicals, microplastics, and pathogens (e.g. E. coli, toxoplasmosis) on marine wildlife health. Pollution associated with sewage is linked to disease outbreaks and mortalities in wildlife populations.	L	R
Hydrologic Modifications	Estuary entrance modifications.	All	moderate	moderate	likely	<b>Water pollution, wildlife disturbance, physical disturbance, water pollution, sedimentation, changes to tidal prism</b> – moderate consequence considered likely due to known impacts of estuary entrance modification on shorebirds, particularly for	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
						threatened species that nest near estuary entrances. Evidence suggests estuary entrance modifications threaten the viability of shorebird populations through degradation, inundation, and permanent loss of habitat, as well as reductions in prey availability.		
<b>Climate change</b>	<b>20 years</b>							
	Climate and sea temperature rise	All	moderate	moderate	likely	<b>Climate and sea temperature rise, reduction in abundances of species and trophic levels</b> – moderate consequence considered likely as increased temperatures are expected to threaten the survival and breeding success of a range of marine wildlife species due to impacts on prey availability, habitat quality, disease outbreaks, thermal tolerances, nest viability, migratory patterns, and energy requirements.	L	R
	Ocean acidification	All	low	minor	likely	<b>Ocean acidification, reduction in abundances of species and trophic levels</b> – minor consequence considered likely due to impacts on species that directly feed on calcifying organisms (e.g. baleen whales, birds) and top-order predators (e.g. dolphins, pinnipeds) through changes in trophic dynamics.	I	R



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Activity	Region	Risk Level	Consequence	likelihood	Key stressors	Confidence A: adequate L: limited I: inferred	Spatial extent L: local R: regional
Altered storm/cyclone activity, flooding, storm surge, inundation from extreme events	All	high	major	likely	<b>Physical disturbance, wildlife disturbance, marine debris, water pollution, altered storm and cyclone activity</b> – major consequence considered likely due to impacts of physical disturbance, reduced water quality, pollution, and marine debris from extreme events on wildlife. Increased storm events can cause increased disease, damage to and inundation of nests, and direct mortalities through osmotic disruption, increased strandings, and injury.	L	R
Sea level rise	All	high	major	likely	<b>Physical disturbance, wildlife disturbance, sea-level rise</b> – major consequence considered likely due to inundation and alteration of nearshore habitat, and loss of intertidal foraging habitat and shore-based roosting and nesting habitat, with significant consequences for threatened shorebirds and turtles.	I	R

Appendix C Environmental Risk Matrices and Evidence

Resource Use	Activity	Region	Risk Level	Consequence	likelihood	Key stressors	Confidence A: adequate L: limited I: inferred	Spatial extent L: local R: regional
<b>Climate change</b>	<b>50 years</b>							
Climate change	Altered ocean currents & nutrient inputs	All	moderate	moderate	likely	<b>Altered ocean currents and nutrients, water pollution, reduction in abundances of species and trophic levels</b> – moderate consequence considered likely due to changes to the EAC, water quality, and nutrient levels, which affect wildlife distribution, prey distribution, and wildlife health including disease susceptibility and can cause thermal shock in marine turtles.	I	R
	Climate and sea temperature rise	All	high	major	likely	<b>Climate and sea temperature rise, reduction in abundances of species and trophic levels</b> – major consequence considered likely as increased temperatures are expected to threaten the survival and breeding success of a range of marine wildlife species due to impacts on habitat quality, disease outbreaks, thermal tolerances, nest viability, migratory patterns, and energy requirements.	L	R
	Ocean acidification	All	high	major	likely	<b>Ocean acidification, reduction in abundances of species and trophic levels</b> – major consequence considered likely due to impacts on species that directly feed on calcifying organisms (e.g. baleen whales, birds) and top-order predators (e.g. dolphins, pinnipeds) through changes in trophic dynamics.	I	R
	Altered storm/cyclone activity (including flooding, storm surge, inundation)	All	high	major	likely	<b>Physical disturbance, wildlife disturbance, marine debris, water pollution, altered storm and cyclone activity</b> – major consequence considered	I	R

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					likely due to impacts of physical disturbance, reduced water quality, pollution, and marine debris from extreme events on wildlife. Increased storm events can cause increased disease, damage to and inundation of nests, and direct mortalities through osmotic disruption, increased strandings, and injury.		
Sea level rise	All	high	major	likely	<b>Physical disturbance, wildlife disturbance, sea-level rise</b> – major consequence considered likely due to inundation and alteration of nearshore habitat, and loss of intertidal foraging habitat and shore-based roosting and nesting habitat, particularly for shorebirds and turtles	I	R

## Appendix C Environmental Risk Matrices and Evidence

## Statewide –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.	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.	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.	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.	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.		
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.	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.	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, low 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	low	moderate	possible	<b>Physical disturbance</b> - increased intensity of storms possible to lead to increased	L	R: mostly Hunter and Hawkesbury.

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		South				occurrence of large event river run-off. This will possibly lead to moderate impacts on water quality on the open coast.		
	Climate and sea temperature rise	North	moderate	moderate	likely	<b>Elevated temperatures</b> - larger temperature increases expected to be synergistic with other effects, with moderate impacts likely.	I	R
		Central	low	minor	likely	<b>Elevated temperatures</b> - larger temperature increases expected to be synergistic with minor effects, with low likely.	I	R
		South						
	Ocean acidification	All	low	minor	likely	<b>Increased acidity</b> - minor acidification expected within 20 years, with minor impacts likely.	I	R
<b>Climate change</b>	<b>50 Yrs</b>							
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			
	Climate and sea temperature rise	North	high	major	likely	<b>Elevated temperatures</b> - larger temperature increases expected to be synergistic with other effects, with major impacts likely.	I	R
		Central	moderate	moderate	likely	<b>Elevated temperatures</b> - larger temperature increases expected to be synergistic with other effects, with moderate impacts likely.		
		South						
	Ocean acidification	All	moderate	moderate	likely	<b>Increased acidity</b> - significant acidification expected within 50 years, experiments show potential effects in synergy with temperature, with moderate impacts likely.	I	R
	Altered storm/ cyclone activity (including flooding, storm surge, inundation)	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	I	R

Appendix C Environmental Risk Matrices and Evidence

					impacts likely.		
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Appendix C Environmental Risk Matrices and Evidence

Beaches

Resource use	Activity	Region	Risk level	Conseq	Likelihood	Key stressors	Confidence A: adequate L: limited I: inferred	Spatial extent 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.	L	R
Commercial fishing	Ocean Haul (OH)	North South	moderate	moderate	likely	<b>Physical disturbance</b> , - moderate impacts considered likely from defined stressors, but only at a local scale.	L	L
Recreational fishing	Hand gathering	All	low	minor	likely	<b>Physical disturbance</b> – only minor impacts considered likely from trampling, but only at a local scale.	L	L – at locations where pipis and beachworms are harvested
Recreation and Tourism	Passive recreational use	Central	moderate	moderate	likely	<b>Physical disturbance, marine debris</b> - moderate impacts considered likely from defined stressors.	L	Central: R – majority of coast
		North	low	moderate	possible	<b>Physical disturbance, , marine debris</b> - moderate impacts considered possible from defined stressors, but only at a local scale.	L	L – adjacent to major towns
		South						
	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 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 likely that this level of	A	L. Localised impacts on the few beaches that this activity is allowed. Only several beaches in central region, with many more on the north coast.



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						impact would occur, but only at a local scale where the activity occurs.		
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.	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.	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.	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.	L	North: L - beaches where grooming and nourishment occurs Central: L - nourishment occurring at Cronulla and Narrabeen when nearby channels are dredged. Grooming at large number of beaches South: L - beaches where grooming and nourishment occurs

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	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.	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.	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.	A	L
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.	L	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	moderate	possible	<b>Physical disturbance</b> - beaches with limited capacity to move due to sea walls etc., so moderate impacts are possible.	A	R
	Climate and sea temp rise	All	low	minor	likely	<b>Elevated temperatures</b> - temperature increases expected to be greater with more effect on beach biota, and minor impacts likely.	L	R
	Sea level rise	Central	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	L
		North	low	minor	likely	<b>Physical disturbance</b> - some beaches may be lost due to their limited capacity to extend inland (local	A	L

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		South				certain circumstances), hence minor impacts are likely.		
<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.	L	R
	Ocean acidification	All	moderate	moderate	likely	<b>Increased acidity</b> - larger pH changes may affect sensitive organisms such as echinoderms and molluscs, with moderate impacts likely.	L	R
	Altered storm / cyclone activity	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. Beaches with limited capacity to move due to sea walls etc., so major impacts are likely.	L	R
	Sea level rise	Central	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	L
		North South	moderate	moderate	likely	<b>Physical disturbance</b> - some beaches may be lost due to their limited capacity to extend inland in localised areas, with moderate impacts likely.	L	L

## Appendix C Environmental Risk Matrices and Evidence

## Shallow soft sediments

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 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.	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.	L	L
<b>Land-based impacts</b>								
Landuse intensification	Urban stormwater discharge	All	low	moderate	possible	<b>Water pollution</b> – moderate impacts were considered possible to occur at a local scale due to increased nutrients, contaminants and sediments and reduced salinities which impact biota.	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.	L	L: groomed and nourished beaches only
	Clearing riparian and adjacent habitat including wetland drainage	Central	low	minor	likely	<b>Physical disturbance</b> – only minor impacts were considered likely due to removal/clearing of adjacent habitats under current management is still likely.	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 and dispersed and	A	R: Larger rivers with agricultural catchments which carry pollutants to

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						diluted in nearshore zone.		nearshore zone only, e.g. Hunter, Clarence, Tweed Hawkesbury, 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.	A	L: 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.	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 impact, although maintenance activities will have an ongoing impact.	A	R: all beaches adjacent to estuaries where modifications have occurred
<b>Climate change</b>	<b>20 Years</b>							
	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
<b>Climate change</b>	<b>50 Years</b>							
	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	moderate	major	possible	<b>Increased acidity</b> - larger pH changes may affect sensitive organisms such as molluscs and echinoderms, with major impacts possible.	L	R
	Altered storm/ cyclone	All	moderate	moderate	likely	<b>Physical disturbance</b> - disturbance of shallow soft sediments likely, with moderate impacts	I	R

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	activity					expected against background variation.		
	Sea level rise	All	low	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

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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.	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.	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.	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.	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.		
		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.	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.	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.	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.	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 sea temperature	All	low	moderate	possible	<b>Elevated temperatures</b> - greater temperature increases affect biota, but impacts to be minor in deep soft sediments	L	R



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rise							
Ocean acidification	All	moderate	major	possible	<b>Increased acidity</b> - oceanic organisms expected to be more sensitive to change, with major impacts possible to occur.	L	R
Altered storm/cyclone activity	All	low	minor	likely	<b>Physical disturbance</b> - disturbance of deep soft sediments that is likely to result in minor impacts	I	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.	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.	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.	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.	L	R
Aboriginal Cultural fishing (including permitted as well as native title rights)	Line fishing, spearfishing, hand gathering, traditional fishing methods, related cultural traditions	South	low	minor	likely	<b>Physical disturbance</b> – only minor impacts considered likely from trampling and anchoring, but only at a local scale.	L	L
Recreation and Tourism	Passive recreational use	Central	moderate	moderate	likely	<b>Physical disturbance, marine debris</b> - moderate impacts considered likely from defined stressors.	L	R. - majority of coast
		North	low	moderate	possible	<b>Physical disturbance, marine debris</b> - moderate impacts considered possible from	L	L – North and south: adjacent to

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		South				defined stressors.		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.	L	L
<b>Land-based impacts</b>								
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.	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.	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..	L	L: Only areas near STP discharges: Norah Head, Diamond Bay, Shellharbour
		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.	A	L
Hydrologic modifications	Estuary entrance modifications	North	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.	L	R: all rocky shores adjacent to beaches in the vicinity of estuaries where modifications have occurred
		South						
<b>Climate change</b>	<b>20 Years</b>							
	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

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	Sea level rise	All	low	moderate	possible	<b>Physical disturbance</b> - some rocky shores may be lost due to their limited capacity to extend inland (local certain circumstances), hence moderate impacts are likely.	L	R
	<b>Activity</b>	<b>Region</b>	<b>Risk level</b>	<b>Conseq</b>	<b>Likelihood</b>	<b>Key stressors</b>	<b>Confidence</b>	<b>Spatial extent</b>
	Climate and sea temp rise	North	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.	L	R
		Central South	low	minor	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.	L	R
<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
	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.	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



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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.	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.	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.	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.	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.	L	L
Recreational fishing	Shore-based line and trap fishing	All	low	minor	likely	<b>Marine debris</b> – only minor impacts were considered likely associated with marine debris, principally lost fishing gear on shallow reefs at a	A	L

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						local scale		
	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.	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.	L	L
Aboriginal Cultural fishing	Line fishing, spearfishing, hand gathering, traditional fishing methods, related cultural traditions	South	low	minor	likely	<b>Physical disturbance</b> – only minor impacts considered likely from trampling and anchoring, but only at a local scale.	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.	L	L
	Snorkelling and diving	North	Low	Minor	likely	<b>Physical disturbance</b> – only minor impacts were considered likely associated with diving impacts on shallow reefs	L	L – principally Julian Rocks
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.	L	L
<b>Land-based impacts</b>								
Landuse intensification	Urban stormwater discharge	Central	moderate	moderate	likely	<b>Water pollution</b> – moderate impacts were considered likely to occur at a local scale due to increased nutrients, contaminants and sediments and reduced salinities which impact biota.	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.	L	L
	Agricultural	All	low	minor	likely	<b>Water pollution</b> - only minor impacts were	L	R: Offshore of

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	diffuse source runoff					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.		main large estuaries with high discharge
Point discharges	Industrial discharges	Central	low	moderate	possible	<b>Water pollution</b> - only moderate impacts were considered possible due to contamination from sediments. Discharge from estuaries occurs principally during floods and is dispersed and diluted in nearshore zone.	L	L
	Sewage effluent and septic runoff	Central	low	minor	likely	<b>Water pollution</b> - minor 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.	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
	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.	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
<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	high	major	likely	<b>Elevated temperatures</b> - increased temp and associated reduction of nutrients will affect growth of habitat forming macro-algae resulting in major impacts on shallow reef habitat.	L	R
	Ocean	All	moderate	moderate	likely	<b>Increased acidity</b> - larger pH changes may	L	R



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	acidification					affect sensitive organisms such as urchins and molluscs, with moderate impacts likely.		
	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

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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.	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 physical disturbance from gear types.	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.	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.	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.	L	L: Offshore of main large estuaries with high discharge
Point discharges	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 coastal waters.	A	L: Principally around North Head outfalls

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<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.	L	L
Bait and aquarium trade	Imported baits and fish	All	low	moderate	possible	<b>Water pollution</b> – moderate impacts were considered possible due to the defined stressors, including risks of disease.	L	R
Service infrastructure	Pipelines, cables, trenching and boring	Central	low	minor	likely	<b>Water pollution</b> – only minor impacts were considered likely due to the defined stressors, and level of activity in the region.	L	L
<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.	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.	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 &	North	moderate	moderate	likely	<b>Nutrient changes</b> - reduction of nutrients may result in changes in primary production, with	L	R

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	nutrient inputs	Central				moderate impacts likely.		
		South	Low	minor	likely	<b>Nutrient changes</b> - reduction of nutrients may result in changes in primary production, with minor impacts likely	L	R
	Ocean acidification	All	moderate	moderate	likely	<b>Increased acidity</b> - only small pH changes over this time frame, but colicophores, pteropods are vulnerable, with moderate impacts likely.	I	R
<b>Climate change</b>	<b>50 Years</b>							
Climate change	Altered ocean currents & nutrient inputs	North	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
		Central						
		South	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 temperature rise	All	low	moderate	possible	<b>Elevated temperatures</b> - larger temp increases affect biota, with moderate impacts possible.	L	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 (harvest and bycatch stressors only)**

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	<b>Reduction in abundances of species and trophic levels</b> – with approx. 40% of recent statewide landings taken from this region, harvest was considered likely to have a moderate impact to the trophic/community structure of assemblages.	L	R
		Central	Low	minor	likely	<b>Reduction in abundances of species and trophic levels</b> – with approx. 15% of recent statewide landings taken from this region, harvest was considered likely to have a minor impact to the trophic/community structure of assemblages.	L	R
		South	Moderate	moderate	likely	<b>Reduction in abundances of species and trophic levels</b> – with approx. 35% (2009/10) to 10% (2013/14) of recent statewide landings taken from this region, harvest was considered likely to have a moderate impact to the community structure of assemblages.	L	R
	Ocean Trawl (OT)	North	High	major	likely	<b>Reduction in abundances of species and trophic levels</b> – with approx. 45% of recent landings taken from this region, dominated by one growth overfished, five fully fished and three undefined species in top ten, harvest was considered likely to result in a major impact. In addition, given level of both historical and current trawl effort in this region on this habitat, levels of bycatch determined to result in high impacts on bycatch species.	L	R
		Central South	Low	minor	likely	<b>Reduction in abundances of species and trophic levels</b> – with approx. 10% of landings taken from the central and south regions, and given the level of trawl effort in these regions, levels of harvest and bycatch was considered	A	R

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					likely to result in minor impacts.		
Ocean Haul (OH)	All	Moderate	moderate	likely	<b>Reduction in abundances of species and trophic levels</b> – with approx. 45% of recent statewide landings taken in the north, approx. 15% in the central region, and approx. 25% from the south, with landings dominated by a number of pelagic species with high resilience, it was considered that measurable impacts are evident and harvest was considered likely to have a moderate impact on the trophic structure of fish assemblages.	L	R
Sea urchin and turban shell	North	Low	minor	likely	<b>Reduction in abundances of species</b> - low levels of harvest in this region.	A	L
	Central	Moderate	moderate	likely	<b>Reduction in abundances of species and trophic levels</b> - harvest of SUTS species in the central region were around 5% of the statewide catch, but approx. 30% of red sea urchins and turban shell catch, which are species that have life history characteristics that result in mod-low resilience. These species were considered to be responsible for resulting in a moderate impact that was likely to occur at a local scale on fished reefs.	A	L – fished on only very few reefs
	South	Moderate	moderate	likely	<b>Reduction in abundances of species and trophic levels</b> – harvest of SUTS species in the central region were around 5% of the statewide catch, but approx. 30% of red sea urchins and turban shell catch, which are species that have life history characteristics that result in mod-low resilience. These species were considered to be responsible for resulting in a moderate impact that was likely to occur at a regional scale on fished reefs.	A	R
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.	A	R
Abalone	North	Low	minor	likely	<b>Reduction in abundances of species and trophic levels</b> – the harvest of abalone at low level in these regions were considered likely to	A	L

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		Central				have minor impacts.		
		South	Moderate	moderate	likely	<b>Reduction in abundances of species and trophic levels</b> – the dominance of the statewide harvest of abalone in the southern region, and the life history characteristics that result in mod-low resilience resulted in impacts that were considered likely to be moderate in this region.	A	R
Charter fishing	Line fishing	All	Low	minor	likely	<b>Reduction in abundances of species and trophic levels</b> – impacts reflect the amount of charter fishing effort at a local scale adjacent to the major estuaries. Moderate to high resilience characteristics of the assemblages.	L	L – adjacent to major estuaries
Recreational fishing	Shore-based line and trap fishing	All	Moderate	moderate	likely	<b>Reduction in abundances of species and trophic levels, bycatch</b> – the impact on harvested assemblages and by-catch as a result of shore-based recreational fishing is approx. even in each region, with impacts considered likely to be moderate as negative impacts are evident, however, the level of impact has not influenced the overall recovery capacity, and a change in the overall trophic/community structure is not evident.	L	R
	Boat-based line and trap fishing	All	Moderate	moderate	likely	<b>Reduction in abundances of species and trophic levels, bycatch</b> - the impact on harvested assemblages and by-catch as a result of boat-based recreational fishing is considered likely to be moderate as negative impacts 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.	L	R
	Hand gathering	All	Moderate	moderate	likely	<b>Reduction in abundances of species and trophic levels</b> - moderate impacts were 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.	L	R



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	Spearfishing	All	Low	minor	likely	<b>Reduction in abundances of species and trophic levels</b> – minor impacts were 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.	L	R
Recreation and tourism	Shark control measures	Central	Low	minor	likely	<b>By-catch</b> - minor impacts were 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, which is widespread in the region

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Threatened and protected fish and sharks

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	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.	L	R
		Central South	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 regions, and there are interaction with white sharks and grey nurse sharks. While many individuals are or will be measurably negatively affected, there are no on-going impacts will be evident, and has not or will not significantly affect recovery of these species.	A	R
	Ocean Trawl (OT)	North Central	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 sygnathids and grey nurse sharks in coastal waters.	L	R
		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 sygnathids and grey nurse sharks in coastal waters.	L	R
		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	L

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						ocean haul activities impact on threatened and protected fish and sharks in all regions.		
	Abalone	South	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.	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.	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.	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.	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.	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.	L	L
	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	A	L

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						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.		
<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.	L	R
<b>Climate change</b>	<b>20 Years</b>							
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.	L	R
	Ocean acidification	All	low	minor	likely	<b>Increased acidity</b> - only small pH changes over this time frame, 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.	L	R
	Ocean acidification	All	low	minor	likely	<b>Increased acidity</b> - pH changes over this time frame expected to have minor impacts on FMA species.	A	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	North South	low	minor	likely	<b>Wildlife disturbance, physical disturbance, marine debris</b> – minor consequence considered likely due to less port activity in the north and south, but some individuals reported as struck by vessels in NSW and a strong evidence base from Australia and international literature highlighting the risk of large commercial vessels to marine fauna. Evidence suggests a minor risk to marine fauna from vessel strike, noise disturbance, and wildlife disturbance, and additional impacts from marine debris.	L	L
		Central	high	major	likely	<b>Physical disturbance, wildlife disturbance, marine debris</b> - Major consequence considered likely due to many individuals reported as struck by vessels in the region, concentrated vessel activity, and a strong evidence base from Australia and international literature highlighting the risk of large commercial vessels to marine fauna. Evidence suggests a high risk to marine fauna from vessel strike, noise disturbance, and wildlife disturbance, and additional impacts from marine debris with particular concern for populations of threatened species.	L	R: but most likely near major ports and shipping routes
	Small commercial vessels (ferries, charter boats, etc.)	All	moderate	moderate	likely	<b>Physical disturbance, wildlife disturbance, marine debris</b> - moderate consequence considered likely due to many individuals reported as struck by vessels across NSW and a strong evidence base from Australia and international literature highlighting the risk of commercial vessels to marine fauna. Evidence	L	R

Appendix C Environmental Risk Matrices and Evidence

						suggests a moderate risk to marine fauna from vessel strike, noise disturbance, and wildlife disturbance, and additional impacts from marine debris.		
Commercial fishing	Ocean Trap and Line (OTL)	North	moderate	moderate	likely	<b>Wildlife disturbance, catch of species of conservation concern, physical disturbance, marine debris, ghost fishing</b> – moderate consequence considered likely due to known impacts from gear types used in this fishery (e.g. traps, long-lines, ropes) on marine fauna, which have led to declines in some species outside NSW, and overlap between threatened species at risk and fishing activity. Traps, lines, and ropes pose a particular threat to whales and are the greatest known human impact on wildlife recorded in the NPWS Elements database. Wildlife are further impacted by disturbance and marine debris.	L	R
		Central						
		South	Low	minor	likely	<b>Wildlife disturbance, catch of species of conservation concern, physical disturbance, marine debris, ghost fishing</b> – minor consequence considered likely due to known impacts from gear types used in this fishery (e.g. traps, long-lines, ropes) on marine fauna, which have led to declines in some species outside NSW, and overlap between threatened species at risk and fishing activity. Traps, lines, and ropes pose a threat to whales and are the greatest known human impact on wildlife recorded in the NPWS Elements database. Less activity of the fishery in the south, though populations of threatened species in the region are highly vulnerable. Wildlife are further impacted by disturbance and marine debris.	L	R
	Ocean Trawl (OT)	North	moderate	moderate	likely	<b>Wildlife disturbance, catch of species of conservation concern, physical disturbance, marine debris, ghost fishing</b> – moderate consequence considered likely due to known impacts from gear types used in this	L	R
		Central						

Appendix C Environmental Risk Matrices and Evidence

					fishery on marine fauna, reports of turtle and seal entanglements in the NSW OTF, and overlap between threatened species at risk and fishing activity. Wildlife are further impacted by disturbance and marine debris.		
	South	low	minor	likely	<b>Wildlife disturbance, catch of species of conservation concern, physical disturbance, marine debris, ghost fishing</b> - minor consequence considered likely due to known impacts from gear types used in this fishery on marine fauna, reports of turtle and seal entanglements in the NSW OTF, and overlap between threatened species at risk and fishing activity. Wildlife are further impacted by disturbance and marine debris.	L	R
Ocean Haul (OH)	All	low	moderate	possible	<b>Wildlife disturbance, catch of species of conservation concern, physical disturbance, marine debris, ghost fishing</b> – moderate consequence considered possible due to known impacts from gear types used in this fishery on marine fauna and overlap between threatened species at risk and fishing activity. Wildlife disturbance occurs when fishers access sites or operate near wildlife habitat. Wildlife are further impacted by marine debris.	I	R
Lobster	All	low	moderate	possible	<b>Wildlife disturbance, physical disturbance, marine debris, ghost fishing</b> – moderate consequence considered possible due to known impacts from gear types used in this fishery on marine fauna, reports of cetacean entanglements in the NSW lobster fishery, and overlap between threatened species at risk and fishing activity. Wildlife are further impacted by disturbance and marine debris.	I	R
Charter fishing	Line fishing	low	moderate	possible	<b>Wildlife disturbance, catch of species of conservation concern, physical disturbance, marine debris</b> – moderate consequence considered possible due to many individuals reported as entangled in fishing	I	R

Appendix C Environmental Risk Matrices and Evidence

						gear across NSW, evidence highlighting risk from gear types used in charter fishing to marine fauna, and overlap between threatened species at risk and fishing activity, but uncertainty regarding the extent of interactions with the charter fishery. Wildlife are further impacted by disturbance and to a lesser extent marine debris from charter fishing.		
Recreational fishing	Shore-based line and trap fishing	All	low	minor	likely	<b>Wildlife disturbance, catch of species of conservation concern, physical disturbance, marine debris</b> - minor consequence considered likely due to many individuals reported as entangled and hooked in recreational fishing gear across NSW, evidence highlighting risk from gear types used in shore-based recreational fishing to marine fauna, and overlap between threatened species at risk and fishing activity. Wildlife disturbance is a key issue, particularly for threatened shorebirds when fishing access overlaps with important habitat areas. Wildlife are further impacted by marine debris from recreational fishing.	L	R
	Boat-based line and trap fishing	All	low	minor	likely	<b>Wildlife disturbance, catch of species of conservation concern, physical disturbance, marine debris, ghost fishing</b> - minor consequence considered likely due to many individuals reported as entangled and hooked in recreational fishing gear across NSW, evidence highlighting risk from gear types used in boat-based recreational fishing to marine fauna, and overlap between threatened species at risk and fishing activity. Wildlife are further impacted by disturbance and marine debris.	L	R
	Hand gathering	All	low	minor	likely	<b>Wildlife disturbance, physical disturbance, marine debris</b> - minor consequence considered likely due to disturbance to endangered shorebirds from hand-gathering. Disturbance at roosting, foraging, and nesting	L	L



Appendix C Environmental Risk Matrices and Evidence

						sites is a key threat to shorebirds in NSW. Displacement from foraging areas is a significant threat to endangered shorebirds such as beach-stone curlews and little terns, particularly during summer holiday periods.		
Charter activities	Whale and dolphin watching	All	moderate	moderate	likely	<b>Wildlife disturbance</b> – moderate consequence considered likely due to known impacts of charter activities on marine wildlife including displacement from or abandonment of habitat areas and disturbance to life-history behaviours.	L	R: but most likely near major harbours
Recreation and tourism	Boating and boating infrastructure	All	low	moderate	possible	<b>Physical disturbance, wildlife disturbance, marine debris</b> – moderate consequence considered possible due to many individuals reported as struck by vessels in the region and a strong evidence base highlighting the risk of vessels to marine fauna. Evidence suggests a low risk to marine fauna from vessel strike, noise disturbance, and wildlife disturbance, and additional impacts from marine debris.	L	R
	Passive recreational use	All	moderate	moderate	likely	<b>Physical disturbance, wildlife disturbance, marine debris</b> – moderate consequence considered likely due to a strong evidence base on the threat of recreational activities, particularly domestic dogs, to wildlife. Evidence suggests a significant risk to threatened shorebirds from domestic dogs including impacts on behaviour, breeding success, as well as direct mortalities. Wildlife are also impacted by marine debris and human disturbance including breaches of the marine mammal approach distance regulations.	L	R
	Four-wheel driving	North	high	major	likely	<b>Physical disturbance, wildlife disturbance</b> – major consequence considered likely due to known impacts of four-wheel driving on nesting and foraging habitat for threatened shorebirds and nesting habitat for threatened turtles. Evidence suggests a high risk from four-wheel drives to endangered shorebirds at roost and feeding sites, with potential consequences on	A	L

Appendix C Environmental Risk Matrices and Evidence

			moderate	moderate	likely	breeding success and migration capacity for affected populations.		
		Central	moderate	moderate	likely	<b>Physical disturbance, wildlife disturbance</b> – moderate consequence considered likely due to known impacts of four-wheel driving on nesting and foraging habitat for threatened shorebirds and nesting habitat for threatened turtles. Evidence suggests a moderate risk from four-wheel drives to endangered shorebirds at roost and feeding sites, with potential consequences on breeding success and migration capacity for affected populations.	L	L
	Shark control measures	Central	high	major	almost certain	<b>Physical disturbance</b> – major consequence considered almost certain due to entanglements of marine mammals, turtles, and birds in shark mesh nets deployed under the Shark Meshing (Bather Protection) Program.	A	Illawarra to Newcastle
Dredging	Navigation & entrance management and modification, harbour maintenance etc.	All	low	moderate	possible	<b>Physical disturbance, wildlife disturbance, water pollution, sedimentation</b> – moderate consequence considered possible due to known impacts of dredging activities on marine wildlife. Evidence suggests a low risk to wildlife population health from dredging operations including displacement from habitat areas, disturbance from noise, and degradation of habitats from dumping of dredge spoil and decreased water quality.	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	<b>Wildlife disturbance, physical disturbance, water pollution, marine debris</b> – minor consequence considered likely due to known impacts of urban stormwater discharge and associated pollutants and debris on marine wildlife. Evidence suggests increases in pollution from stormwater discharge have consequences for marine wildlife health, including increases in disease and direct	I	L

Appendix C Environmental Risk Matrices and Evidence

		high			mortalities; though there is uncertainty regarding the extent of impact in the north and south regions.		
	Central	high	major	likely	<b>Wildlife disturbance, physical disturbance, water pollution, marine debris</b> – major consequence considered likely due to known impacts of urban stormwater discharge and associated pollutants and debris on marine wildlife. Evidence suggests increases in pollution from stormwater discharge have major consequences for marine wildlife health, including increases in disease and direct mortalities.	I	R: offshore of major urban centres
Foreshore development	North South	moderate	moderate	likely	<b>Wildlife disturbance, physical disturbance, marine debris</b> – moderate consequence considered likely due to the impact of foreshore development on marine wildlife including the replacement of coastal habitat with man-made structures. Habitat loss and degradation has significant impacts on marine wildlife with moderate consequences for wildlife health, breeding success and subsequent population viability. Wildlife are further impacted by increased disturbance, marine debris, and alteration of resources.	L	L
	Central	high	major	Almost certain	<b>Wildlife disturbance, physical disturbance, marine debris</b> – major consequence considered almost certain due to the impact of foreshore development on marine wildlife including the replacement of coastal habitat with man-made structures. Habitat loss and degradation has significant impacts on marine wildlife with major consequences for wildlife health, breeding success and subsequent population viability. Wildlife are further impacted by increased disturbance, marine debris, and alteration of resources. Populations in the central region have a low resilience due to large-scale legacy impacts.	L	L
Beach	Central	moderate	moderate	Almost	<b>Wildlife disturbance, physical disturbance –</b>	I	L

Appendix C Environmental Risk Matrices and Evidence

nourishment and grooming				certain	moderate consequence considered almost certain due to impacts of beach nourishment and grooming on shorebirds and turtles through wildlife disturbance and physical disturbance to shore-based habitat including reductions in prey availability.		
	North South	Low	minor	likely	<b>Wildlife disturbance, physical disturbance</b> – minor consequence considered likely due to impacts of beach nourishment and grooming on shorebirds and turtles through wildlife disturbance and physical disturbance to shore-based habitat including reductions in prey availability; though some uncertainty regarding the extent of impact in the north and south regions.	I	R: Activity occurs in many locations along the coast from Tweed River, Cudgen creek
Clearing riparian and adjacent habitat	Central	high	major	likely	<b>Wildlife disturbance, physical disturbance</b> – major consequence considered likely due to permanent loss of shorebird habitat from clearing and wetland drainage with potential consequences for the viability of already threatened species and additional impacts on turtle nesting habitat. Populations in the central region have a low resilience due to large-scale legacy impacts.	L	L
	North South	low	moderate	possible	<b>Wildlife disturbance, physical disturbance</b> – moderate consequence considered possible due to permanent loss of shorebird habitat from clearing and wetland drainage with potential consequences for the viability of already threatened species and additional impacts on turtle nesting habitat; though some uncertainty regarding the extent of impact in the north and south regions.	L	L
Deliberate introduction of plants and animals	All	high	major	Almost certain	<b>Physical disturbance, wildlife disturbance</b> – major consequence considered almost certain due to a strong evidence base outlining the impact of deliberately introduced pests such as foxes on the population viability of threatened shorebirds. Foxes have been linked to regional declines and localised extinctions of some	A	R

Appendix C Environmental Risk Matrices and Evidence

						shorebird and seabird species in NSW.		
Hydrologic modifications	Estuary entrance modifications	All	moderate	moderate	likely	<b>Water pollution, wildlife disturbance, physical disturbance, water pollution, sedimentation, changes to tidal prism</b> – moderate consequence considered likely due to known impacts of estuary entrance modification on shorebirds, particularly for threatened species that nest near estuary entrances. Evidence suggests estuary entrance modifications threaten the viability of shorebird populations through degradation, inundation, and permanent loss of habitat, as well as reductions in prey availability.	L	L
<b>Climate change</b>	<b>20 years</b>							
Climate change	Altered ocean currents & nutrient inputs	All	low	minor	likely	<b>Altered ocean currents and nutrients, water pollution, reduction in abundances of species and trophic levels</b> – minor consequence considered likely due to changes to the EAC, water quality, and nutrient levels, which affect wildlife distribution, prey distribution, and wildlife health including disease susceptibility and can cause thermal shock in marine turtles. The impact is not expected to be significant in a 20-year timeframe.	I	R
	Climate and sea temperature rise	All	moderate	moderate	likely	<b>Climate and sea temperature rise, reduction in abundances of species and trophic levels</b> – moderate consequence considered likely as increased temperatures are expected to threaten the survival and breeding success of a range of marine wildlife species due to impacts on prey availability, habitat quality, disease outbreaks, thermal tolerances, nest viability, migratory patterns, and energy requirements.	L	R
	Ocean acidification	All	low	minor	likely	<b>Ocean acidification, reduction in abundances of species and trophic levels</b> – minor consequence considered likely due to	I	R

Appendix C Environmental Risk Matrices and Evidence

						impacts on species that directly feed on calcifying organisms (e.g. baleen whales, birds) and top-order predators (e.g. dolphins, pinnipeds) through changes in tropic dynamics. The impact of ocean acidification on marine wildlife is not expected to be significant in a 20-year timeframe.		
	Altered storm/cyclone activity (including flooding, storm surge, inundation)	All	high	major	likely	<b>Physical disturbance, wildlife disturbance, marine debris, water pollution, altered storm and cyclone activity</b> – major consequence considered likely due to impacts of physical disturbance, reduced water quality, pollution, and marine debris from extreme events on wildlife. Increased storm events can cause increased disease, reduction in prey, damage to and inundation of nests and chicks, and direct mortalities through osmotic disruption, increased strandings, and injury.	L	R
	Sea level rise	All	high	major	likely	<b>Physical disturbance, wildlife disturbance, sea-level rise</b> – major consequence considered likely due to inundation and alteration of nearshore habitat, and loss of intertidal foraging habitat and shore-based roosting and nesting habitat, with major consequences for threatened shorebirds and turtles.	L	R
<b>Climate change</b>	<b>50 years</b>							
Climate change	Altered ocean currents & nutrient inputs	All	high	major	likely	<b>Altered ocean currents and nutrients, water pollution, reduction in abundances of species and trophic levels</b> – major consequence considered likely due to changes to the EAC, water quality, and nutrient levels, which affect wildlife distribution, prey distribution, habitat connectivity, and wildlife health including disease susceptibility and can cause thermal shock in marine turtles.	I	R
	Climate and sea temperature	All	high	major	likely	<b>Climate and sea temperature rise, reduction in abundances of species and trophic levels</b> – major consequence considered likely	I	R

Appendix C Environmental Risk Matrices and Evidence

rise					as increased temperatures are expected to threaten the survival and breeding success of a range of marine wildlife species due to impacts on prey availability, habitat quality, disease outbreaks, thermal tolerances, nest viability, migratory patterns, and energy requirements.		
Ocean acidification	All	moderate	moderate	likely	<b>Ocean acidification, reduction in abundances of species and trophic levels</b> – moderate consequence considered likely due to impacts on species that directly feed on calcifying organisms (e.g. baleen whales, birds) and top-order predators (e.g. dolphins, pinnipeds) through changes in tropic dynamics.	I	R
Altered storm/cyclone activity (including flooding, storm surge, inundation)	All	high	major	likely	<b>Physical disturbance, wildlife disturbance, marine debris, water pollution, altered storm and cyclone activity</b> – major consequence considered likely due to impacts of physical disturbance, reduced water quality, pollution, and marine debris from extreme events on wildlife. Increased storm events can cause increased disease, reduction in prey, damage to and inundation of nests and chicks, and direct mortalities through osmotic disruption, increased strandings, and injury.	I	R
Sea level rise	All	high	major	likely	<b>Physical disturbance, wildlife disturbance, sea-level rise</b> – major consequence considered likely due to inundation and alteration of nearshore habitat, and loss of intertidal foraging habitat and shore-based roosting and nesting habitat, with significant consequences for threatened shorebirds and turtles	I	R







## Appendix D Social, Cultural and Economic Risk Matrix and Evidence

		Social benefits															Economic benefits								
Tier 1 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 and Intangible Aboriginal cultural heritage (traditions, spiritual values, knowledge, places, items, and source of food)			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
Tier 1 threats	Stressors																								
Resource use conflict	Conflict over resource access and use	1	Mod	Mod	2	Mod	Mod	3	Low	Low	4	Low	Low	5	High	High	6	Low	Low	7	Low	Low	8	Low	Low
	Anti-social behavior and unsafe practices	9	Mod	Mod	10	Mod	Mod	11	Mod	Mod	12	Low	Min	13	High	High	14	Mod	Low	15	Mod	Low	16	Mod	Low
	Overcrowding / congestion	17	Mod	Mod	18	Mod	Mod	19	Low	Low	20	Low	Low	21	Mod	Mod	22	Mod	Low	23	Min	Min	24	Mod	Low
	Loss or decline of marine industries	25	Low	Mod	26	Min	Low	27	Min	Min	28	Low	Mod	29	Mod	Mod	30	Min	Min	31	Mod	Mod	32	Min	Min
	Excessive or illegal extraction	33	Low	Low	34	Min	Low	35	Min	Min	36	Low	Low	37	Mod	Mod	38	Min	Min	39	Low	Mod	40	Low	Low
Environmental	Water pollution on environmental values - septic runoff, point source pollution and sewage overflows (such as outfalls, STPs, etc) and	41	Low	Low	42	Low	Low	43	Mod	Mod	44	Low	Low	45	Mod	Mod	46	Low	Min	47	Low	Mod	48	Low	Min
	Water pollution on environmental values - urban stormwater discharge	49	Mod	Mod	50	Mod	Mod	51	Mod	Mod	52	Mod	Mod	53	High	High	54	Mod	Mod	55	Mod	Mod	56	Mod	Mod
	Water pollution on environmental values - agricultural diffuse source runoff	57	Mod	Mod	58	Mod	Mod	59	Mod	Mod	60	Mod	Mod	61	High	High	62	Mod	Mod	63	Mod	Mod	64	Mod	Mod
	Water pollution on environmental values - litter, solid waste, marine debris and microplastics	65	Mod	Mod	66	Mod	Mod	67	Mod	Mod	68	Mod	Mod	69	High	High	70	Mod	Mod	71	Mod	Mod	72	Mod	Mod
	Wildlife disturbance (shorebirds, turtles, whales) and impacts to ecological health by dog walkers, 4WD, marine vessels etc.	73	Low	Low	74	Low	Low	75	Mod	Mod	76	Min	Min	77	High	High	78	Low	Low	79	Min	Min	80	Low	Low
	Habitat (physical) disturbance (e.g. from foreshore development, commercial and recreational fishing methods, four wheel driving, and extractive industries (mining).	81	Low	Low	82	Low	Low	83	Mod	Mod	84	Mod	Mod	85	High	High	86	Low	Low	87	Min	Min	88	Low	Low
	Reductions in abundances of species and trophic levels	89	Low	Low	90	Low	Low	91	Mod	Mod	92	High	High	93	High	High	94	Mod	Mod	95	Mod	Mod	96	Low	Low
	Pests and diseases	97	Mod	Mod	98	Low	Low	99	Low	Low	100	Mod	Mod	101	Mod	Mod	102	Low	Low	103	Mod	Mod	104	Low	Low
	Modified hydrology/hydraulics and flow regime	105	Low	Low	106	Mod	Mod	107	Low	Low	108	Mod	Mod	109	Mod	Mod	110	Low	Low	111	Low	Low	112	Low	Low
	Sediment contamination (toxicants in sediment; dioxins in Sydney Harbour, Cooks River)	113	Mod	Low	114	Mod	Low	115	Mod	Low	116	Mod	Low	117	High	High	118	Mod	Low	119	Mod	Low	120	Mod	Low
	Climate change stressors 20 years (sea level rise, altered storm/cyclone activity, flooding, climate and sea temperature rise, altered ocean currents and nutrient inputs)	121a	Low	Low	122a	Low	Low	123a	Mod	Mod	124a	Mod	Mod	125a	High	High	126a	Low	Low	127a	Mod	Mod	128a	Mod	Mod
Climate change stressors 50 years (sea level rise, altered storm/cyclone activity, flooding, climate and sea temperature rise, altered ocean currents and nutrient inputs)	121b	High	High	122b	High	High	123b	High	High	124b	High	High	125b	High	High	126b			127b			128b			
Governance of the marine estate	Inadequate, inefficient regulation, over-regulation (agencies)	129	Mod	Mod	130	Low	Low	131	Mod	Low	132	Mod	Mod	133	High	High	134	Min	Min	135	Mod	Mod	136	Low	Low
	Lack of or ineffective community engagement or participation in governance	137	Low	Low	138	Low	Low	139	Low	Low	140	Low	Low	141	High	High	142	Min	Min	143	Min	Min	144	Min	Min
	Lack of community awareness of the marine estate, associated threats and benefits, regulations and opportunities for participation	145	Min	Min	146	Min	Min	147	Mod	Mod	148	Low	Low	149	High	High	150	Low	Low	151	Low	Low	152	Low	Low
	Lack of compliance with regulations (by users) or lack of compliance effort (by agencies)	153	Mod	Mod	154	Mod	Mod	155	Mod	Mod	156	Mod	Mod	157	High	High	158	Low	Low	159	Mod	Mod	160	Low	Low
Public safety	Wildlife interactions (e.g. shark bite, jellyfish, boat striking a whale)	161	Low	Low	162	Low	Low	163	Min	Min	164	Min	Min	165	Min	Min	166	Min	Min	167	Min	Min	168	Min	Min
	Seafood contamination	169	Mod	Low	170	Min	Low	171	Min	Min	172	Mod	Mod	173	High	High	174	Low	Min	175	Mod	Low	176	Min	Min
	Other water pollution/contamination affecting human health and safety (such as toxic algal blooms, e. coli concentrations, etc.)	177	Low	Low	178	Low	Low	179	Low	Low	180	Min	Min	181	High	High	182	Low	Low	183	Low	Low	184	Low	Low
Critical knowledge gaps	Inadequate social and economic information	185	Mod	Mod	186	Mod	Mod	187	Mod	Mod	188	Mod	Mod	189	High	High	190	Mod	Mod	191	Mod	Mod	192	Mod	Mod
Lack of access availability	Limited or lack of access infrastructure to the marine estate	193	Mod	Mod	194	Mod	Mod	195	Mod	Mod	196	Mod	Mod	197	Mod	Mod	198	Min	Min	199	Mod	Mod	200	Mod	Low
	Loss of public access (either by private development or Government area closures)	201	Mod	Mod	202	Low	Low	203	Low	Low	204	Mod	Mod	205	High	High	206	Mod	Mod	207	Low	Mod	208	Low	Low

Note: Cell 126,127,128 = unknown

Appendix D Social, Cultural and Economic Risk Matrix and Evidence

**Draft Statewide TARA – social, cultural and economic justification table.**

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
1	Moderate	Likely	Moderate	<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>likely</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 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]</li> <li>• Wellbeing (including relaxation): the relaxation benefits associated with use of the coast can be threatened by competing use of coastal land (e.g.</li> </ul>	L	Local but common across the state in localised settings	1-2 years	Stable

Appendix D Social, Cultural 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>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].</p> <ul style="list-style-type: none"> <li>• Submissions received during the public engagement period of the draft TARA demonstrated that conflict over resource access and use are occurring on an ongoing basis with numerous concerns about and examples of conflict over resource use and access, such as illegal camping in parks and headlands in the marine estate, kite surfing, power boats used by dive operators, the impact of wakeboarding boats in the Tweed River, and tension between the local community and tourists. Further research supports this view, with examples of such issues including the response to illegal camping in Kempsey Shire Council (ABC News, 2016) and a scientific assessment of the impact of boat wake in the Tweed River (SMEC, 2012).</li> </ul>				
2	Moderate	Likely	Moderate	<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>1. Increasing feelings of marginalisation 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]</li> <li>2. 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]</li> </ol>	L	Local but common across the state in localised settings	1-2 years	Stable

Appendix D Social, Cultural 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>and see [5]).</p> <p>3. Concerns around discrimination towards Aboriginal people relating to cultural fishing and commercial fishing [3, 6-8]</p> <p>Submissions received during the public engagement period of the draft TARA demonstrated that conflict over resource access and use are occurring on an ongoing basis with numerous concerns about and examples of conflict over resource use and access, such as illegal camping in parks and headlands in the marine estate, kite surfing, power boats used by dive operators, the impact of wakeboarding boats in the Tweed River, and tension between the local community and tourists. Further research supports this view, with examples of such issues including the response to illegal camping in Kempsey Shire Council (ABC News, 2016) and a scientific assessment of the impact of boat wake in the Tweed River (SMEC, 2012). 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>likely</i>.</p>				
3	Minor	Likely	Low	<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 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</p>	L	Local	1-2 years	Stable

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				<p>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 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.</p> <p>Likelihood is therefore considered to be <i>Likely</i>.</p>				
4	Moderate	Possible	Low	<p>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</p>	L	Regional	1-2 years	Stable

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				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> .				
5	Major	Likely	High	<p>Conflict over resource use and allocation is already occurring between the recreational, commercial and 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. Major consequences are therefore <i>likely</i> and include concerns around discrimination towards Aboriginal people relating to cultural fishing and commercial fishing [3, 6-8]</p> <p>Examples highlighted in workshop discussions include: local South Coast Abalone and issues with collecting cultural foods such as 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> <p>Four wheel drive and trial bikes impact sites particularly burial sites and middens. There are also concerns with the development of divested Crown Land along the coastal zone where Native Title may exist [45].</p> <p>Intangible Aboriginal heritage can be impacted by conflict over resource access</p>	L	Local	1-2 years	Increasing



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				and use. There are many factors affecting the capacity to conduct cultural traditions, ranging from poor health of elders, to demographic change, to access restrictions on resources and resource collecting places [7]				
6	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
7	Minor	Likely	Low	<p>Resource use conflict can have impacts on the viability of businesses (e.g. commercial fishing vs. recreational 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 necessarily negative (i.e. the economic benefits of extraction could equal or outweigh the lost economic benefits from tourism activities).</p>	L	Local	1-2 years	Increasing
8	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>	L	Local	1-2 years	Increasing

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				Given the highly localised nature of these incidents, the community-wide impact is only likely to be minor.				
9	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 (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>	L	Local	1-2 years	Increasing
10	Moderate	Likely	Moderate	Social benefits and values cannot be considered as homogenously applicable across the community. Different sections of the community seek different benefits	L	Local	1-2 years	Increasing

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				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. 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.				
11	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
12	Minor	Possible (N&S) Likely (C)	Minimal (N&S) Low (C)	Moderate impacts (overall minor community wide consequences) may be associated with a loss of 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> .	L	Local	1-2years	Stable
13	Major	Likely	High	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 artefacts or heritage places particularly places of significance for	L	Local	1-2 years	Increasing

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				<p>Aboriginal women [7]. Loss or damage to significant places is almost certain to have major consequences on the tangible cultural heritage of affected Aboriginal communities and major statewide consequences.</p> <p>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 ant-social behaviour are considered to be of major consequence for Aboriginal communities.</p>				
14	Moderate	Possible (N&S) Likely (C)	Low (N&S) Moderate (C)	<p>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 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>	L	Local	1-2 years	Increasing
15	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>	L	Local	1-2 years	Increasing

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				<p>Submissions received during the public engagement period of the draft TARA highlighted that unsafe practices, (e.g. recreational boating and fishing) may impact the viability of aquaculture businesses (such as oyster production) in the form of damage to oyster racks and other related infrastructure. Unsafe piloting of vessels have also been noted to impact marine tourism businesses such as the whale watching industry.</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. Occurrence and impacts are expected to be greater in the higher density Central region.</p> <p>(See example: ABC News 'Coogee beach booze ban after disgraceful Christmas day' 27/12/2016; <a href="http://www.abc.net.au/news/2016-12-27/coogee-beach-booze-ban-after-disgraceful-christmas-day/8149670">http://www.abc.net.au/news/2016-12-27/coogee-beach-booze-ban-after-disgraceful-christmas-day/8149670</a>)</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-for-job-losses-if-trouble-persists/2005/12/18/1134840742474.html?page=fullpage#contentSwap1">http://www.smh.com.au/news/national/tourism-braces-for-job-losses-if-trouble-persists/2005/12/18/1134840742474.html?page=fullpage#contentSwap1</a>)</p>				
16	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</p>	L	Local	1-2 years	Increasing

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				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]. 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.				
17	Moderate	Likely (N&S) Almost certain (C)	Moderate	Threats related to resource conflict (see justification 1) and anti-social behaviour (see justification 9) 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. The Marine Estate Community Survey identified overcrowding as a potential social threat that may 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.	L	Local	10 years	Increasing
18	Moderate	Likely (N&S) Almost certain (C)	Moderate	Threats related to resource conflict (see justification 2) and anti-social behaviour (see justification 10) 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
19	Moderate	Possible	Low	Threats related to resource conflict (see justification 31) 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. 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	L	Local	10 years	Increasing

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				population (31%), North East (33%) and Central (35%) regions. Intercept survey participants in Sydney also identified overcrowding as their third priority threat (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.				
20	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
21	Moderate	Likely	Moderate	Overcrowding/congestion can impact on tangible Aboriginal heritage e.g. source of food by too much competition causing a reduction in natural resources [7].  As areas become increasingly developed there is increased access to beaches, tracks and significant lakes particularly in the Sydney Region which furthers degradation of important cultural/burial sites. This may also be exacerbated by divestment of crown land with Aboriginal values. [45]  Increased tourism is also a major contributor which is now occurring all year round in many areas of the state. In high populated areas vandalism is more prevalent for example at Red Rock tourists dig into midden and ochre site which damages the cultural site.  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	I	Local	1-2 years	Increasing

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				Mystery Bay which have traditionally been important camps for Aboriginal people but are now popular camping sites within non-Indigenous communities as well.				
22	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
23	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
24	Moderate	Possible (N&S) Likely (C)	Low (N&S) Moderate (C)	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 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. 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. Overcrowding is expected to increase as an issue due to population increases in	L	Local	1-2 years	Increasing



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				NSW.				
25	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 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 (e.g. increasing privatisation of wharves and harbours and associated costs for boat based businesses of mooring, repairs and docking etc).</li> <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</p>	A	Regional	10 years	Stable

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				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>				
26	Minor (C) Moderate (N&S)	Possible	Minimal (C) Low (N&S)	Changes in the economic viability of traditional maritime industries can impact the community sense of 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> ).	A	Regional	20 years	Increasing
27	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
28.	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, 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].	A	Regional	1-2 years	Increasing (short term) Longer term decreasing
29	Moderate	Likely	Moderate	Decline in marine industry viability particularly professional fishing and aquaculture	L	Statewide	10 years	Stable

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				<p>may impact the ability of Aboriginal people to maintain traditional connections and employment in these industries. Aboriginal commercial fishers are affected by an inability to provide and to afford licences which forces them out of the industry. It is anticipated that there were previously 172 Aboriginal commercial fishers and now there are approximately 20 [45]. There is considerable evidence that Indigenous people employed in these industries consider their jobs as part of their cultural identity [6, 34].</p> <p>In addition, family economics and trade are impacted by the loss of the fishing industry which has existed in NSW prior to European settlement. The loss of fishers also results in the loss of the cultural practice of passing the tradition to and training younger generations.</p> <p>These impacts are both local and regional (<i>moderate</i> consequences) and expected to occur (<i>likely</i> likelihood).</p>				
30	-	-	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.	-	-	-	-
31	Major	Possible	Moderate	<p>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 employees etc.).</p> <p>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.</p>	I	Local	20 years	Increasing
32	-	-	Minimal	Not applicable, individual enjoyment value is unlikely to be impacted by declining marine business viability. Where declining business viability is a function of	-	-	-	-

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				reduced demand, consumer surpluses are not expected to be impacted.				
33	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
34	Minor	Possible (N&C) Likely (S)	Minimal (N&C) Low (S)	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 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> in the north and central regions and <i>likely</i> in the south region due to instances of illegal abalone takes on the NSW South Coast in recent years (see NSW DPI, 2017; Bega District News, 2014; Merimbula News, 2014). Media reports show that this issue is causing division in the community (ABC News 2017), suggesting a higher risk in the South Coast.	L	Local	1-2 years	Stable
35	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
36	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

## Appendix D Social, Cultural 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
37	Moderate	Likely	Moderate	<p>Excessive or illegal extraction can impact on tangible Aboriginal heritage e.g. source of food by causing a reduction in natural resources [7] as has occurred with traditional Gugumbul (turban snails) which have been wiped out by blueberry pickers [45].</p> <p>Whole gathering areas for pipis have been lost due to excessive extraction. In addition, four wheel drives can harm pipis and contribute to user conflicts [45]. Therefore moderate consequences are considered likely.</p> <p>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]</p>	L	Regional	Unknown	Unknown
38	Minor	Possible	Minimal	<p>The Marine Estate Community Survey did not identify excessive or illegal extraction as an economic or social threat [1], implying that the impacts on intrinsic and bequest values are only minor.</p> <p>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.</p>	L	Local	20 years	Unknown
39	Moderate	Possible (N&C) Likely (S)	Low (N&C) Moderate (S)	<p>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).</p> <p>For instance, there have been numerous instances of illegal abalone takes on the NSW South Coast which have impacted the profitability of commercial operators. As a result, <i>moderate</i> impacts are considered <i>likely</i> in the Southern Region as a result of illegal extraction.</p> <p>(See examples: NSW DPI 'Largest Abalone Seizure in more than 20 years' <a href="http://www.dpi.nsw.gov.au/about-us/media-centre/releases/2017/largest-abalone-">http://www.dpi.nsw.gov.au/about-us/media-centre/releases/2017/largest-abalone-</a></p>	L	Local	20 years	Increasing

## Appendix D Social, Cultural 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><u>seizure-in-more-than-20-years;</u></p> <p>Bega District News 'South Coast abalone poachers face serious penalties' <a href="http://www.begadistrictnews.com.au/story/2104307/south-coast-abalone-poachers-face-serious-penalties/">http://www.begadistrictnews.com.au/story/2104307/south-coast-abalone-poachers-face-serious-penalties/</a>, 21/02/2014</p> <p>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 'possible' in the north and central and likely in the south region due to abalone issues on the South Coast.</p>				
40	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), the likelihood of such consequences are assumed to be only 'possible'.	A	Local	20 years	Increasing
41	Moderate	Possible	Low	<p>The consequences of water pollution events associated with septic runoff, point source discharges and sewage overflows are likely to be localised and temporary impacts on wellbeing associated with relaxation and 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, moderate consequences are considered possible in response to the threat of septic runoff, point source pollution sewage overflows.</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. Nutrients are carried in septic runoff in many estuaries throughout NSW that contain adjacent septic systems. The risk associated with "sewage effluent and septic runoff" was low in ocean waters and localised around outfalls and</p>	A	Local	10 years	Stable

## Appendix D Social, Cultural 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
				moderate (north and south regions) to high (central region) in estuarine waters, but septics consistent with the environmental TARA was the major contributor to the risk and the impacts were likely to be localised.				
42	Moderate	Possible	Low	<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>moderate</i> consequences are considered <i>possible</i> in response to the threat of septic runoff, point source pollution and sewage overflows in all three regions.</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 consistent with the environmental TARA was the major contributor to the risk and the impacts were likely to be localised.</p>	L	Local	1-2 years	Stable
43	Moderate	Almost certain	Moderate	<p>Loss of amenity associated with pollution from septic runoff, point source pollution and sewage overflows 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%)</p>	L	Local	1-2 years	Stable

## Appendix D Social, Cultural 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>Hawkesbury/Pittwater (52%) and Eden (37%) participants identified water pollution/litter as their second highest threat [1], therefore <i>moderate</i> consequences are considered <i>almost certain</i>.</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 consistent with the environmental TARA was the major contributor to the risk and the impacts were likely to be localised. This particularly occurs in estuaries that contain adjacent septic systems.</p> <p>Common toxicants from industrial discharges includes metals and metalloids, petrochemicals, garden pesticides and fertilisers. Elevated metal and organic chemical concentrations in sediments have been linked to significant risk to aquatic organisms. Based on a small dataset and limited toxicity information, a potential risk was indicated for dolphins living near urban or industrial estuaries. These dolphins had higher toxic equivalents in their bodies than mammals living in the open ocean [50].</p>				
44	Moderate	Possible	Low	<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>moderate</i> consequences are considered <i>possible</i> in response to the threat of septic runoff, point source pollution and sewage overflows in all three regions.</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</p>	A	Local	1-2 years	Stable



## Appendix D Social, Cultural 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
				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 is the major contributor to the risk and the impacts were likely to be localised.				
45	Major	Possible	Moderate	<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]. There was particular concern raised surrounding polychlorinated biphenyls (PCBs) contaminating rivers and fish supplies which impacts traditional Aboriginal food sources. Water pollution can also cause damage to places associated with cultural practices and traditions [45]</p> <p>Sewage on beaches impacts the ability of Aboriginal people to fish due to contamination, this has occurred at La Perouse. Similarly, Aboriginal people rely on high protein diets particularly consisting of fresh fish. [45]</p> <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 waters, but septic was the major contributor to the risk and the impacts were likely to be localised.</p>	L	Local	1-2 years	Increasing
46	Minor	Possible (N&S) Almost	Minimal (N&S) Low (C)	Water pollution including septic runoff, 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	A	Statewide, regional (populated)	1-2 years	Stable

Appendix D Social, Cultural 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
		certain (C)		<p>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 was the major contributor to the risk and the impacts were likely to be localised.</p>		areas)		
47	Minor (C) Moderate (N&S)	Likely (N&S) Almost certain (C)	Moderate (N&S) Low (C)	<p>Water pollution including septic runoff, 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 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 septics contributed to the risk and the impacts were likely to be localised consistent with the environmental TARA.</p>	A	Statewide, regional (populated areas)	1-2 years	Increasing

## Appendix D Social, Cultural 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
48	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 46), 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). Submissions received during the public engagement period of the draft TARA noted the impacts of sewage overflows in estuaries, which may impact aquaculture producers (such as oyster growers) leading to reduced availability of seafood.</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 was the major contributor to the risk and the impacts were likely to be localised.</p>	A	Statewide, regional (populated areas)	1-2 years	Increasing
49	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 potentially 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</p>	L	Local	10 years	Stable

## Appendix D Social, Cultural 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>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 177.</p> <p>The NSW general community listed water pollution from sediment or run-off (29%) as a third priority threat. 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>likely</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>				
50	Moderate	Likely(N &S) Almost certain (C)	Moderate	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>likely</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.	L	Local	10 years	Stable
51	Moderate	Likely (N&S) Almost certain (C)	Moderate	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 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.	L	Local	10 years	Stable
52	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	L	Local	10 years	Stable

## Appendix D Social, Cultural 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
				events in this region.				
53	Major	Likely (N&S) Almost certain (C)	High	<p>Water pollution particularly from stormwater can also cause damage to places associated with cultural practices and traditions.</p> <p>Pollution and environmental damage is resulting in cultural practices such as weaving, abalone collection, gathering of pipis, and other practices no longer occurring. This has major impacts across many aspects of cultural life and, in many instances, is severely curtailing the ability of Aboriginal people to not only enjoy their cultural fishing rights today but impeding their ability to hand on cultural information and practice cultural activities with their younger generations.[45]</p> <p>Storm water runoff is a major issue (e.g. Ballina, Nelson Bay, Coffs Harbour, Harrington, Myall Lakes).</p> <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>	L	Unknown	Unknown	Unknown
54	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 potentially toxic contaminants. This was higher in the central compared to north and south regions due to higher population density and industrialisation.</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 Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
55	Moderate	Likely	Moderate	The environmental TARA reported both sewerage and industrial discharges as having impacts from combined stressors of nutrients, suspended sediments and potentially toxic contaminants. This was higher in the central compared to north and south regions due to higher population density and industrialisation. 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). Submissions received during the public engagement period of the draft TARA raised the issue of urban stormwater overflows impacting oyster producers. At a State-wide scale, the consequences of these impacts are categorised as moderate.	A	State-wide, regional (populated areas)	1-2 years	Increasing
56	Moderate	Likely (N&S) Almost certain (C)	Moderate	The environmental TARA reported both sewerage and industrial discharges as having impacts from combined stressors of nutrients, suspended sediments and potentially 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 run-off, therefore resulting in a major impact on their enjoyment value, resulting in a moderate consequence rating.	A	Statewide, regional (populated areas)	1-2 years	Increasing
57	Moderate	Likely	Moderate	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 Posidonia 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	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
				<p>concern for the public [1]. 72% thought the most important benefits was clean waters that support a variety of habitats and marine life.</p> <p>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 response to the threat of agricultural runoff in all regions</p>				
58	Moderate	Likely	Moderate	<p>For the Environmental TARA evidence, refer to cell 57 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>likely</i> in response to the threat of agricultural runoff across all regions</p>	L	Unknown	Unknown	Unknown
59	Moderate	Likely	Moderate	<p>For the Environmental TARA evidence, refer to cell 57 above. For the social implications refer to the evidence presented in 51 above.</p>	L	Unknown	Unknown	Unknown
60	Moderate	Likely	Moderate	<p>For the Environmental TARA evidence, refer to cell 57 above. For the social implications refer to the evidence presented in 51 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>likely</i> in response to the threat of agricultural runoff across all regions.</p>	L	Unknown	Unknown	Unknown
61	Major	Likely	High	<p>Water pollution particularly from stormwater can also cause damage to places associated with cultural practices and traditions.</p> <p>Pollution and environmental damage is resulting in cultural practices such as weaving, abalone collection, gathering of pipis, and other practices no longer</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
				<p>occurring. This has major impacts across many aspects of cultural life and, in many instances, is severely curtailing the ability of Aboriginal people to not only enjoy their cultural fishing rights today but impeding their ability to hand on cultural information and practice cultural activities with their younger generations. [45]</p> <p>Storm water runoff is a major issue (e.g. Ballina, Nelson Bay, Coffs Harbour, Harrington, Myall Lakes).</p> <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>				
62	Moderate	Likely	Moderate	<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>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.</p>	A	Statewide, regional (regional areas with more agricultural activity)	1-2 years	Increasing
63	Moderate	Likely	Moderate	<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>	A	Statewide, regional (regional areas with more agricultural	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 Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				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.		activity)		
64	Moderate	Likely	Moderate	<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
65	Moderate	Likely	Moderate	<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 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</p>	L	Unknown	Unknown	Unknown

Appendix D Social, Cultural 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>and other sharp objects, human or animal waste etc.) Recently concerns have been raised about the occurrence of discarded syringes on beaches particularly those used for surf carnivals as it exacerbates the discomforting image of sharp objects hidden in soft sand with the potential to impact health and safety [49]. There is also the potential that fish and shellfish meant for human consumption may contain micro plastics [49].</p> <p>Litter affects 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).</p> <p>Litter also has the potential to block stormwater drainage systems which can cause flooding during periods of heavy rain. Flooding can endanger human life and provides an ideal breeding ground for disease-carrying insects such as mosquitoes in tropical climates [47].</p> <p><i>Moderate</i> consequences are considered <i>likely</i> in response to the threat of rubbish and debris across all regions.</p>				
66	Moderate	Likely	Moderate	<p>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 connection and interaction.</p> <p>It is known that 92% of people believe that littering is socially unacceptable and that litter makes an area look dirty and uncared for, unpleasant to be in and less likely to be used and enjoyed by the community [48]. Therefore, individuals are less likely to socialise in an area where litter is present which adversely impacts the ability to create a sense of community.</p> <p>Littered places also send a strong message that social control has been relaxed or</p>	L	Unknown	Unknown	Unknown

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				<p>is non-existent. These places can suggest a local relaxation of sanctions against littering and this can lead to a perception that littered areas may be the haunt of petty criminals, or particular groups with different norms to those of wider society. This may prevent groups socialising in these places and fostering a sense of community [46].</p> <p><i>Moderate</i> consequences are considered <i>likely</i> in response to the threat of rubbish and debris across all regions.</p>				
67	Moderate	Likely	Moderate	<p>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.).</p> <p>At least 77 species of marine wildlife found in Australian waters have been impacted by entanglement in, or ingestion of, plastic debris during the last thirty years. The affected species include six species of marine turtles, 12 species of cetaceans, at least 34 species of seabirds, dugongs, six species of pinnipeds, and at least 10 species of sharks and rays, and at least eight other species groups. This contributes to an inability of individuals to enjoy and appreciate the biodiversity of the marine estate [49].</p> <p><i>Moderate</i> consequences are considered <i>likely</i> in response to the threat of rubbish and debris.</p>	L	Unknown	Unknown	Unknown
68	Moderate	Likely	Moderate	<p>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.</p> <p>Species for consumptive use are also impacted by entanglement in, or ingestion</p>	L	Unknown	Unknown	Unknown

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				<p>of litter and debris. With reduced species this impacts the recreational and commercial fishers [49].</p> <p>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>likely</i> in response to the threat of rubbish and debris across all regions.</p>				
69	Major	Likely	High	<p>Water pollution particularly from litter can also cause damage to places associated with cultural practices and traditions.</p> <p>Pollution and environmental damage is resulting in cultural practices such as weaving, abalone collection, gathering of pipis, and other practices no longer occurring. This has major impacts across many aspects of cultural life and, in many instances, is severely curtailing the ability of Aboriginal people to not only enjoy their cultural fishing rights today but impeding their ability to hand on cultural information and practice cultural activities with their younger generations.[45]</p> <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]. Water pollution can also cause damage to places associated with cultural practices and traditions. The spiritual seascape and food resources are impacted by water pollution and the decline of species e.g. turtles caused by same. A major pollutant is waste from fishing.</p>	L	Unknown	Unknown	Unknown
70	Moderate	Likely	Moderate	<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 recreational 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</p>	A	Statewide, regional (populated areas)	1-2 years	Increasing

Appendix D Social, Cultural 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>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>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. In the central region the likelihood is higher due to increased population density, however in the north and south regions whilst there may not be as much pollution individuals place higher value on the cleanliness of the marine estate and therefore are less likely to litter in these regions and therefore be less tolerant of litter and marine debris. This can be described as place attachment where there is both emotional use of and emotional attachment to a location. Those with higher levels of place dependence such as those in north and south regions are known to exhibit more environmentally responsible behaviour [46].</p>				
71	Moderate	Likely	Moderate	<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 recreational fishers poses a threat to turtles, seals and seabirds through ingestion and entanglement.</p> <p>These stressors will likely cause major impacts on businesses 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. Despite the increased population density in the central region, the likelihood is the same in all regions because there is an increased expectation of a clean environment in the north and south region.</p>	A	Statewide, regional (populated areas)	1-2 years	Increasing

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				Another economic impact is that Local Councils and community groups invest money and time to clean-up litter to preserve the beauty of tourist beaches and to remove the waste that might injury holiday makers. With the expectation of cleanliness in the north and south regions litter poses a moderate consequence as litter had the potential to adversely impact tourism in these regions [47].				
72	Moderate	Likely	Moderate	<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 recreational fishers poses a threat to turtles, seals and seabirds through ingestion and entanglement.</p> <p>Litter in oceans and seas is an aesthetic problem, incurs considerable costs to clean and can have severe impacts on marine organisms and habitats. In 2014-15 litter costs \$180 million with much of this funding delegated to cleaning up litter so that the aesthetic appeal and ability to enjoy public places particularly in the marine environment is not limited [48].</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
73	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> </ul>	L	Unknown	Unknown	Unknown

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				<ul style="list-style-type: none"> <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 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.</p>				
74	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 73	I	Unknown	Unknown	Unknown
75	Moderate	Almost certain	Moderate	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	A	Local	10 years	Unknown

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				<p>(including shorebirds, seabirds, turtles and whales) will impact on the intrinsic values derived from the marine estate given:</p> <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 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> <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>				
76	Minor	Unlikely	Minimal	Given wildlife watching is not considered an extractive activity; there will be little impact on consumptive use. Refer to cell 73	I	Local	10 years	Stable
77	Major	Almost certain	High	<p>Wildlife disturbance can impact on totemic or culturally significant species.</p> <p>This is evidenced by the impact to migratory shorebirds and resident birds of illegal dog walking and four wheel drive use. These activities also impact pipis as the sand is compacted. This disturbance has the potential to cause cultural deficiency syndrome.</p> <p>With the temperature of waterways increasing this will bring different species to different waterways which also results in a loss of fish that are important food resources and may have totemic significance to Aboriginals [45]</p>	A	Statewide	1-2 years	Increasing



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				<p>In regards to totemic species sharks and shark netting often contributes to cultural sickness. This is particularly an issue for communities on the South Coast who have totemic ties to whales and communities on the North Coast with ties to dolphins. [45]</p> <p>Wildlife interactions can impact on both tangible and intangible Aboriginal cultural heritage as a lack of or changing wildlife interactions can impact on spiritual connections e.g. totemic species, culturally significant species, links to Country, food sources.</p> <p>The 5 Islands Nature Reserve off the coast of Wollongong has had a lot of work to ensure survival of sea birds, including penguins after non-native species and neglect. These are significant islands in the local Aboriginal cultural landscape with dreaming stories and extensive connections [45]</p>				
78	Minor	Likely	Low	Concern over habitat disturbance and physical damage were lower in the Marine Estate Community Surveys [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, four wheel drives and marine vessels are similarly unlikely to be widespread.	L	Local	10 years	Increasing
79	Minor	Possible	Minimal	The impacts from dog walkers, four wheel drives and marine vessels are unlikely to be widespread, 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
80	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 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.	L	Local	10 years	Increasing

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81	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 Survey [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)</li> <li>• Declines in fish abundance associated with loss of nurse areas for important seafood species and flow on impacts on health and wellbeing for seafood consumers and recreational fishers 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</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 Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				habitat protection measures now in place within the marine estate.				
82	Moderate	Possible	Low	As per justification 42, 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 suite of habitat protection measures now in place within the marine estate.	L	Unknown	Unknown	Unknown
83	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> <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.	L	Local	10 years	Increasing

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84	Moderate	Likely	Moderate	Declines in fish abundance associated with loss of 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.	L	Local	10 years	Increasing
85	Major	Almost Certain	High	<p>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 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.</p> <p>For example, freshwater lagoons contain significant cultural species such as long-neck turtles and frogs which are now endangered (Killalea lagoon and Shellharbour Swamp). Marine developments are destroying culturally significant habitats and changing water flows (e.g. Shell Cove Precinct Development at Bass Point). Four wheel drive activity on beaches is causing significant damage to key species such as pipis. Four wheel drive tracks and overuse on Stockton Beach has resulted in major erosion and disruption of nesting areas for shore birds and migratory species in the adjacent wetlands [45].</p> <p>Development at beaches for tourism purposes e.g. installation of board walks, cleaning sand, covering oysters, introduction of cruise ships causes destruction to culturally significant sites.</p> <p>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.</p> <p>A/Prof. Stephan Schnierer notes threat is non-Indigenous use and management that fails to accommodate Aboriginal connections to Sea country [8].</p>	A	Statewide	1-2 years	Increasing

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86	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 impacted.	L	Local	10 years	Increasing
87	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, For example, the damage to bethos from anchoring may have a negative impact on scuba diving operators. Conversely, 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'.	A	Local	10 years	Increasing
88	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).	A	Local	10 years	Increasing
89	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 local product is better for their health [3]. Decline in availability of local seafood may result in some overall decline in seafood consumption.</li> <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</li> </ul>	L	Statewide	10 years	Stable

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				<p>fishing. The environmental TARA reported commercial fishing impacts on abundancies of top and lower trophic levels coasts and oceans and estuary general as moderate on the basis of potential changes to trophic structure and uncertainties in understanding the effect of the fish stocks on ecosystem function.</p> <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>				
90	Moderate	Possible	Low	<p>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>.</p>	L	Local	10 years	Stable
91	Moderate	Likely	Moderate	<p>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</p>	L	Statewide	10 years	Stable

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				<p>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 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.</p> <p>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 are therefore considered to be <i>moderate</i> across the whole community. These consequences are considered <i>likely</i>.</p>				
92	Major	Likely	High	<p>Declines in fish abundance will impact those sectors 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</p>	L	Regional	10 years	Stable

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				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.				
93	Major	Likely	High	<p>Reductions in abundances of top and lower order trophic levels can impact on tangible and intangible Aboriginal heritage as environmental degradation can impact on spiritual connections e.g. totemic species, culturally significant species, links to Country, food sources [7].</p> <p>Environment Impact studies highlight that Grey Nurse Shark habitats are being impacted by mining, particularly below sea level blasting. This can impact on spiritual connections e.g. totemic species, culturally significant species, links to Country, food sources [45].</p> <p>Further evidence of the reduction in abundances of species and trophic levels is that beaches including Shelley Beach and Miners Beach near Coffs Harbour used to have large stocks of abalone and these have completely disappeared. Similarly, starfish have disappeared from beaches including Town Beach, Coffs Harbour. Dolphin numbers and sightings are fewer and changing patterns of fish types are being noticed in areas such as Nambucca River and surrounding areas. In addition, catches of prawns and mud crabs have reduced significantly in locations including Yamba and Port Macquarie. The reduction in these species as well as pipis and prawns impacts spiritual connections as fish, sharks and whales are all totemic animals with spiritual and cultural significance for Aboriginal groups, particularly along the North Coast. In addition, cultural gathering and fishing is directly impacted by lower numbers [45].</p> <p>The significant impact on Aboriginal cultural heritage of the reduction in species is</p>	A	Regional	Unknown	Increasing



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				highlighted by the need of Aboriginal communities to re-learn what species to catch and what constitutes a safe food source [45].				
94	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.	L	Statewide	10 years	Increasing
95	Moderate	Likely	Moderate	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. Additionally, this may have an impact on tourism operators whom rely on the abundance of fish. Examples include the whale and dolphin watching industries and scuba diving and snorkelling business.  The threat of decline may be greater in areas with more pressure on fish habitats (higher in central than in north and south); although the net economic impacts may be felt more in regional economies where there may be a greater dependence upon fisheries or marine tourism businesses.	L	Local and Statewide	10 years	Increasing
96	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 negative impacts	L	Local and Statewide	10 years	Increasing
97	Moderate	Likely	Moderate	The impacts of pests and disease are particularly significant (major) for the aquaculture industry and seafood consumers: <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> </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
				<ul style="list-style-type: none"> <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> <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.</p> <p>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</p>				

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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
				oyster businesses with \$2.4 million worth of oysters sold annually (DPI, 2013). The 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.				
98	Minor	Likely	Low	As per justification 90 – 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 97.	L	Local	10 years	Stable
99	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 <i>possible</i> . Refer also to cell 97.	L	Regional	10 years	Stable
100.	Moderate	Likely	Moderate	As per justification 97 – 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 97.	L	Local	10 years	Stable
101.	Major	Possible	Moderate	Pests and diseases can impact on tangible Aboriginal cultural heritage as	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
				environmental degradation can impact on spiritual connections e.g. totemic species, culturally significant species, links to Country, food sources [7]. 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].				
102.	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 97.	I	Regional	20 years	Increasing
103.	Major	Possible	Moderate	<p>Pests/diseases will impact on tourism operators, commercial fishers and aquaculture producers where impacts on habitats and marine life are significant. Recent examples include the outbreak of white spot disease in the Queensland prawn industry and QX disease in the NSW Oyster industry. These incidents have resulted in severe disruption to aquaculture businesses and to local communities in general.</p> <p>Submissions received during the public engagement period of the draft TARA highlighted that the outbreak of pests and diseases on the availability of seafood may also impact NSW's reputation as a tourism destination. This can impact large tourism operators such as the Sydney Fish Markets (SFM). The SFM is a leading tourism destination for international visitors with the main drawcard being the fresh, local supply of seafood.</p> <p>Outbreaks of pests and diseases have the potential to affect potential visitors at significant cost to the wider economy.</p> <p>Additionally, the impacts may be felt in the north and south regions. For instance,</p>	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 Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				if visitors are not confident about getting fresh oysters from the Hawkesbury or South Coast due to diseases outbreaks, visitors may choose to visit elsewhere, causing lost business.  Impact dependent on the scale and impact of the pest/diseases. Refer also to cell 97.				
104	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 97.	I	Regional	20 years	Increasing
105	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. Submissions received during the public engagement period of the draft TARA noted the impact on some lagoons after storm events, specifically around the impact on the entrance conditions. This includes the impact on lagoon foreshores inside of the entrance that become inundated, affecting the area's social amenity. For instance, bike paths and dog walking reserves become inaccessible.  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</i> and <i>likely</i> .	L	Local	10 years	Stable
106	Moderate	Likely	Moderate	Consequences of modified flows on socialisation and sense of community are likely to be largely sectoral and site specific, relates mostly to common community	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
				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 105.				
107	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 105.	L	Local	10 years	Stable
108	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 105.	L	Local	10 years	Stable
109	Moderate	Likely	Moderate	<p>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]. Pipis are also significantly impacted.</p> <p>Another example raised by Aboriginal people consulted on the draft TARA was the impacts of the weir at Ulladulla creek which empties into bay and disrupts fish breeding and has other negative environmental impacts which are considered important cultural resources [45]</p> <p>The stressor modified freshwater flows 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. It can also cause damage to places associated with cultural practices and traditions</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
				[7]. Refer also to cell 105.				
110	Minor	Likely	Low	Limited information available. Modified hydrology/hydraulics and flow regime issues are largely site-specific.	I	Local	20 years	Stable
111	Minor	Likely	Low	Limited information available. Modified hydrology/hydraulics and flow regimes issues are largely site-specific.	I	Local	20 years	Stable
112	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
113	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 moderate overall), with impacts on wellbeing associated with relaxation and enjoyment. This is considered possible in north and south regions and likely 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 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 [50].</p>	L	Local	10 years	Stable
114	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 moderate overall), if it inhibits or discourages the use of the coast as a place for social connections and community use. This is considered possible in north and south regions and likely in central region.	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
115	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
116	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
117	Major	Likely	High	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]. Degradation and Williamstown is a major issue. Contamination from coal mining prevents Aboriginal people fishing in traditional areas due to run off and pollution.[45]  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
118	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
119	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	L	Local	20 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
				greater in areas of greater population density and waste production.				
120	Minor (N&S) Moderate (C)	Likely	Low (N&S) Moderate (C)	See justification 118; 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
121a	Moderate	Possible	Low	<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 [42]. Within the 20 year time frame, sea level rise and altered storm and cyclone activity were likely to have the highest impacts.</p> <p>In the near future (now to 2031) it is predicted that increases in heavy rainfall events are expected to increase the likelihood of flooding along urban streams. The effects of increased flood incidence include poor water quality with impacts on beach use.</p> <p>Decrease in primary production leading to further emigration from rural towns, where agriculture is the dominant industry, leading to multiple flow-on effects including health and community cohesion impacts. There will also be increasing mental health issues associated with coping with greater extremes in climatic conditions and more frequent natural hazards will make injuries in the community more likely,</p> <p>The south coast has seen significant population growth, this has been due to immigration of retirees, which has offset out-migration by youth. As a result, the coastal sub-region has an ageing population. This trend is expected to continue, with the population aged 65 years and over increasing to 35% by 2031 [43]. People over 65 are generally considered a vulnerable group within the community. In the context of climate change they are more susceptible to its direct impacts such as heatwaves and this is expected to lead to an increased demand for health services [43].</p> <p>Another climate change pressure is the potential of extreme heat days to increase which can lead to poor quality air days. The impact this may have on human</p>	L	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 Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				<p>health including increased stress on cardio vascular and respiratory systems which is also likely to contribute to increased service delivery demand for emergency departments, medical centres, day clinics, ambulances and GPs [44].</p> <p>Overall community wide consequences across a 20-year timeframe are considered to be moderate with a possible likelihood with risk expected to increase over time (as identified by higher risk levels for 50 years in the environmental TARA).</p>				
121b	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>	L	Local	Uknown	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
				Overall community wide consequences are considered to be major, given the likely wide scale loss of enjoyment and recreational opportunities associated with damage and loss of foreshore areas. Major consequences at a 50 year timeframe are attributed to the cumulative impact of multiple climate change stressors, together impacting on social values.				
122a	Moderate	Possible	Low	<p>The consequences of damage and loss associated with increased frequency and severity of storm and erosion events include implications for socialisation and sense of community.</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 [42]. Within the 20 year time frame, sea level rise and altered storm and cyclone activity were likely to have the highest impacts.</p>	L	Regional	20 years	Increasing
122b	Major	Likely	High	As per justification 121b, <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> . Major consequences at a 50 year timeframe is attributed to the cumulative impact of multiple climate change stressors, together impacting on social values.	L	Local	Unknown	Unknown
123a	Moderate	Likely	Moderate	<p>Consequences of damage and loss associated with increased frequency and severity of storm and erosion events are likely 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.</p> <p>Tourism is a significant industry on the North Coast and leads to large influxes of people, particularly during the school holidays who often come to enjoy the biodiversity of the Marine Estate.</p> <p>With warming in the north region projected to be on average 0.7°C in the near future (the period to 2031) the region will be particularly sensitive to increased</p>	L	Regional	20 years	Increasing

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				summer rainfall and rising sea levels. This is likely to see the biodiversity that cannot adapt to these changes deplete [42].				
123b	Major	Almost certain	High	As per justification 121b, 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. These consequences are considered <i>major</i> . Major consequences at a 50 year timeframe are attributed to the cumulative impact of multiple climate change stressors, together impacting on social values.	I	Local	Unknown	Unknown
124a	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 flooding. 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 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 moderate and likely, and include changes in abundance in marine species valued for consumptive use and impacts of acidification on aquaculture operations and on crustaceans more broadly.  The effects of increased flood incidence on private property, loss of crops and livestock, nutrient runoff, standing water following flood and sedimentation in rivers and drainage systems include poor water quality with impacts on terrestrial, aquatic and marine coastal ecosystems, commercial (e.g. oyster production) and recreational fishing and beach use [42].	L	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 Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
124b	Major	Almost certain	High	<p>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 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.</p> <p>In addition, submissions received during the public engagement period raised concerns regarding the potential large scale impacts of climate change on consumptive use in particular on fishing and tourism industries (e.g. see Wynberg et al 2016 Verges et al 2016).</p> <p>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. Major consequences at a 50 year timeframe is attributed to the cumulative impact of multiple climate change stressors, together impacting on social values.</p>	I	Local	Unknown	Unknown
125a	Major	Likely	High	<p>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].</p> <p>With increased sea temperatures species movements, spatially and seasonally shift which has a significant tangible and intangible impact on cultural heritage.</p>	L	Statewide	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 Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				<p>This impacts Indigenous fishing rights as people who rely on specific species e.g. totemic species can no longer access same due to species shifts [45].</p> <p>Flooding and high rain fall because of climate change also impacts totemic species such as the Bellinger River Snapping Turtle, due to blueberry chemicals being washed down catchments to estuaries. Similarly, phosphate impacts on environmental vegetation, reduces habitats and impacts fish that consume contaminants [45].</p> <p>Climate change initiatives such as the construction of sea walls impacts on Aboriginal cultural heritage as some walls have been built on rocky shores which were previously oyster collection areas [45].</p> <p>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].</p>				
125b	Major	Likely	High	Major consequences at a 50 year timeframe is attributed to the cumulative impact of multiple climate change stressors, together impacting on cultural values. Refer to cell 125a	I	Statewide	Unknown	Unknown
126a	Minor	Likely	Low	<p>Impacts of climate change are likely to have significant impacts on the intrinsic benefits some people and communities derive from the marine estate, including extractive users and passive users.</p> <p>Increased flood incidence due to increased summer rainfall in the near future (now to 2031) is likely to displace people and impact water quality that affects terrestrial, aquatic and marine coastal ecosystems, commercial and recreational fishing and beach use. In the near future, these events are likely to have minor impacts on the ability of people and communities to derive intrinsic and bequest values from the marine estate [42].</p>	L	Statewide	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 Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
126b			Unknown	It is anticipated, as with the 20 year assessment, that impacts of climate change on Intrinsic & bequest values, Employment & value of production, and Individual enjoyment value (consumer surplus) will increase over time. In particular, significant impacts can be expected where climate change impacts upon business assets and access to the marine environment, and where climate change affects the distribution, abundance, breeding cycles and migrations of marine plants and animals that people rely on for food, income and enjoyment. However, different economic uses of the marine estate will experience different impacts, and economic adjustment strategies are expected to seek to minimise losses and identify new opportunities. Therefore, impacts on economic benefits cannot be predicted over a long term time frame with the same certainty as environmental impacts. Economic modelling is not available to support the determination of risk ratings for economic uses of the marine estate over a 50-year time-frame.				
127a	Moderate	Likely	Moderate	<p>The climate change impacts are identified as putting upward pressure on costs as revenue is almost certain to be influenced by temporary loss of market access, temporary loss of tourism and worker absenteeism.</p> <p>With a change in temperature, sea level rises and seasonal rainfall it is also almost certain loss of agricultural and fisheries production will occur. The effects of increased flood incidence on private property, loss of crops and livestock, nutrient runoff, standing water following flood and sedimentation in rivers and drainage systems may lead to poor water quality with impacts on commercial (e.g. oyster production) and recreational fishing [42].</p> <p>Increased rainfall in the north coast region is likely to see an increase in the incidence of major weather events particularly flooding. Flooding will not only lead to worker absenteeism but may see a temporary loss of tourism which is likely to have an impact on employment opportunities in the region and employment stability.</p> <p>Threats to natural resource-based industries in the south coast area including the agriculture, fisheries and tourism sectors as a result of some ecosystems being diminished, for example the coastal lakes inundated by sea level rise. The natural</p>	L	Statewide	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 Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				resources sector forms the mainstay of several local economies in the region both directly, and through its need for products and services supplied by local business operators, for example, coastal sub-regions' tourism economy. Thus, changes in climate that impact on ecosystems may reduce the profitability of local businesses via the impacts on natural resource-based industries [43].				
127b			Unknown	It is anticipated, as with the 20 year assessment that impacts of climate change on Intrinsic & bequest values, Employment & value of production, and Individual enjoyment value (consumer surplus) will increase over time. In particular, significant impacts can be expected where climate change impacts upon business assets and access to the marine environment, and where climate change affects the distribution, abundance, breeding cycles and migrations of marine plants and animals that people rely on for food, income and enjoyment. However, different economic uses of the marine estate will experience different impacts, and economic adjustment strategies are expected to seek to minimise losses and identify new opportunities. Therefore, impacts on economic benefits cannot be predicted over a long term time frame with the same certainty as environmental impacts. Economic modelling is not available to support the determination of risk ratings for economic uses of the marine estate over a 50-year time-frame.				
128a	Moderate	Likely	Moderate	Impacts of climate change are 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.). This will particularly impact the more than 12 million visitors annually who visit the region for its enjoyment benefits derived from the marine estate [42].	L	Statewide	20 years +	Increasing
128b			Unknown	It is anticipated, as with the 20 year assessment, that impacts of climate change on Intrinsic & bequest values, Employment & value of production, and Individual enjoyment value (consumer surplus) will increase over time. In particular, significant impacts can be expected where climate change impacts upon business assets and access to the marine environment, and where climate change affects the distribution, abundance, breeding cycles and migrations of marine plants and animals that people				



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				rely on for food, income and enjoyment. However, different economic uses of the marine estate will experience different impacts, and economic adjustment strategies are expected to seek to minimise losses and identify new opportunities. Therefore, impacts on economic benefits cannot be predicted over a long term time frame with the same certainty as environmental impacts. Economic modelling is not available to support the determination of risk ratings for economic uses of the marine estate over a 50-year time-frame.				
129	Moderate	Likely	Moderate	<p>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:</p> <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 significant concern [2, 10-13].</li> <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> </ul> <p>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</p>	L	Regional	1-2 years	Stable

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				<p>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 MPAs and other conservation management regulations. 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 requires further investigation.</li> </ul> <p>Given the largely sectoral nature of the impacts the overall consequence is considered to be <i>moderate</i> and <i>likely</i>.</p>				

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130	Moderate	Possible	Low	Examples highlighted in Justification 129 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 and possible</i> .	L	Local	10 years	Stable
131	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]. For example 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 MPA protection exists at present.	L	Local	10 years	Stable
132	Moderate	Likely	Moderate	As per justification 129, 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 and likely</i> .	L	Regional	10 years	Stable
133	Major	Likely	High	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	A	Statewide	1-2	Stable / Increasing

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				<p>generation, causing reductions in wellbeing. Licences in the commercial fishing industry are now largely out of reach for many within Aboriginal 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.</p> <p>There is also inadequate recognition of rights and 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.</p> <p>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.</p> <p>There is also a reduced community capacity to undertake cultural practices i.e. knowledge is not being transferred, elders are unwell etc [7].</p>				
134	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
135	Moderate	Likely	Moderate	The Marine Estate Community Survey identified increasing costs and regulation of local businesses as the fourth largest threat to economic activity [1].	L	Statewide	10 years	Stable/decreasing

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				Submissions received during the public engagement period of the draft TARA have noted the difficulty of obtaining licences and approvals to operate due to the presence of multiple regulatory bodies for the tourism industry. In addition, other marine businesses have noted the cost of compliance activities placing financial strain on businesses. Submissions also noted the potential impact of inefficient/over-regulation on the viability businesses. Examples include the impact of marine parks, beach access controls by councils, the implications of native title on fishing and the impact of ineffective consultation. The impact of over-regulation at a local or regional level may have statewide impacts. For instance, reduced commercial fishing access may result in reduced ability to supply seafood, which may impact larger tourism businesses such as the Sydney Fish Markets. Overall, <i>moderate</i> impacts are considered <i>likely</i> .				
136	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
137	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
138	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, if 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

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				<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>				
139	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 moderate flow on impacts on community enjoyment of biodiversity values possible [20, 21]. It is also likely to influence compliance with regulations which may also impact people enjoyment of beauty and biodiversity values.	L	Regional	10 years	Stable
140	Moderate	Possible	Low	As per justification 139 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 moderate and possible.	L	Regional	10 years	Stable
141	Major	Likely	High	The lack of community engagement or participation in governance stressor has an	L	Local	1-2 years	Increasing

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				<p>impact on tangible and intangible Aboriginal cultural heritage. There is inadequate consultation with Aboriginal communities affected.</p> <p>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].</p>				
142	Minor	Possible	Minimal	Similar to justification for 137: Governance processes that are seen to be unfair or inequitable, or 'imposed' 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.	L	Statewide	10 years	Stable
143	Minor	Possible	Minimal	Similar for justification to 142, with impacts on employers and employees. Impacts on actual production and employment likely to be minor	L	Statewide	10 years	Stable
144	Minor	Possible	Minimal	See justification for 142	L	Statewide	10 years	Stable
145	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</p>	I	Statewide	10 years	Stable

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				<p>general lack of awareness or opinion on current management and threats of the marine estate [1].</p> <p><i>Minor</i> consequences on community health and wellbeing are therefore considered <i>possible</i> as a result of lack of knowledge or awareness of the marine estate.</p>				
146	Minor	Possible	Minimal	As per justification 145. <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
147	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
148	Minor	Likely	Low	<p>As per justification 147, a lack of knowledge and understanding of the marine estate may influence fishing behaviour and compliance with regulations, which may in turn impact the health of local fisheries and the enjoyment of the experience of other users.</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]. <i>Minor</i> consequences on consumptive use values are therefore</p>	L	Statewide	10 years	Stable



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				considered <i>likely</i> as a result of lack of knowledge or awareness of the marine estate.				
149	Major	Likely	High	<p>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].</p> <p>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].</p>	L	Unknown	Unknown	Unknown
150	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 intrinsic values.	L	Statewide	10 years	Stable
151	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
152	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	L	Statewide	10 years	Stable

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				threats; these may in turn, impact upon individual enjoyment value.				
153	Moderate	Likely (N&S) Almost certain (C)	Moderate	Anti-social behaviour was the number one concern of marine estate users in the Sweeney research – this is likely to relate to two 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 with marine estate users by Voyer and colleagues 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.	L	Local	1-2 years	Unknown
154	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
155	Moderate	Likely	Moderate	Lack of compliance with regulations put in place to manage, protect and enhance biodiversity values or 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	L	Local	10 years	Unknown

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				appreciation of these values.				
156	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
157	Major	Likely	High	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>major</i> and <i>likely</i> . This is particular evident where the regulation regarding the bag limit of pipis is inadequate and therefore the cost of buying pipis for important cultural ceremonies is too high [45].  There are few specific regulatory protections for intangible cultural heritage therefore a lack of compliance with regulations is unlikely to significant 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).	L	Unknown	Unknown	Unknown
158	Moderate	Possible	Low	Lack of compliance with regulations is linked to anti-social behaviour and has a similar risk profile (see justification 14). 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 (?)
159	Major	Possible	Moderate	Similar to justification 15. 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 (?)

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160	Moderate	Possible	Low	A 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 (?)
161	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 meshing programs and other public safety issues are managed. 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.  While there is evidence of short term and immediate impacts on beach usage following attacks research by Gibbs & Warren indicate that overall beach users interact regularly with shark and it does not seem to deter longer term usage patterns [25].  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.	A	Local	1-2 years	Increasing
162	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
163	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,	L	Local	1-2 years	Increasing

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				swimmers and surfers. Overall risk rating is therefore determined to be <i>minor</i> and <i>unlikely</i> .				
164	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
165	Insignificant	Unlikely	Minimal	No foreseen impacts associated with tangible cultural heritage associated with shark interactions and jellyfish etc.	I	Unknown	Unknown	Unknown
166	Insignificant (C&S) Minor (N)	Unlikely (C&S) Likely(N)	Minimal (C&S) 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.	I	Unknown	Unknown	Unknown
167	Minor (S&C), Moderate (N)	Possible	Minimal (S&C)/ Low (N)	See justification 166; similar impacts for businesses (e.g. tourism operators, businesses dependent on beach traffic).	L	Local	1-2 years	Unknown (?)
168	Minor (S&C), Moderate (N)	Possible	Minimal (S&C)/ Low(N)	See justification for 166, 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 (?)
169	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	L	Regional	1-2 years	Stable

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				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.				
170	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
171	Minor	Unlikely	Minimal	No foreseen impacts on enjoyment of biodiversity or beauty of marine estate	I	Local	10 years	Stable
172	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
173	Major	Likely	High	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>high</i> overall) on Indigenous communities are <i>likely</i> .  In addition, river health is critical as mining and agricultural runoff impacts water quality there are issues with traditional food consumption of pipis and oysters that	L	Statewide	1-2	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 Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				are subject to QX disease. This is particularly evident in Newcastle where pesticide runoff from farms is impacting water quality. Similarly in Wollongong there is concerns over heavy metal contamination from the BHP Billiton site at Port Kembla [45].  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>high</i> overall) on Indigenous communities are <i>likely</i> .				
174	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, 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.	L	Local	10 years	Unknown
175	Moderate	Possible (N&S)/ Likely (C)	Low (N&S) Moderate (C)	Similar risk profile to justification 174. In some cases, economic impacts on businesses and employment may be severe. For instance, contamination incidents have the potential to undermine NSW's tourism profile of being a key food destination for international visitors. The reputation of large tourism businesses such as the Sydney Fish Markets, which generate tourism benefits of \$72 million per year, may also be impacted. Thus, moderate impacts are considered likely in the central region as a result of seafood contamination.	L	Local	10 years	Unknown
176	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 (?)
177	Moderate	Possible	Low	The environmental TARA reported sources of water pollution as having major	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 Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				impacts almost certain from combined stressors of nutrients, suspended sediments and potentially 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 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 [1]. 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> .				
178	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
179	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
180	Minor	Possible	Minimal	Contamination of seafood associated with marine pollution would be the main impact on consumptive use and this is addressed in justification 172. <i>Minor</i> consequences outside of seafood contamination are considered <i>possible</i> but re likely to be short term and localised.	L	Local	10 years	Increasing
181	Major	Likely	High	Impacts on tangible cultural heritage are high. Pollution or contamination impacts the ability or Aboriginal communities to make use of important sites or participate	I	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
				<p>in important cultural practises. In addition, river health is critical as mining and agricultural runoff impacts water quality there are issues with traditional food consumption of pipis and oysters that are subject to QX disease. This is particularly evident in Newcastle where pesticide runoff from farms is potentially impacting water quality. Similarly in Wollongong there are concerns over heavy metal contamination from the BHP Billiton site at Port Kembla [45].</p> <p>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.</p>				
182	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
183	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 ongoing impacts on a range of local businesses and employment. See justification for 182 for further explanation.	A	Local	20 years	Increasing
184	Major	Possible	Low	See justification 182; impacts for enjoyment values more localised.	A	Local	20 years	Increasing
185	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	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 Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				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 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.				
186	Moderate	Likely	Moderate	As per justification 185– 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
187	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	I	Statewide	10 years	Decreasing

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				are therefore considered <i>likely</i> as a result of inadequate information to guide decision-making.				
188	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
189	Major	Likely	High	Inadequate scientific information stressor has an impact on tangible and intangible 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 e.g. more work is also needed in the Twofold Shelf marine bioregion in regard to cultural resource use beyond abalone [7]. <i>Major</i> community wide consequences are therefore considered <i>likely</i> as a result of inadequate information to guide decision making.  The extent of the knowledge gap is evidenced by a lack of education and training that Aboriginal communities believe exists. This is particularly evident in communities where fish stocks have been depleted and commercial fishers have lost employment. There is a lack of knowledge of other opportunities e.g. eel farming that is available. This has an impact on Aboriginal cultural heritage where a loss of employment can contribute to a loss of culturally identity or prevent traditions being passed on to younger generations [45].  Further research is also need around fisheries	I	Statewide	10 years	Decreasing
190	Moderate	Likely	Moderate	Key knowledge gaps and inadequate scientific information have been identified	I	Statewide	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
				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.				(?)
191	Moderate	Likely	Moderate	See justification for 198. 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 (?)
192	Moderate	Likely	Moderate	See justification for 198; 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 (?)
193	Moderate	Likely	Moderate	<p>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.</p> <p>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.</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>	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 Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				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.  As per workshop discussion – there are disabled access issues for island in the bioregion				
194	Moderate	Likely	Moderate	Refer to justification 193	I	Local	10 years	Increasing
195	Moderate	Likely	Moderate	Refer to justification 193	I	Local	10 years	Increasing
196	Moderate	Likely	Moderate	Refer to justification 193	I	Local	10 years	Increasing
197	Moderate	Likely	Moderate	Lack of access to infrastructure is impacting tangible and intangible cultural heritage values. Without access to affordable boats and/or cars there is a lack of access to important cultural sites, totemic species and traditional food resources. Lack of access to infrastructure is a <i>moderate</i> consequence that is <i>likely</i> to occur.	I	Unknown	Unknown	Unknown
198	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
199	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
200	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	A	Local	1-2 years	Increasing

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				(e.g. overcrowded infrastructure on weekends and in school holidays during Summer). The overall risk level is likely to be low for the north 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.				
201	Moderate	Likely	Moderate	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.  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%).  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	L	Local	10 years	Increasing

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				<p>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>Submissions received during the public engagement period of the draft TARA demonstrated that highlighted mental health impacts for people in the fishing industry resulting from a number of stressors including area closures these impacts include stress and anxiety on fishers and their families. Further research supports this view, with evidence provided to the Parliamentary Inquiry into Commercial Fishing identifying the "significant social and emotional impact of the reform process" on the industry. In its summary report, the committee has made a recommendation that NSW DPI commissions a Social Impact Assessment of the Business Adjustment Program on commercial fishers in NSW and makes the findings public.</p> <p>Loss of public access is therefore considered to be of a <i>moderate</i> consequence, and <i>likely</i> likelihood.</p>				
202	Moderate	Possible	Low	<p>As per justification 201 – 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 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,</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 Local (site) Regional Statewide	Temporal 1-2 years 10 years 20 years	Trend Decreasing Stable Increasing
				however only <i>possible</i> likelihood given management mechanisms in place to preserve and protect public space and balance competing uses in MPA management.				
203	Moderate	Possible	Low	<p>As per justification 201 – 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
204	Moderate	Likely	Moderate	<p>As per justification 201, 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. 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>	I	Local	10 years	Increasing
205	Major	Likely	High	Impacts are largely cumulative and relate to historic and ongoing loss of access to the coast associated with urbanisation, private development and protected area	L	Unknown	Unknown	Unknown



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				<p>closures. This may lead to damage to cultural sites or artefacts and limit the opportunities for access to food sources [34]. 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>Areas that are currently underwater were previously hunting grounds, tracks and culturally significant sites. Access is prevented due to inundation however the cultural significance and stories remain. An example of where this has occurred is the Solitary Islands [45].</p> <p>Drainage of wetlands has resulted in weed infestation and consequent reduction in sedge grass availability. This has occurred at women’s traditional places in the Ballina Byron region. These ecological shifts negatively impact the traditional hunting and gathering process. In addition, these traditional sites has specific culturally healing uses and without access to these sites and materials found at same, many traditional activities such as weaving practice, grass and sedge collection cannot be continued [45].</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 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</p>				

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				<p>in the marine estate. In addition there is inadequate recognition of rights to benefit economically from commercial fishing.</p> <p>Restrictions to important burial sites is also an issue created by loss of public access e.g. burial sites at Botany Bay Other culturally significant sites that Aboriginal communities are being denied or limited access to include Bare Island (accessible via one NPWS bridge), La Perouse and Kamay Botany Bay National Park. [45]</p> <p>Marine Parks and National Parks commonly prevent access for Aboriginal people and can place restrictions on the types of activities permitted. Examples include Depot Beach and Brush Island where the establishment of a marine park has prevented access to marine resources and locations. Similarly Comerong Island at the mouth of the Shoalhaven River which was previously free to access for Aboriginal community members, now has a \$10 entry fee imposed on all visitors by Shoalhaven Council [45].</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].</p>				

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				<p>Dr Sue Feary (2015) report [7] notes lack of access to aquaculture venture opportunities.</p> <p>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.</p> <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 [34].</p> <p>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.</p> <p>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.</p>				
206	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 201).	L	Local	10 years	Increasing
207	Moderate	Possible (C) Likely	Low (C) Moderate (N&S)	Net impacts on businesses and employment is likely to be moderate in the north and south regions; there may be business opportunities in private business developments or in other closures. Some impacts on tourism operators and	L	Local	10 years	Increasing

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		(N&S)		commercial fishers may occur if public access is severely restricted.				
208	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 201, the likelihood of this occurring is still relatively low, but of greater likelihood than in justifications 206 & 207 because of the direct impacts on enjoyment and use values.	L	Local	10 years	Increasing

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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.

**Spatial extent** – the scale of the risk of the threat to a benefit being realised e.g. local, regional or statewide.

**Stakeholder** – a person, organisation (including agencies) that can affect, be affected by, or perceive themselves to be affected by a decision or activity.

**Stressor** – a consequence of an activity (e.g. water pollution, overcrowding) that causes an effect on an environmental asset (e.g. clean waters) or social and economic benefit (e.g. recreation and tourism activities at a local beach or waterway). Different activities may lead to the same stressors (e.g. foreshore development and dredging activities can produce different forms of water pollution if not managed effectively).

**Temporal scale** – the timeframe in which the risk of the threat being realised will occur e.g. 1-2 years, 10 years or 20 years.

**Threat** – a broad activity, event or process that poses a potential level of risk to an environmental asset or social or economic benefit. Threats often affect multiple assets/benefits and similarly, an asset/benefit may be affected by multiple threats.

**Threat and risk assessment** – a process that identifies, assesses and prioritises threats and their associated risks to the marine estate. It also highlights areas where information is lacking and research is needed.

**Trade-off** – the relinquishment of one benefit or value for another that is regarded as more desirable or of greater importance.

**Trend** – how a threat varies over time e.g. increasing, decreasing or stable.

**Value** – the term used by the *Marine Estate Management Act 2014* for 'community benefit'.

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## 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.



Coastal and marine waters		Marine Habitats and Assemblages															Threatened and Protected Species						Score															
		Clean waters			Beaches			Shallow soft sediments			Deep soft sediments			Rocky Shores			Shallow Reefs			Deep Reefs				Planktonic Assemblages			Fish assemblages (harvest and bycatch)			Species and communities protected under			Species protected under BCA					
Resource use		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	North	Central	South	North	Central	South	High	Moderate	Low	Minimal
Shipping	Large commercial vessels and associated port activities and industries (trade ships, cruise ships, etc.) Small commercial vessels (ferries, charter boats etc.)	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	2	1	5	22
		Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	High	Low	Moderate			
Commercial fishing	Ocean Trap and Line	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	0	3	11	16
	Ocean Trawl	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	1	6	10	12
	Ocean Haul	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	1	7	9	13
	Sea urchin and turban shells	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	0	5	5	10
	Lobster	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	0	2	1	12
	Abalone	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	0	0	6	20
Charter fishing	Line fishing	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	0	1	3	12
Recreational fishing	Shore-based line and trap fishing	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	0	0	12	21
	Boat-based line and trap fishing	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	0	5	10	12
	Spearfishing	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	0	6	6	18
	Hand Gathering	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	0	0	6	21
Aboriginal Cultural fishing (including permitted as well as native title rights)	Line fishing, spearfishing, hand gathering, traditional fishing methods, related cultural traditions	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	0	3	12	6
Charter activities	Whale and dolphin watching	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	0	0	2	31
Aquaculture	Fish farming	NA	NA	Minimal	NA	NA	Minimal	NA	NA	Minimal	NA	NA	Minimal	NA	NA	Minimal	NA	NA	Minimal	NA	NA	Minimal	NA	NA	Minimal	NA	NA	Minimal	NA	NA	Minimal	Minimal	Minimal	Minimal	0	3	1	18
Bait and aquarium trade	Imported baits, imported fish and other aquatic sp.	Minimal	Minimal	Minimal	NA	NA	Minimal	NA	NA	Minimal	NA	NA	Minimal	NA	NA	Minimal	NA	NA	Minimal	NA	NA	Minimal	NA	NA	Minimal	NA	NA	Minimal	NA	NA	Minimal	Minimal	Minimal	Minimal	0	0	1	9
Research and education	Collecting, sampling and tagging	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	0	0	3	12
Recreation and tourism	Boating and boating infrastructure	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	0	0	9	21
	Snorkelling and diving	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	0	0	1	20
	Passive recreational use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	0	5	4	9
	Four wheel driving	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	0	5	4	9
	Shark control measures	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3	1	0	2
Dredging (includes placement)	Navigation & entrance management and modification, harbour maintenance etc.	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	2	0	1	4
Modified freshwater flows	Extraction, artificial barriers to estuarine flow	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	0	1	5	24
Mining and extractive industries	Oil, gas, minerals, sand, aggregate, mining coal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0
Service infrastructure	Pipelines, cables, trenching and boring	NA	Low	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	6	4
<b>Land-based impacts</b>																																						
Landuse intensification	Urban stormwater discharge	Low	Low	Low	Moderate	Moderate	Moderate	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	1	4	12	13
	Foreshore development	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	2	5	0	23
	Beach nourishment and grooming	NA	NA	NA	Moderate	Moderate	Moderate	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	0	4	3	8
	Clearing riparian and adjacent habitat including wetland drainage	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	1	1	5	23
	Agricultural diffuse source runoff	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	0	0	15	15
	Deliberate introduction of pests and weeds (e.g. foxes, bitou bush)	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3	0	0	9
Point discharges	Industrial discharges	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	0	0	4	26
	Thermal discharges	NA	Minimal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	10
	Sewage effluent and septic runoff	Low	Low	Low	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	0	2	13	14
Hydrologic modifications	Estuary entrance modifications + Breakwaters	Minimal	Minimal	Minimal	High	High	High	High	Low	Low	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	3	3	5	19
<b>Climate change 20 years</b>																																						
Climate change	Altered ocean currents & nutrient inputs	Moderate	Low	Low	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	3	9		27
	Climate and sea temperature rise	Moderate	Low	Low	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	0	3	12	15
	Ocean acidification	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	0	8	7	15
	Altered storm/cyclone activity	Moderate	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	0	3	9	18
	Sea level rise	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	3	4	11	12
<b>Climate change 50 years</b>																																						
Climate change	Altered ocean currents & nutrient inputs	Moderate	Moderate	Low	Moderate	Moderate	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	13	17	0	73
	Climate and sea temperature rise	High	Moderate	Low	Moderate	Moderate	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	7	10	2	15
	Ocean acidification	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	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	6	24	3	0
	Altered storm/cyclone activity	Moderate	Moderate	Moderate	High	High	High	High																														





## 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 Coastal and Marine Waters (Statewide)	Score	Combined Environmental (Statewide)	Score
Agricultural diffuse source runoff	73	Climate change 20 year timeframe	27	Urban stormwater discharge	69 in estuaries 11 in coastal and marine
Urban stormwater discharge	69	Commercial fishing - ocean trawl	17	Estuary entrance modifications + breakwaters	63 in estuaries 15 in coastal and marine
Estuary entrance modifications + breakwaters	63	Foreshore development	16	Agricultural diffuse source runoff (in estuaries)	73 in estuaries 0 in coastal and marine
Clearing riparian and adjacent habitat including wetland drainage	58	Estuary entrance modifications + breakwaters	15	Clearing riparian and adjacent habitat including wetland drainage	58 in estuaries 5 in coastal and marine
Modified freshwater flows	54	Commercial fishing - Ocean Trap and Line	15	Climate change 20 year timeframe	31 in estuaries 27 in coastal and marine
Recreation - boating and boating infrastructure	48	Recreational boat-based line and trap fishing	12	Modified freshwater flows (in estuaries)	54 in estuaries 0 in coastal and marine
Navigation & entrance management and modification, harbour maintenance etc.	41	Urban stormwater discharge	11	Foreshore development	34 in estuaries 16 in coastal and marine
Foreshore development	38	Four wheel driving	11	Recreation- boating and boating infrastructure (in estuaries)	48 in estuaries 0 in coastal and marine
Sewage effluent and septic runoff	37	Recreational fishing - shore-based line and trap fishing	10	Navigation & entrance management and modification, harbour maintenance etc.	41 in estuaries 2 in coastal and marine
Stock grazing of riparian and marine vegetation	36	Passive recreational use	10	Sewage effluent and septic runoff	37 in estuaries 4 in coastal and

## Appendix F Method for Calculating Prioritisation Scores

Raw Estuarine Areas (Statewide)	Score	Raw Coastal and Marine Waters (Statewide)	Score	Combined Environmental (Statewide)	Score
					marine
Climate change 20 year timeframe	31	Commercial Fishing -Ocean Haul	10	Stock grazing of riparian and marine vegetation (in estuaries)	36 in estuaries 0 in coastal and marine
Four wheel driving	24	Deliberate introduction of plants and animals (e.g. foxes, Bitou bush)	9	Four wheel driving	24 in estuaries 11 in coastal and marine
Shipping - large commercial vessels and associated port activities and industries (trade ships, cruise ships, etc.)	18	Shipping - large commercial vessels and associated port activities and industries (trade ships, cruise ships, etc.)	8	Recreational fishing -boat-based line and trap fishing	10 in estuaries 12 in coastal and marine
Industrial discharges	13	Beach nourishment and grooming	8	Passive recreational use	12 in estuaries 10 in coastal and marine
Commercial fishing - estuary general	14	Shipping - small commercial vessels (ferries, charter boats etc.)	6	Recreational fishing-shore-based line and trap fishing	10 in estuaries 10 in coastal and marine
Oyster aquaculture	12	Recreational fishing - hand gathering	6	Beach nourishment and grooming	10 in estuaries 8 in coastal and marine
Passive recreational use	12	Whale and dolphin watching	6	Commercial fishing -ocean trawl (in coast and marine waters)	0 in estuaries 17 in coastal and marine
Beach nourishment and grooming	10	Shark control measures	6	Commercial fishing - ocean trap and line (in coast and marine waters)	0 in estuaries 15 in coastal and marine
Recreational fishing - shore-based line and trap fishing	10	Clearing riparian and adjacent habitat including wetland drainage	5	Commercial fishing- estuary general (in estuaries)	14 in estuaries 0 in coastal and marine
Recreational boat-based line and trap fishing	10	Sewage effluent and septic runoff	4	Deliberate introduction of plants and animals (e.g. foxes, Bitou bush)	9 in estuaries 9 in coastal and marine

## Appendix F Method for Calculating Prioritisation Scores

Raw Estuarine Areas (Statewide)	Score	Raw Coastal and Marine Waters (Statewide)	Score	Combined Environmental (Statewide)	Score
Deliberate introduction of plants and animals (e.g. foxes, Bitou bush)	9	Commercial fishing - sea urchin and turban shells	4	Shipping- small commercial vessels (ferries, charter boats etc.)	6 in estuaries 6 in coastal and marine
Pipelines, cables, trenching and boring	8	Navigation & entrance management and modification, harbour maintenance etc.	2	Oyster aquaculture (in estuaries)	12 in estuaries 0 in coastal and marine
Shipping -small commercial vessels (ferries, charter boats etc.)	6	Commercial fishing - abalone	2	Commercial fishing-ocean haul (in coastal and marine waters)	0 in estuaries 10 in coastal and marine
Thermal discharges	6			Recreational fishing- hand gathering	4 in estuaries 6 in coastal and marine
Recreational fishing- hand gathering	4			Whale and dolphin watching	4 in estuaries 6 in coastal and marine
Whale and dolphin watching	4			Shipping -large commercial vessels and associated port activities and industries (trade ships, cruise ships, etc.)	Not considered a Statewide priority as only rated High or Moderate in 2 of the 3 regions 18 in estuaries 8 in coastal and marine
Oil, gas, minerals, sand, aggregate, coal mining	4			Industrial discharges (in estuaries)	Not considered a Statewide priority as only rated High or Moderate in 1 of the 3 regions 13 in estuaries 0 in coastal and marine
Commercial fishing – estuary prawn trawl	2			Pipelines, cables, trenching and boring (in estuaries)	Not considered a Statewide priority as

Appendix F Method for Calculating Prioritisation Scores

Raw Estuarine Areas (Statewide)	Score	Raw Coastal and Marine Waters (Statewide)	Score	Combined Environmental (Statewide)	Score
					only rated High or Moderate in 1 of the 3 regions 8 in estuaries 0 in coastal and marine
				Shark control measures (in coastal and marine waters)	Not considered a Statewide priority as only rated High or Moderate in 1 of the 3 regions 0 in estuaries 6 in coastal and marine
				Thermal discharges (in estuaries)	Not considered a Statewide priority as only rated High or Moderate in 1 of the 3 regions 6 in estuaries 0 in coastal and marine
				Commercial fishing - sea urchin and turban shells (in coastal and marine waters)	Not considered a Statewide priority as only rated High or Moderate in 1 of the 3 regions 0 in estuaries 4 in coastal and marine
				Oil, gas, minerals, sand, aggregate, coal mining (in estuaries)	Not considered a Statewide priority as only rated High or Moderate in 1 of the

Raw Estuarine Areas (Statewide)	Score	Raw Coastal and Marine Waters (Statewide)	Score	Combined Environmental (Statewide)	Score
					3 regions 4 in estuaries 0 in coastal and marine
				Commercial fishing- abalone (in coastal and marine waters)	Not considered a Statewide priority as only rated High or Moderate in 1 of the 3 regions 0 in estuaries 2 in coastal and marine
				Commercial fishing - estuary prawn trawl (in estuaries)	Not considered a Statewide priority as only rated High or Moderate in 1 of the 3 regions 2 in estuaries 0 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
Clearing riparian and adjacent habitat including wetland drainage	23	Climate change 20 year timeframe	11	Estuary entrance modifications	21 in estuaries 5- in coastal and marine
Agricultural diffuse source runoff	23	Commercial fishing - ocean trap and line	7	Clearing riparian and adjacent habitat including wetland drainage (in estuaries)	23 in estuaries 0- in coastal and marine
Estuary entrance modifications	21	Commercial fishing - ocean trawl	9	Agricultural diffuse source runoff (in estuaries)	23 in estuaries 0 in coastal and marine
Modified Freshwater flows	20	Recreation and tourism - four wheel driving	6	Climate Change 20 year timeframe	11 in estuaries 11 in coastal and marine
Urban stormwater discharge	19	Estuary entrance modifications	5	Urban stormwater discharge (in estuaries)	19 in estuaries 2 in coastal and marine
Recreation and tourism -boating and boating infrastructure	14	Recreational fishing - Shore-based line and trap fishing	4	Modified freshwater flows (in estuaries)	20 – in estuaries 0 in coastal and marine
Navigation & entrance management and modification, harbour maintenance, etc.	13	Recreational fishing - Boat-based line and trap fishing	4	Recreation and tourism -Boating and boating infrastructure (in estuaries)	14 in estuaries 0 in coastal and marine
Stock grazing of riparian and marine vegetation	12	Commercial fishing – ocean haul	4	Recreation and tourism - four wheel driving	8 in estuaries 6 in coastal and marine
Sewage effluent and septic runoff	12	Foreshore development	4	Foreshore development	10 in estuaries 4 in coastal and marine
Stock Grazing of riparian and marine vegetation	12	Deliberate introduction of plants and animals (e.g. foxes, Bitou bush)	3	Navigation & entrance management and modification, harbour maintenance, etc. (in estuaries)	13 in estuaries 0 in coastal and marine
Climate Change 20 year timeframe	11	Urban stormwater Discharge	2	Sewage effluent and septic runoff	12 in estuaries 0 in coastal and

## 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
					marine
Foreshore development	10	Shipping - small commercial vessels (ferries, charter boats, commercial fishing, whale watching etc.)	2	Stock grazing of riparian and marine vegetation (in estuaries)	12 in estuaries 0 in coastal and marine
Recreation and tourism - four wheel driving	8	Recreational fishing - hand gathering	2	Commercial fishing - ocean trawl (in coastal and marine)	0-In estuaries 9 in coastal and marine
Commercial fishing – estuary general	6	Sewage effluent and septic runoff	2	Recreational fishing - Shore-based line and trap fishing	4 in estuaries 4 in coastal and marine
Recreational fishing - boat-based line and trap fishing	4	Charter activities – whale and dolphin watching	2	Recreational fishing - boat-based line and trap fishing	4 in estuaries 4 in coastal and marine
Recreational fishing - shore-based line and trap fishing	4	Passive recreational use	2	Commercial fishing - ocean trap and line (in coastal and marine)	0-In estuaries 7 in coastal and marine
Oyster aquaculture	4	Beach nourishment and grooming	2	Commercial fishing – estuary general (in estuaries)	6 in estuaries 0 Coast and marine
Passive recreational use	4			Passive recreational use	4 in estuaries 2 in coastal and marine
Deliberate introduction of plants and animals (e.g. foxes, Bitou bush)	3			Deliberate introduction of plants and animals (e.g. foxes, Bitou bush)	3 in estuaries 3 in coastal and marine
Commercial fishing – estuary prawn trawl	2			Recreational fishing - hand gathering	2 in estuaries 2 in coastal and marine
Charter activities – whale and dolphin watching	2			Oyster aquaculture (in estuaries)	4 in estuaries 0 in coast and marine
Beach nourishment and grooming	2			Commercial fishing – ocean haul (in coastal and marine)	0 in estuaries 4 in coastal and marine

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
Recreational fishing - hand gathering	2			Charter activities – whale and dolphin watching	2 in estuaries 2 in coastal and marine
				Beach nourishment and grooming	2 in estuaries 2- in coastal and marine
				Shipping - small commercial vessels (ferries, charter boats, commercial fishing, whale watching etc.) (in coast and marine)	0 in estuaries 2 in coastal and marine
				Commercial fishing – estuary prawn trawl (in estuaries)	2 in estuaries 0 in coast and marine



## Appendix F Method for Calculating Prioritisation Scores

Table F3 Combined Environmental Priorities for the Central Region

Raw Estuarine Areas (Central Region)	Score	Raw Coastal and Marine (Central Region)	Score	Combined Environmental (Central Region)	Score
Urban stormwater discharge	31	Climate change 20 year timeframe	9	Urban stormwater discharge	31 in estuaries 7 in coastal and marine
Agricultural diffuse source runoff	23	Shipping - large commercial vessels and associated port activities and industries (trade ships, cruise ships, etc.)	8	Foreshore development	18 in estuaries 8 in coastal and marine
Estuary entrance modifications	21	Foreshore development	8	Estuary entrance modifications (in estuaries)	21 in estuaries 3 in coast and marine
Recreational boating - boating and boating infrastructure	20	Urban stormwater discharge	7	Shipping - large commercial vessels and associated port activities and industries (trade ships, cruise ships, etc.)	16 in estuaries 8 in coast and marine
Foreshore development	18	Commercial fishing - ocean trawl	6	Agricultural diffuse source runoff (in estuaries)	23 in estuaries 0 in coast and marine
Clearing riparian and adjacent habitat including wetland drainage	18	Recreation and tourism - Shark control measures	6	Clearing riparian and adjacent habitat including wetland drainage	18 in estuaries 5 in coast and marine
Modified freshwater flows - modified freshwater flows	17	Passive Recreational Use	6	Climate change 20 year timeframe	11 in estuaries 9 in coastal and marine
Shipping - large commercial vessels and associated port activities and industries (trade ships, cruise ships, etc.)	16	Recreation and tourism – four wheel driving	5	Recreational Boating - boating and boating infrastructure (in estuaries)	20 in estuaries 0 in coast and marine
Navigation & entrance management and modification, harbour maintenance, etc.	15	Clearing riparian and adjacent habitat including wetland drainage	5	Sewage effluent and septic runoff	13 in estuaries 4 in coastal and marine

## 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
Sewage effluent and septic runoff	13	Estuary entrance modifications	5	Navigation & entrance management and modification, harbour maintenance, etc.	15 in estuaries 2 in coastal and marine waters
Industrial discharges	13	Commercial fishing - ocean trap and line	4	Modified freshwater flows - modified freshwater flows (in estuaries)	17 in estuaries 0 in coast and marine
Stock grazing of riparian and marine vegetation	12	Recreational fishing - shore-based line and trap fishing	4	Industrial discharges (in estuaries)	13 in estuaries 0 in coast and marine
Climate change 20 year timeframe	11	Recreational fishing – boat-based line and trap fishing	4	Recreation and tourism – four wheel driving	8 in estuaries 5 in coastal and marine waters
Small commercial vessels (ferries, charter boats, whale watching vessels, fishing vessels etc)	9	Beach nourishment and grooming	4	Stock grazing of riparian and marine vegetation (in estuaries)	12 in estuaries 0 in coast and marine
Recreation and tourism – four wheel driving	8	Sewage effluent and septic runoff	4	Small commercial vessels (ferries, charter boats, whale watching vessels, fishing vessels etc) (in estuaries)	9 in estuaries 2 coastal and marine
Service infrastructure – pipes, cables trenching and boring	8	Deliberate introduction of plants and animals (e.g. foxes, Bitou bush)	3	Beach nourishment and grooming	6 in estuaries 4 in coastal and marine waters
Beach nourishment and grooming	6	Estuary entrance modifications	3	Service infrastructure – pipes, cables trenching and boring (in estuaries)	8 in estuaries 0 in coast and marine
Thermal discharges	6	Shipping - Small commercial vessels (ferries, charter boats, commercial fishing, whale watching etc.)	2	Recreational fishing – Shore-based line and trap fishing	4 in estuaries 4 in coastal and marine waters
Commercial fishing – estuary general	4	Commercial fishing – ocean Haul	2	Recreational fishing – boat-based line and trap fishing	4 in estuaries 4 in coastal and marine waters
Recreational fishing – shore-based line and trap fishing	4	Commercial fishing – sea urchin and turban shells	2	Recreation and tourism – passive recreational use	4 in estuaries 3 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
Recreational fishing – boat-based line and trap fishing	4	Recreational fishing – hand gathering	2	Thermal discharges (in estuaries)	6 in estuaries 0 in coast and marine
Oyster aquaculture	4	Charter activities – Charter whale and dolphin watching	2	Commercial fishing - ocean trawl	0 in estuaries 6 in coastal and marine waters
Mining and extractive industries	4	Passive Recreational Use	3	Recreation and tourism - shark control measures	0 in estuaries 6 in coastal and marine waters
Passive recreational use	4	Navigation & entrance management and modification, harbour maintenance, etc.	2	Commercial fishing – estuary general (in estuaries)	4 in estuaries 0 in coast and marine
Deliberate introduction of plants and animals (e.g. foxes, Bitou bush)	3			Oyster aquaculture (in estuaries)	4 in estuaries 0 in coast and marine
Recreational fishing – hand gathering	2			Recreational fishing – Hand gathering	2 in estuaries 2 in coastal and marine waters
				Mining and extractive industries (in estuaries)	4 in estuaries 0 in coast and marine
				Commercial fishing - ocean Trap and Line (in coastal and marine waters)	4 in coastal and marine waters
				Commercial fishing – ocean Haul (in coastal and marine waters)	0 in estuaries 2 in coastal and marine waters
				Commercial fishing – sea urchin and turban shells (in coastal and marine waters)	0 in estuaries 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
				Charter activities – charter whale and dolphin watching (in coastal and marine waters)	0 in estuaries 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	27	Climate change 20 year timeframe	5	Agricultural diffuse source runoff (in estuaries)	27 in estuaries 0 in coast and marine
Estuary entrance modifications	21	Estuary entrance modifications + breakwaters	5	Estuary entrance modifications	21 in estuaries 5 in coastal and marine
Urban stormwater discharge	19	Commercial fishing - ocean haul	4	Urban stormwater discharge	19 in estuaries 2 in coastal and marine
Modified freshwater flows – modified freshwater flows	17	Recreational fishing - boat-based line and trap fishing	4	Modified Freshwater flows - modified freshwater flows (in estuaries)	17 in estuaries 0 in coast and marine
Clearing riparian and adjacent habitat including wetland drainage	17	Commercial fishing - ocean trap and line	4	Clearing riparian and adjacent habitat including wetland drainage (in estuaries)	17 in estuaries 0 in coast and marine
Recreation and tourism -boating and boating infrastructure	14	Foreshore development	4	Climate change 20 year timeframe	9 in estuaries 5 in coastal and marine
Navigation & entrance management and modification, harbour maintenance, etc.	13	Deliberate introduction of plants and animals (e.g. foxes, Bitou bush)	3	Recreation and tourism -boating and boating infrastructure (in estuaries)	14 in estuaries 0 in coast and marine
Stock grazing of riparian and marine vegetation	12	Shipping - Small commercial vessels (ferries, charter boats, commercial fishing, whale watching etc.)	2	Foreshore development	10 in estuaries 4 in coastal and marine waters
Sewage effluent and septic runoff	12	Commercial fishing – sea urchin and turban shells	2	Navigation & entrance management and modification, harbour maintenance, dredging etc. (in estuaries)	13 in estuaries 0 in coast and marine

## 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
Foreshore development	10	Commercial fishing - abalone	2	Stock grazing of riparian and marine vegetation (in estuaries)	12 in estuaries 0 in coast and marine
Climate change 20 year timeframe	9	Recreational fishing - Shore-based line and trap fishing	2	Sewage effluent and septic runoff (in estuaries)	12 in estuaries 0 in coast and marine
Recreation and tourism – four wheel driving	8	Recreational fishing - hand gathering	2	Recreation and tourism – four wheel driving (in estuaries)	8 in estuaries 0 in coast and marine
Commercial fishing – estuary general	4	Charter activities – whale and dolphin watching	2	Recreational fishing - boat-based line and trap fishing	2 in estuaries 4 in coastal and marine waters
Oyster aquaculture	4	Urban stormwater discharge	2	Deliberate introduction of plants and animals (e.g. foxes, Bitou bush)	3 in estuaries 3 in coastal and marine
Passive recreational use	4	Beach nourishment and grooming	2	Passive recreational use	4 in estuaries 2 in coastal and marine
Deliberate introduction of plants and animals (e.g. foxes, Bitou bush)	3	Passive recreational use	2	Commercial fishing – estuary general	4 in estuaries 0 in coast and marine
Shipping – Large commercial	2			Oyster aquaculture (in estuaries)	4 in estuaries 0 in coast and marine
Recreational fishing – boat-based line and trap fishing	2			Commercial fishing - ocean haul	0 in estuaries 4 in coastal and marine waters
Recreational fishing – shore-based line and trap fishing	2			Recreational fishing – shore-based line and trap fishing	0 in estuaries 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			Beach nourishment and grooming	2 in estuaries 2 in coastal and marine waters
Charter activities – Whale and dolphin watching	2			Charter activities – Whale and dolphin watching	2 in estuaries 2 in coastal and marine waters
				Commercial fishing - Ocean Trap and Line	0 in estuaries 4 in coastal and marine waters
				Commercial fishing – Abalone (in coastal and marine waters)	0 in estuaries 2 in coastal and marine waters
				Commercial fishing – Sea urchin and turban shells (in coastal and marine waters)	0 in estuaries 2 in coastal and marine waters
				Recreational fishing - Hand Gathering (in coastal and marine waters)	0 in estuaries 2 in coastal and marine waters
				Shipping - Small commercial vessels (ferries, charter boats, commercial fishing, whale watching etc.)	0 in estuaries 2 in coastal and marine waters
				Shipping – Large commercial (in estuaries)	2 in estuaries 0 in coast and marine



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