

— CHAPTER 9 —

RISKS TO THE REGION'S VALUES



◀ *Giant clam in a degraded reefscape.* © Matt Curnock 2017

RISKS TO THE REGION'S VALUES

'an assessment of the risks to the ecosystem ...' within the Great Barrier Reef Region, s 54(3)(d) of the *Great Barrier Reef Marine Park Act 1975*

'an assessment of the risks to the heritage values ...' of the Great Barrier Reef Region, paragraph 116A(2)(b) of the *Great Barrier Reef Marine Park Regulations 1983*

9.1 Background

Management of the Region must consider the full range of threats to the Region's ecosystem and heritage values (natural, Indigenous, historic and other heritage values). Action should be focused on addressing those threats that pose the greatest risk and, increasingly, recognise the cumulative contribution of those threats and the interactions among them.^{1467,1468}

The comprehensive risk assessments contained in the 2009 and 2014 Outlook Reports^{1,2} identified climate change, land-based run-off, coastal development and some aspects of extractive direct use as the areas of most serious risk. The assessments have guided subsequent decision-making and helped set management priorities.^{1,9,1468,1469}

The risk assessment described below is based on the information presented in preceding chapters. The assessment systematically reviews the current and future risks presented by known threats, and summarises the residual risk to the Reef after consideration of existing protection and management measures.

The assessment is based on overall risk to the ecosystem (natural heritage value) and overall risk to heritage values (Indigenous, historic and other heritage values).

9.2 Identifying and assessing the threats

9.2.1 Identifying the threats

The current and potential threats to the Region's ecosystem and heritage values considered in this risk assessment are informed by the evidence presented in Chapters 5 and 6. The 45 threats considered in this risk assessment are listed in Appendix 6, including a comparison with those assessed in the 2014 Outlook Report.

Forty-five threats are identified for assessment

The list of threats includes direct and indirect threats and some that are consequential (arising as a result of other threats). For example, stress on corals from environmental pressures, such as sea-temperature rise and nutrient and sediment run-off, may increase the likelihood of coral disease outbreaks.

Four threats have been added to the assessment since 2014 (defined in Appendix 6). In combination with previously included threats, such as marine debris and chemical and oil spills, the addition of 'genetic modification' recognises emerging and potential future activity in relation to coral reef restoration and resilience-building interventions.^{24,1020,1470} The three other newly-added threats acknowledge the potential for undesirable behaviours and other considerations to affect the condition of Indigenous and historic heritage values in ways not captured in the previous list of threats.

It is important to note that this assessment can only consider the threats that are known and identified. There are likely to be more unknown and unexpected threats that have not been considered. These other threats will be assessed in future reports as they are identified.

9.2.2 Assessing threats

Two separate risk assessments are presented — one for the Region's ecosystem (natural heritage value) and one for its heritage values (Indigenous, historic and other). The Australian Standard for risk management (AS ISO 31000)¹⁴⁷¹ was followed. The likelihood and consequence of each threat is ranked on the five-point scale set out in Appendix 7. The criteria for selecting a consequence level for the ecosystem are different to those for heritage values. An overall risk level for each threat is determined by applying a risk matrix that combines its likelihood and consequence. Risk is considered to be residual — the risk that remains once any reductions provided by existing management measures have been taken into consideration.

A standard risk assessment method is used, taking into account likelihood and consequence

The assessment is based on information in Chapters 2 to 8 of this report, including the current state and resilience of the Region's ecosystem and heritage values, major factors influencing the Region's values (including human use), and effectiveness of management. Additionally, input on risk levels from experts external⁷ and internal to the Marine Park Authority made an important contribution to the process.

Because of the size and complexity of the Region, and because many threats affect its values over different time and spatial scales and at different intensities and interact in many different ways, the assessment presented here is necessarily high level. Several important broad assumptions were made in undertaking the assessment:

- Each threat was initially assessed in isolation from others; compounding effects are discussed separately (Section 9.3.7).
- Each threat was assumed to be possible at any geographic location within or, where relevant, adjacent to the Region.
- Threats were assessed as they are today (for example, current fishing catch amounts and techniques) or on the basis of documented trends (for example, trends in sea temperature and ocean acidification).
- Threats were assessed with existing, but not any future, management measures in place (that is, the mitigating effect of a management measure was only considered if the measure was already in place).

In understanding the consequence of a threat to the ecosystem (natural heritage value), variations in the extent of the threat's likely effect are taken into account by having different criteria for broad-scale and local-scale effects (Appendix 7). In order to understand the true level of risk, for each threat the higher consequence grade is adopted in determining the overall risk. For heritage values (Indigenous, historic and other), consequence level is considered using a single criterion that encapsulates both the geographic scale of effects and the range of heritage values affected (Appendix 7).

9.2.3 Information on community views

The risk assessment process considered input from Reef scientists on risks to the Reef. As part of an elicitation workshop, members of the Reef scientific and heritage expert communities provided advice on likelihood and consequence for a supplied list of threats.⁷ In addition, the views of other community sectors were considered in a qualitative way, using information from various sources:

Community views informed the risk assessment

- Respondents to a national opinion survey were asked to rank a provided list of threats.⁸⁴⁴
- Residents of the Catchment as well as members of the fishing and tourism sectors (including both tourists and tourism operators) were surveyed regarding the three most serious threats.⁷⁸⁵
- The public and targeted consultation processes used to develop the *Aboriginal and Torres Strait Islander Heritage Strategy for the Great Barrier Reef Marine Park* were drawn on.^{803,1472}

9.3 Outcomes of risk assessment

9.3.1 Community views

While community views on the key threats to the Reef vary, climate change and pollution are common concerns

The views of various community sectors on threats to the Great Barrier Reef are summarised in Table 9.1. Many sectors named climate change, pollution (including marine debris), land-based run-off and fishing as key threats. Concern about marine debris and other pollution has continued to increase since previous Outlook Reports and concern about natural disasters, such as cyclones and floods, has also become more prominent.

Table 9.1 Community views on threats facing the Great Barrier Reef
A range of sectors were canvassed about their views on threats to the Great Barrier Reef ecosystem using various survey methods (Section 9.2.3).^{844,785,803,1472} The data gathered is not directly comparable among groups.

Community sector	Ranking of perceived threats				
	First	Second	Third	Fourth	Fifth
Australians generally	Marine debris and beach litter	Climate change	Agricultural run-off	Crown-of-thorns starfish	Shipping
Reef Catchment residents	Pollution (includes marine debris)	Climate change/global warming	Fishing (includes overfishing, illegal fishing)	Poor water quality (for example, from land-based run-off)	Coral bleaching
International tourists	Climate change/global warming	Pollution (includes marine debris)	Tourism	Humanity (for example, overpopulation)	Fishing (includes overfishing, illegal fishing)
Domestic tourists	Pollution (includes marine debris)	Climate change/global warming	Humanity (for example, overpopulation)	Tourism	Mining
Marine tourism operators	Climate change/global warming	Poor water quality (for example, from land-based run-off)	Fishing (includes overfishing, illegal fishing)	Governance (for example, government policies and management)	Natural disasters (for example, cyclones and floods)
Commercial fishers	Fishing (includes overfishing, illegal fishing)	Poor water quality (for example, from land-based run-off)	Climate change/global warming	Governance (for example, government policies and management)	Natural disasters (for example, cyclones and floods)
Traditional Owners and others consulted on the Aboriginal and Torres Strait Islander Heritage Strategy	(threats of concern mentioned in feedback, in alphabetical order) Climate change, damage to sites and other components of heritage, illegal hunting/harvesting of marine resources, sea-level rise, species shifts				
Scientific and heritage experts	(highest perceived threats for either ecosystem or heritage values at either a Region-wide or local scale, in alphabetical order) Altered weather patterns, barriers to flow, dredging, illegal fishing and poaching, incidental catch of species of conservation concern, marine debris, modifying coastal habitats, nutrient run-off, ocean acidification, outbreak of crown-of-thorns starfish, sea-level rise, sea-temperature increase, sediment run-off, vessel strike				

LIKELIHOOD						
Rare	Unlikely	Possible	Likely	Almost certain		
				<ul style="list-style-type: none"> E H Ocean acidification E H Sea-temperature increase 	Catastrophic	
	<ul style="list-style-type: none"> E H Spill – large chemical E H Spill – large oil 		<ul style="list-style-type: none"> E H Outbreak of disease H N Fragmentation of cultural knowledge 	<ul style="list-style-type: none"> E H Altered weather patterns E H Illegal fishing and poaching E H Incidental catch of species of conservation concern E H Modifying coastal habitats E H Nutrient run-off E H Outbreak of crown-of-thorns starfish E H Sea-level rise E H Sediment run-off 	Major	
		<ul style="list-style-type: none"> E H Acid sulfate soils H N Behaviour impacting heritage values H Damage to seafloor E H Grounding – large vessel 	<ul style="list-style-type: none"> E H Extraction from spawning aggregations 	<ul style="list-style-type: none"> E H Altered ocean currents E H Artificial light E H Barriers to flow E H Damage to reef structure E H Discarded catch E H Extraction of particle feeders E H Extraction of predators H Illegal activities – other H Incompatible uses E H Marine debris E H Pesticide run-off 	Moderate	
		<ul style="list-style-type: none"> E H Atmospheric pollution E H N Genetic modification 	<ul style="list-style-type: none"> E H Disposal of dredge material E H Dredging E H Exotic species E Extraction of herbivores H N Foundational capacity gaps E H Outbreak of other species E H Vessel strike 	<ul style="list-style-type: none"> E Damage to seafloor E H Grounding – small vessel E Illegal activities – other E H Noise pollution E H Terrestrial discharge E H Vessel waste discharge E H Wildlife disturbance 	Minor	
			<ul style="list-style-type: none"> H Extraction of herbivores 	<ul style="list-style-type: none"> E H Spill – small 	Insignificant	

Low risk
 Medium risk
 High risk
 Very high risk
 E Ecosystem
 H Heritage
^ Risk increased since 2014
 v Risk decreased since 2014
N New addition

Figure 9.1 Risks to the Region’s ecosystem and heritage values from identified threats

This risk matrix is consistent with the principles, framework and processes outlined by the Australian Standard (AS ISO 31000) using terms and definitions detailed in Appendix 7. The assessment is based on current and documented future trends in the identified threats and existing management measures. The compounding effects of threats are not considered. The full description for each of the identified threats is provided in Appendix 6 and the risk assessment for each threat is summarised in Appendix 8. The four threats added in 2019 are marked as new additions. Symbols indicate where a threat has been assessed as having the same combination of likelihood and consequence ratings for both ecosystem and heritage values (that is, its natural, Indigenous, historic and other heritage values). If a threat has different ratings for ecosystem and heritage, it is presented twice and each entry is shown with a single symbol. Some threats are only relevant to heritage values and only appear once. If the assessed risk has increased or decreased since the 2014 Outlook Report this is indicated.

9.3.2 Level of likely risk

The outcomes of the risk assessments for the 45 threats to the Region's ecosystem (natural heritage value) and heritage values (Indigenous, historic and other) are presented in Appendix 8 and summarised in Figure 9.1.

The close connections between the Region's ecosystem and its heritage values mean that the projected risk of almost all threats is the same in both assessments — although for some threats the likelihood and consequence of the effect differ between ecosystem and heritage values.

Two threats present a different level of risk to the Region's heritage values when compared to their impact on the ecosystem. Illegal activities that damage Indigenous and historic sites and intangible cultural values poses a higher risk to heritage. Extraction of herbivores poses a lower risk to heritage values as, when performed by Traditional Owners, this activity supports traditional use and maintenance of cultural practices. Assessments for the threats 'illegal activities' and 'extraction of herbivores' did not include consideration of illegal fishing and poaching activities, due to the separate assessment conducted for 'illegal fishing and poaching'.

9.3.3 Sources, scale and timing

The identified threats to the Region's ecosystem and heritage values arise from a number of sources and are highly variable in both scale and timeframe. Figure 9.2 links these individual threats to their probable causes (the factors identified in Chapter 6 as key influences on the condition of the Region's values) and indicates the spatial scale and likely timing of each threat's effect.

The threats that pose the highest risk are Region-wide in scale; most are already having an impact

The threats identified as highest risk are affecting the ecosystem and heritage values at a broad, often Region-wide, scale and are happening now. Most of the very high risk threats are associated with climate change or land-based run-off, and the remainder are linked to coastal development (modifying coastal habitats) and direct use of the Region (illegal fishing and poaching, and incidental catch of species of conservation concern).

The threats rated as high risk are almost all related to direct use, at both Region-wide and local or regional scales (for example, extraction of predators, discarded catch, marine debris, damage to reef structure, and several threats related to the ability of Traditional Owners (and others) to access and maintain cultural heritage). Overall, threats that are more localised in their effects are generally rated as having a lower risk and are generally associated with direct use of the Region.

9.3.4 Highest risk threats

Based on assessments of the 45 identified threats (Figure 9.1 and Figure 9.2), the 10 threats identified in 2014 as presenting a very high risk to the Region's ecosystem and heritage values are again rated as very high risk. Another 11 and 14 threats are rated as high risk to the Region's ecosystem and heritage values, respectively. Very high is the highest level of risk in the assessment matrix (Appendix 7); no further increase in risk level occurs even if a threat's likelihood continues to increase or its consequences continue to worsen.

The threats that pose highest risk arise from climate change, coastal development, land-based run-off and some aspects of direct use

Climate change remains the single most pervasive and persistent influencing factor, with four climate change-related threats posing very high risk (and one posing high risk) to the Reef on a Region-wide scale (Figure 9.2). These risks are predicted to increase in the future (Sections 3.2 and 6.3). The implications of global tipping points in the physical climate system are of urgent concern⁴⁸⁷ (Section 6.3.1). Not only is the direct influence

of these threats on the Region's values significant, they also have the potential to exacerbate and amplify the impact of other threats. For example, corals already under stress due to poor water quality and interactions with direct use activities (such as fishing) may be further stressed by the effects of sea-temperature rise (such as increased frequency, distribution and intensity of coral bleaching). The effects of these threats may also exacerbate the susceptibility of corals to disease (Section 3.6.1).^{2,990,1421,1473}

Risks to Indigenous, historic and other heritage values from activities that physically disturb or place material on the seafloor may be underestimated because systematic identification and understanding of the extent and location of many heritage values (for example, burial sites, wrecks and archaeological sites) is limited. The potential for significant or permanent damage to sites of particular cultural or historical importance is a concern.

Threat	Risk		Timing	Influencing factor			
	Ecosystem	Heritage values		Climate change	Coastal development	Land-based run-off	Direct use
Altered weather patterns	Very high risk	Very high risk	Now	●			
Sea-temperature increase	Very high risk	Very high risk	Now	●			
Ocean acidification	Very high risk	Very high risk	Now	●			
Sea-level rise	Very high risk	Very high risk	10+	●			
Modifying coastal habitats	Very high risk	Very high risk	Now		●		
Nutrient run-off	Very high risk	Very high risk	Now			●	
Sediment run-off	Very high risk	Very high risk	Now			●	
Outbreak of crown-of-thorns starfish	Very high risk	Very high risk	Now			●	●
Illegal fishing and poaching	Very high risk	Very high risk	Now				●
Incidental catch of species of conservation concern	Very high risk	Very high risk	Now				●
Altered ocean currents	High risk	High risk	Now	●			
Barriers to flow	High risk	High risk	Now		●		
Marine debris	High risk	High risk	Now			●	●
Discarded catch	High risk	High risk	Now				●
Extraction of particle feeders	High risk	High risk	Now				●
Extraction of predators	High risk	High risk	Now				●
Fragmentation of cultural knowledge		High risk	Now				●
Foundational capacity gaps		High risk	Now				●
Incompatible uses		High risk	Now				●
Artificial light	High risk	High risk	Now		●		●
Damage to reef structure	High risk	High risk	Now				●
Extraction from spawning aggregations	High risk	High risk	Now				●
Illegal activities – other	Medium risk	High risk	Now				●
Pesticide run-off	High risk	High risk	Now			●	
Outbreak of disease	High risk	High risk	Now	Cumulative effect of many factors			
Outbreak of other species	Medium risk	High risk	Now	Cumulative effect of many factors			
Terrestrial discharge	Medium risk	High risk	Now			●	
Acid sulfate soils	Medium risk	High risk	Now		●	●	
Disposal of dredge material	Medium risk	High risk	Now		●		●
Dredging	Medium risk	High risk	Now		●		●
Noise pollution	Medium risk	High risk	Now		●		●
Exotic species	Medium risk	High risk	Now		●	●	●
Behaviour impacting heritage values	Medium risk	High risk	Now				●
Damage to seafloor	Medium risk	High risk	Now				●
Extraction of herbivores	Medium risk	Low risk	Now				●
Grounding – large vessel	Medium risk	High risk	Now				●
Grounding – small vessel	Medium risk	High risk	Now				●
Spill – large chemical	Medium risk	High risk	Now		●		●
Spill – large oil	Medium risk	High risk	Now		●		●
Vessel strike	Medium risk	High risk	Now				●
Vessel waste discharge	Medium risk	High risk	Now				●
Wildlife disturbance	Medium risk	High risk	Now				●
Atmospheric pollution	Low risk	High risk	Now		●		●
Genetic modification	Low risk	High risk	5+				●
Spill – small	Low risk	High risk	Now				●

Figure 9.2 Summary of threats arising from factors influencing the Region's values, and associated scale, timing and risk level
This figure links identified threats with the key factors (Chapter 6) that have most influence on them, either directly or indirectly. Instances where a factor is likely to only have an insignificant influence on a threat are not displayed (no dot shown). The risk level for each threat is shown, along with the scale of the risk and expected timing of the effects of the threat.

Threat	Risk		Timing	
Region-wide	Low risk	High risk	▲ Now	10+ More than 10 years
Local or regional	Medium risk	Very high risk	5+ More than 5 years	

9.3.5 Trends in risks to the Region's values

The risk level for a number of the threats to the Region's ecosystem has changed since the assessment presented in the Outlook Report 2014 (Figure 9.3).

Increases in assessed risk: Risk level has increased for seven threats: altered ocean currents, artificial light, damage to reef structure, extraction of particle feeders, illegal activities (not including illegal fishing and poaching), grounding of small vessels, and wildlife disturbance (Figure 9.3). Increases in a risk grade since 2014 have generally been attributed to an increased understanding of the threat, its distribution and frequency, or the likely severity of its consequences.

Some changes to ocean currents (for example, the East Australian Current) are starting to be observed, noting that the understanding of likely future consequences for the Region's ecosystems is limited.

Risks posed by several threats associated with direct use have increased; in other cases, management changes have mitigated risk increases

The current context of widespread elevated environmental stress on sensitive habitats (Chapters 2, 6 and 8) amplifies the overall consequences of minor disturbances or damage. Small vessel groundings and damage to reef structure (from anchors, snorkelling and diving fins, fishing equipment and other direct use interactions) are now considered to be more significant risks than they were in 2014. Anecdotally, these interactions are commonplace and reporting of damage to reef structure from them is likely to be low. Individual incidents may be relatively minor and people may not always be aware damage has occurred.

Extraction of particle feeders from the ecosystem by fishing activities was considered a medium risk in 2014. Since then a significant decline in the saucer scallop population has been detected and there are concerns around declining catch rates and potential localised depletion for some crab species (Section 5.4). Successful implementation of management reforms under the Queensland Sustainable Fisheries Strategy⁸⁹² may reduce the risk to crustaceans and other particle feeders in the future.

Since 2014, understanding has improved about the increase in artificial light glow emitted from ports and developed areas, and its effects on sensitive species, including those of conservation concern (Sections 2.4.10, 6.4.2 and 8.3.5). Also, people's ability to access the Region through vessel ownership and availability of boat ramps and road access continues to become more widespread (Sections 5.5 and 6.2.2). These factors, along with the ready availability of personal drones, have increased potential levels of wildlife disturbances.

The assessment of the threat posed by illegal activities (other than illegal fishing and poaching, which are assessed separately) now explicitly includes illegal damage to Indigenous or historic heritage sites and objects (Appendix 6). The risk posed to the Region's heritage values by this threat is considered high, an increase from a medium level of risk in 2014. This increase in assessed risk reflects the more specific inclusion of illegal damage to heritage sites within the scope of illegal activities, and also the concerns expressed by Traditional Owners and Reef managers regarding the potential for serious impacts as a result of some activities. The consequence of vandalism, looting and accidental illegal damage of places and artefacts of Indigenous or historic heritage value can be significant at multiple scales, and can be irreversible.

Risk posed by threats added to assessment: The four new threats not described or assessed in 2014 are considered to present a range of risks (from low to high) to the Region (Figure 9.3). Information on the likelihood and consequential impact of genetic manipulation (including assisted evolution¹¹³⁴) is expected to grow rapidly over the next decade as scientific knowledge and manipulation techniques advance and the results from various trials of restoration and adaptation interventions (including coral gardening) become available. Likewise, there is a need for an improved understanding around



Figure 9.3 Threats with a changed risk level since 2014
 Threats that have a different risk level in 2019 compared to 2014 are shown, as are threats added to the assessment in 2019. Seven threats are assessed as having a higher risk than in 2014. Where the change is only related to either the ecosystem or heritage values, this is indicated. One threat (disposal of dredge material) has a lower risk than in 2014, due to new management requirements that restrict some marine disposal of material from capital works.

the nature, intensity, distribution and impact of the three new heritage-related threats — behaviour that affects intangible heritage values; fragmentation of cultural knowledge; and foundational capacity gaps — so associated risk levels and management responses may be better informed.

Reductions in assessed risk: The risk posed to the Region's ecosystem and heritage values by disposal of dredge material has been lowered to medium (Figure 9.3). A reduced risk level is warranted given sea disposal of large amounts of capital dredge material is no longer allowed in the Marine Park (Section 5.7).

Unchanged risk levels: Ongoing and evolving management of direct use activities has, in general, resulted in stable risk levels for many associated threats. This effectiveness limits the risk of impacts on the Region's values from oil and other chemical spills, exotic species, large vessel groundings and other threats. Nevertheless, further effort to limit and reduce very high and high-risk threats from direct use is still needed. For example, reducing illegal fishing and poaching and incidental catch of species of conservation concern remains a high priority.

Climate change is an extremely significant influence on the Region, as reflected in the continued assessment of very high risk levels for the related threats (including sea-temperature increase and altered weather patterns). Similarly, risk levels for several coastal development-related threats have not changed since 2014. Barriers to flow and modification of coastal habitats continue to be of concern given the implications for functional connectivity among terrestrial, freshwater and marine ecosystems and the delivery of ecological services to the Region.

9.3.6 Effectiveness of threat management

It is widely acknowledged that many of the threats with the highest risk levels originate outside the Region. The overall risk associated with climate change (very high), coastal development (high) and land-based run-off (high) have remained the same as in the 2009 and 2014 Outlook Reports. However, the effectiveness of management in relation to climate change has continued to weaken (Figure 9.4, Sections 7.3.9 and 7.6).

By contrast, positive management effectiveness gains have occurred for coastal development in almost all parts of the management cycle, and also for the inputs and outputs aspects of management of land-based run-off (Figure 9.4, Sections 7.3.10, 7.3.11 and 7.6). Progress in reducing threats related to land-based run-off relies heavily on industry members voluntarily adopting best practice land management, and uptakes rates can be difficult to measure, accelerate and maintain. There are also time lags between on-ground action and better water quality outcomes in the Region (Sections 6.5 and 7.3.11). As a result, major improvements in effectiveness in terms of outcomes have not yet been realised for the Region's values. Development of northern Australia (including parts of the Catchment) may be a future influence on the risk posed by threats from coastal development and land-based run-off (Section 6.4.2).

The overall risk to the Region from direct use remains medium (Figures 9.2 and 9.4). Among the many uses of the Region, ports and fishing have begun major reform processes during the last five years. Some positive achievements have occurred for ports in the early stages of implementation (Sections 5.7 and 7.3.4). Nevertheless, maintenance dredging and disposal can still be permitted and, with larger ships visiting the Region (Section 5.8), port related infrastructure and activities may need to evolve to accommodate larger ships. This may increase the risk of damage to the seafloor (for example, from increased ship anchoring and resuspension of sediments from ship propellers).

Some Region-wide threats have the highest risk levels and are being managed least effectively, particularly those related to climate change



Signs like this one at Cape Bowling Green help Reef users avoid fishing illegally. © GBRMPA



A vessel pushed up on the shore by cyclone Debbie in 2017. © GBRMPA

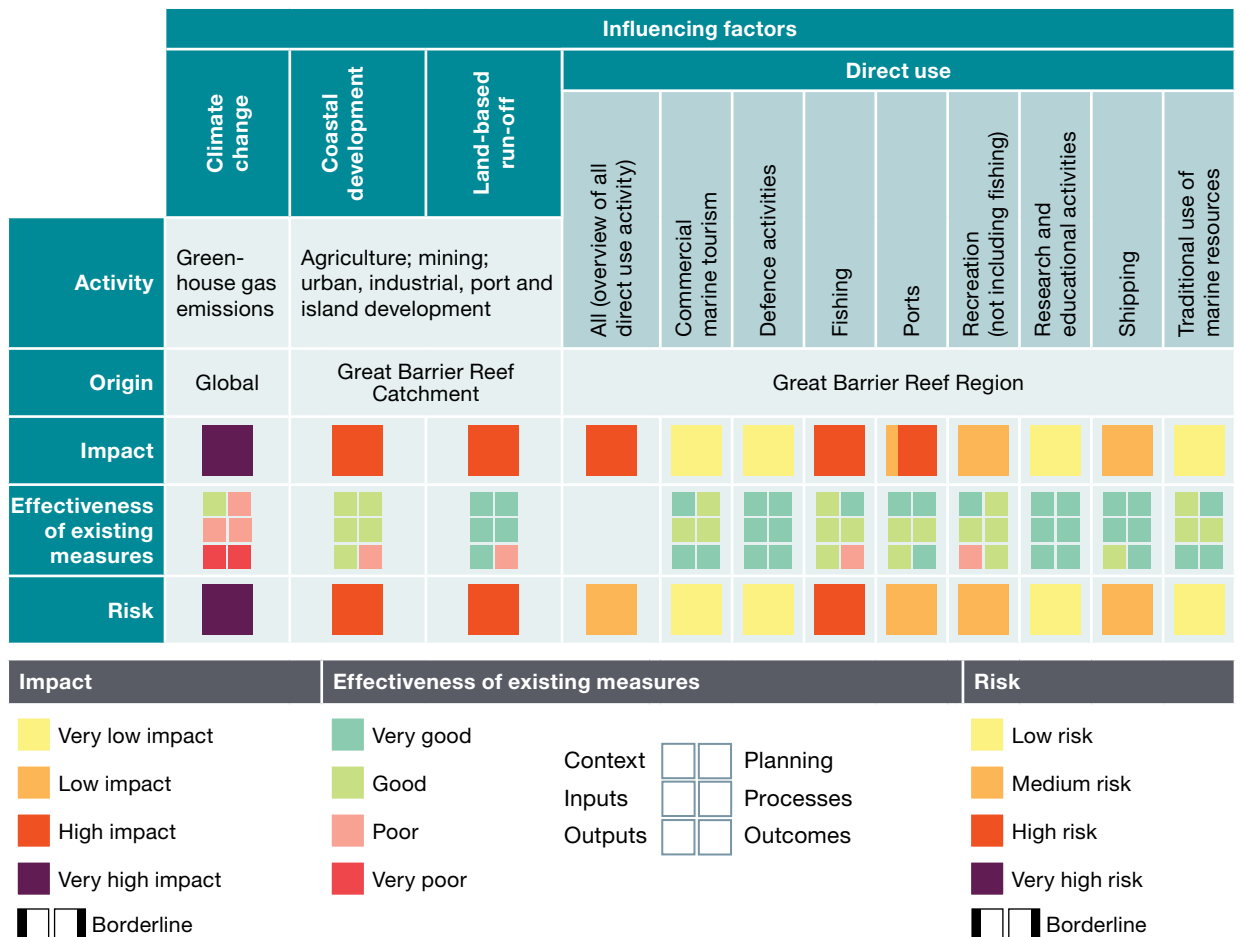


Figure 9.4 Management effectiveness, impacts and risk associated with factors influencing the Region’s values
 Impact grades for the factors influencing the Region’s values (Chapters 5 and 6), the independent assessment of the effectiveness of current protection and management (Chapter 7), and overarching risk levels (Figure 9.2) are shown, including for component activities of direct use. The effectiveness grades are for the six elements of the management cycle (Chapter 7). The assessment for the topic of climate change is only in relation to management measures undertaken specifically to protect and manage the Reef. The influencing factors that present the highest overall risk to the Region’s values have their origins outside the Region. Higher risk also corresponds with uses and influencing factors that have both higher impact on values and weaker management effectiveness.

Management effectiveness gains in relation to fishing are expected to strengthen over the next five years through implementation of the Queensland Sustainable Fisheries Strategy (Sections 5.4 and 7.3.3).⁸⁹² Increasing coastal populations, changing demographics and expanding access in the north of the Catchment have the potential to increase risks associated with recreational fishing. This increased level of risk is based on recent information on rates of non-compliance with Marine Park zoning (Section 5.4.3).

The effectiveness of management for shipping, defence and research activities is, overall, very good (Section 7.6).

9.3.7 Cumulative impacts

The threats assessed individually in Figure 9.1 do not operate in isolation. Threats are connected through the geographic areas in which they occur, the timeframes in which they act, and the affect they have on the Region’s natural heritage value (habitats, species, ecosystem processes) and Indigenous, historic and other heritage values. Cumulative impacts result from the interaction of effects from one or more threats as well as past, present and reasonably foreseeable future influences.^{1467,1468}

Threats from climate change are having a critical and immediate impact on the Great Barrier Reef; they also intensify the effect of other threats

Impacts from a single threat can accumulate in a range of ways through time and space.^{1468,1474} For example, seagrass meadows can receive sequential influxes of sediment-laden floodwater, a coral reef may not fully recover from a cyclone or marine heatwave before being affected by another one, a single reef may receive nutrients in land-based run-off from multiple catchments simultaneously, and ecosystem and

heritage values can be exposed to both acute and chronic (long-term) effects of climate change. Some threats build up slowly over decades, while exposure to others can occur as acute events over short periods of time.

The cumulative effect of multiple threats is even more complex. Assessing cumulative impacts requires consideration of the direct, indirect and consequential impacts of threats that originate in the Region, the Catchment and globally (Figure 9.2 and Figure 9.5).¹⁴⁷⁵ On the Reef, coral reefs can be successively or simultaneously affected by crown-of-thorns starfish, cyclones and bleaching from thermal stress. Similarly, modification of coastal ecosystems and physical barriers within waterways and overland flow paths can have cumulative consequences in terms of altered connectivity between land and sea.^{683,1476}

It is important to understand the area and time scale at which impacts are occurring and the scope of response needed to manage the relevant threats and impacts.¹⁴⁷⁴ Reef managers are increasingly likely to examine alternative strategies for management planning and intervention by using forecasting scenarios that explicitly consider climate, the global economy and other factors. Developing and implementing effective responses to cumulative impacts are areas of ongoing work for Reef managers, requiring continued evolution of policy and practical actions.^{1467,1468,1477,1478}

The extent, nature and implications of the cumulative impacts on the Region's ecosystems from disturbances over the past 10 to 15 years are not yet fully understood. However, the extensive coral bleaching events in 2016 and 2017^{88,91,141} highlighted the fragility of the system and the need to actively address climate change, continue efforts to support resilience, and reduce and manage all other threats (Chapters 6, 7 and 8).

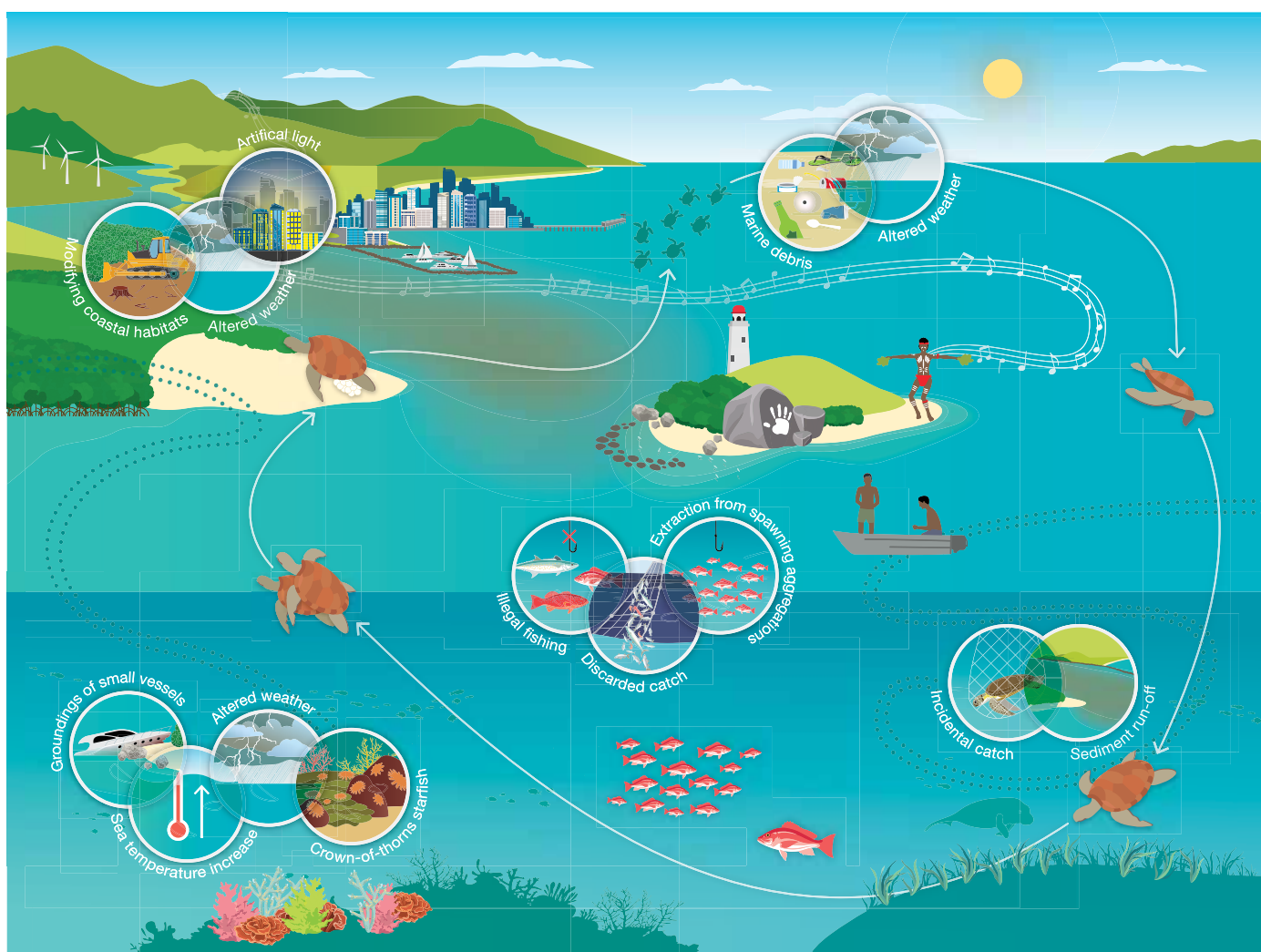


Figure 9.5 Threats to ecosystem and heritage values are cumulative

Multiple threats, including those presenting high risk to the Region's values, can affect an individual, species or habitat in multiple places and at multiple times. This exposure can combine to present a serious cumulative risk. The figure shows examples of location and lifecycle exposure.






9.4 Assessment summary – Risks to the Region’s values











Paragraph 54(3)(d) of the *Great Barrier Reef Marine Park Act 1975* requires ‘... an assessment of the risks to the ecosystem ...’ within the Great Barrier Reef Region.





























Paragraph 116A(2)(b) of the *Great Barrier Reef Marine Park Regulations 1983* requires ‘... an assessment of the risks to the heritage values ...’ of the Great Barrier Reef Region.

Separate risk assessments are provided for the Region’s ecosystem (natural heritage value) and its heritage values (Indigenous, historic and other) based on their current state and trends, factors influencing them, effectiveness of protection and management measures and an understanding of their overall resilience.

9.4.1 Risks to the Region’s ecosystem and heritage values

Grading statements – risks					Trend since last report	
					↑	Increased
Low risk Given current management arrangements, any threats considered likely or certain to occur are predicted to have no more than insignificant consequences for the Region’s ecosystem or heritage values. There may be minor or moderate consequences for the Region’s ecosystem or heritage values for other less likely threats.	Medium risk Given current management arrangements, few of the threats considered likely or certain to occur are predicted to have moderate consequences for the Region’s ecosystem or heritage values and none will have catastrophic consequences. Some unlikely threats may have major consequences for the Region’s ecosystem or heritage values.	High risk Given current management arrangements, many of the likely or almost certain threats are predicted to have moderate or major consequences for the Region’s ecosystem or heritage values.	Very high risk Given current management arrangements, there are likely or almost certain threats that are predicted to have catastrophic consequences for the Region’s ecosystem or heritage values.	Borderline Indicates where a component or criterion is considered close to satisfying the adjacent grading statement.	↔	Stable
					↓	Decreased
					—	No consistent trend
					Future trend	
					↑	Increasing
					↔	Stable
					↓	Decreasing
					—	No consistent trend
					Confidence	
					●	Adequate high-quality evidence and high level of consensus
					◐	Limited evidence or limited consensus
					○	Inferred, very limited evidence

Grade and trend			Confidence		Criterion and component summaries
2009	2014	2019	Grade	Trend	
					Overall risk to the ecosystem Natural heritage values: The threats likely to affect the Region’s ecosystem in the future are increasing and compounding, placing the ecosystem at very high risk. The most serious risks arise from certain threats associated with climate change, land-based run-off, coastal development and some aspects of direct use (particularly fishing). Other threats relating to direct use are more effectively managed and of less overall risk to the Reef.
					Overall risk to heritage values Indigenous, historic and other heritage values: Many heritage values are closely connected to the ecosystem. The projected risk to the Region’s heritage values from most threats are, therefore, the same as for the ecosystem. Heritage values are at very high and increasing risk. The most serious risks are climate change, land-based run-off, coastal development and some aspects of direct use.
			●	●	Climate change Ecosystem: The risk from climate change has continued to increase and the associated threats and their impacts are increasingly observed in the Region. Risk is likely to increase in future due to emission trajectories and unavoidable future climate change, locked in by past and current emissions.
			◐	◐	Heritage: The threats to the ecosystem associated with climate change flow on to present a serious risk to heritage values, particularly intangible Indigenous values and the Great Barrier Reef World Heritage Area’s outstanding universal value.

Grade and trend			Confidence		Criterion and component summaries
2009	2014	2019	Grade	Trend	
					Coastal development Ecosystem: Coastal development remains a serious risk to the Reef. The combined effect of modifications to coastal ecosystems across the Catchment is not irreversible but widespread and serious. The function of linked terrestrial–freshwater–estuarine–marine ecosystems is affected by barriers to flow and modification of coastal habitats. Artificial light from urban and industrial facilities and developments will continue to grow. Direct use creates demand for some aspects of coastal development. Further development of the northern portion of the Catchment is likely. Heritage: Legacy and some contemporary changes in terrestrial coastal habitats as a result of coastal development will continue to affect the outstanding universal value and integrity of the world heritage property. Natural aesthetic values may also be further diminished, along with Indigenous heritage values.
					
					Land-based run-off Ecosystem: The continuing inputs of nutrients, sediments and pesticides and the time lag between reduced inputs and improved ecosystem condition, mean land-based run-off will continue to be a serious risk to the ecosystem. Marine debris from all sources is likely to remain a high risk. If outcomes from current management efforts in the Catchment can be accelerated, future risk is expected to decrease. Heritage: Indigenous heritage values and the overall aesthetic value of wide areas of the Region will continue to be affected by declines in the condition of ecosystem values from pollutants carried by land-based run-off. Attributes of outstanding universal value will continue to diminish, especially in inshore areas. If outcomes from current management efforts in the Catchment can be accelerated, future risk is expected to decrease.
					
 (non-extractive)  (extractive)					Direct use Ecosystem: While some threats from direct use are of low risk to the Region's values, others continue to pose a significant risk. Illegal fishing and poaching, extraction of predators and particle feeders, extraction from unidentified or unprotected spawning aggregations, incidental catch of species of conservation concern and discarded catch are all rated as high or very high risk. The escalating activity around active physical interventions in the Region (for example, coral gardening and assisted evolution) to support the resilience of the Reef has introduced more threats to consider. Heritage: The risks that direct use presents to the ecosystem (and its associated natural beauty) are reflected in its risk to heritage values. Risks may arise from some threats that cause serious or irreversible damage to heritage sites and artefacts (for example, vandalism). The effects of fragmentation of cultural knowledge and undesirable behaviours at heritage sites are likely to continue, and may affect the ability of Traditional Owners to undertake cultural practices.
					

9.5 Overall summary of risks to the Region's values

Based on current management, the Region's ecosystem and heritage (natural, Indigenous, historic and other heritage) values face a range of increasing risks in the future. The identified threats to the Region's values arise from a range of sources and are highly variable in both scale and timeframe. The close connections between ecosystem components and heritage values mean the projected risk for many threats is equivalent for both sets of values. The 2019 risk assessment considers several threats not examined in 2014. These threats have been added either because of their emerging relevance to the Region or to better capture influences on heritage values.

Of the very high risk threats, most relate to climate change or land-based run-off (water quality)

The overall risk to both ecosystem and heritage values is very high, and has increased since 2014. The most serious threats are those associated with climate change, land-based run-off, coastal development and some aspects of direct use (including the remaining impacts of fishing).

The implications of global tipping points in the physical climate system are of urgent concern. Threats associated with climate change, such as increased sea temperatures, altered weather patterns, ocean acidification, and rising sea level, are expected to become increasingly severe in the future. Each impact will be compounded by the others, as well as by other existing regional and local threats. This amplifies the risk they pose to the Region's ecosystem and heritage values. Significant impacts from sea temperature increases and extremes have already occurred in the Region.

Land-based run-off and coastal development are assessed as posing high risk overall. Nevertheless, some positive gains have been made since 2014 in management effectiveness for coastal development and land-based run-off, and the risk from associated threats may decrease somewhat over time as a result. Proposed development of the northern part of the Catchment could have significant implications for threats to the Region's values.

Threats identified as posing the highest risk are already affecting ecosystem and heritage values at a Region-wide scale

Management arrangements are keeping many risk levels stable; examples include the continued strong management of direct uses, such as defence, research activities and shipping. Direct use of the Region is assessed overall as a medium risk. However, at a more detailed level, some significant risks remain. Fishing activities contribute to multiple threats assessed as posing very high risk (illegal fishing and poaching and the incidental take of species of conservation concern) and high risk (discarded catch, extraction from unprotected or unidentified spawning aggregations, and extraction of particle feeders, predators and herbivores).

Across the whole assessment, only one risk has decreased since 2014 — the risk posed by disposal of dredge material. It has decreased from high to medium because of new management measures that restrict disposal of material from capital dredging. Maintenance dredging remains an ongoing activity.

Community members viewed climate change, pollution (including marine debris), land-based run-off and fishing as among the greatest threats to the Region. Community concern about some threats, including marine debris and extreme weather events, appears to have increased since 2014.

There is a very real and present danger that the combination of threats present in the Region will continue to weaken the resilience of the Reef ecosystem. As a consequence, the Reef's ability to recover from serious and increasingly frequent environmental disturbances (such as mass coral bleaching events) remains at high risk. The need for a combination of Reef-wide, regional and local solutions is well recognised, as is the importance of continuing to improve methods for understanding and responding to cumulative impacts.



Painted sweetlips at Lizard Island. © Victor Huertas 2017

