Australian Government
Great Barrier Reef Marine Park Authority

Humpback whales

Information valid as of June 2014

Summary

Diversity

Single species — humpback whale (*Megaptera novaeangliae*)

Susceptibility

The primary feeding area for humpback whales that migrate along the eastern Australian seaboard and spend time in the Great Barrier Reef World Heritage Area is in the Southern Ocean. It is predicted that these food resources will be susceptible to climate change impacts. Within the World Heritage Area, humpback whales are likely to be increasingly susceptible to vessel strike, disturbance and displacement, entanglement and acoustic noise pollution.

Major pressures

Impacts of climate change on food resources and commercial whaling outside of the Australian Whale Sanctuary (outside the 200 nautical mile exclusive economic zone territorial limits).

Within the World Heritage Area, pressures include the potential impacts from vessel strike and disturbance and displacement created by underwater noise.

Cumulative pressures

Cumulative impacts are of concern as they are likely to act over space and time to expose humpback whales to multiple pressures. Such impacts within the World Heritage Area are likely to occur from elevated levels of underwater noise and vessel-related disturbance from increasing coastal development, ports and shipping activities and other activities such as vessel-based tourism. It is considered that these pressures may impact the reproductive potential of humpback whales over the long term.

Management in the Great Barrier Reef

Legislative management tools for the conservation of dugongs that are in force in the World Heritage Area include:

- Action Plan for Australian Cetaceans
- *Great Barrier Reef Marine Park Act 1975*
- Environment Protection and Biodiversity Conservation Act 1999
- *Nature Conservation Act 1992* (Qld)
- Nature Conservation and Other Legislation Amendment and Repeal Regulation (No. 1) (Qld)
- Others (refer to management table, page 10).

Adult humpback whales can grow up to 15 metres in length and weigh up to 45 tonnes

Existing management actions

Management actions in the World Heritage Area aim to be outcomes focused and in part put legislative management tools into effect. They also provide strategic direction or additional guidance to management operations in the Marine Park.

In 2014, a comprehensive strategic assessment of the Great Barrier Reef World Heritage Area and adjacent coastal zone was completed. There are two components to the assessment, a marine component and a coastal component, which were undertaken by the Australian and Queensland governments, respectively.

Recommendations from the marine component of the strategic assessment report informed a separate Program Report for the Great Barrier Reef Region. The Program Report is a detailed description of the GBRMPA's management arrangements and future commitments to protect and manage the Great

Barrier Reef. The Program Report details how the GBRMPA's current foundational management will continue to adapt and be strengthened to achieve its responsibilities over the next 25 years.

The *Great Barrier Reef Outlook Report 2014*[1] highlights threats to the Great Barrier Reef and reports humpback whales that migrate to the Great Barrier Reef as being in good condition. Management of this species in the Great Barrier Reef will be guided by the Program Report and strategic direction provided by the Great Barrier Reef Biodiversity Conservation Strategy 2013 to improve management outcomes for humpback whales.

A number of other management actions are in place in the World Heritage Area. These include:

- Australian National Guidelines for Whale and Dolphin Watching 2005
- Operational Policy on Whale and Dolphin Conservation in the Great Barrier Reef Marine Park 2007
- Nature Conservation and Other Legislation Amendment and Repeal Regulation (No. 1) 2013 (Qld)
- Species Conservation (Whale or Dolphin Protection) Special Management Areas
- Marine Wildlife Strandings Program (for recording and reporting stranded marine animals in Queensland.

Great Barrier Reef Outlook Report 2014

assessment: As a species group, whales in the Great Barrier Reef receive an assessment of good. Humpback whales are not assessed separately.

Vulnerability assessment: low

- The major concern for the larger cetaceans, especially the baleen whales that overwinter in the waters of the Marine Park but spend summers in the Southern Ocean, stems from the pressure that climate change may exert upon their food resources in the Southern Ocean. This pressure exists almost exclusively beyond the boundaries of the World Heritage Area.
- Coastal development, ports and shipping activities and increasing levels of recreational vessel registrations (and therefore recreational vessel use) in areas adjacent to the Marine Park all contribute to cumulative impacts from underwater noise, disturbance and displacement. This may have long-term implications for the eastern Australian humpback whale stock.
- The eastern Australian stock of humpback whales is growing 10 to 11 per cent each year and this may present greater challenges to management agencies that have the responsibility to respond to humpback whales within the World Heritage Area that may have become entangled in fishing equipment.
- The growing humpback whale population is likely to be used by tourism operators in the World Heritage Area wishing to provide whale-watching opportunities to tourists. This emerging industry will require close management to ensure risks to the whales and people are minimised.

During the austral winter, female humpback whales migrate to the warm waters of the Great Barrier Reef to give birth or to mate

Background

Brief description of humpback whales

Taxonomy and characteristics

Humpback whales (*Megaptera novaeangliae)* are moderately large baleen whales of the family Balaenopteridae (or the rorquals) and are one of two genera within the family. The genus *Megaptera* is monotypic and no sub-species exist.

They typically grow to 14–15 metres though they are recorded as reaching 16–17 metres. There is no discernible sexual dimorphism in the species.[2,3] Calves are approximately 4–4.5 metres at birth and approximately 8–10 metres at independence, which is usually at the end of the natal year.

The upper side of the body is black with variable pigmentation on the underside (black, white or mottled) from which it is possible to identify an individual. Flippers are characteristically large (approximately one-third the length of the body) and are mostly white for the east Australian stock. The head and jaws have numerous knobs (called tubercles) which are also characteristic of the species.

As with all rorquals, humpbacks have a series of pleats on the ventral surface that run from the tip of the lower jaw to the umbilicus.

Stock

Southern Hemisphere humpback whales form seven distinct breeding stocks[4] recognised by the International Whaling Commission and these are linked with varying degrees of confidence to six feeding areas in the Antarctic. East Australian humpback whales (stock E1) are currently thought to comprise a single discrete population with low levels of interchange with the West Australian and South Pacific populations,[5] although this is not yet well defined. Recent genetic evidence has also raised the possibility that northbound males and females migrating along the eastern Australian coast may include individuals from different stocks.[6,7]

Diet, migration and life-history characteristics

The great whales, such as humpback and blue whales, undertake regular migrations between higher latitudes (where they feed) and lower latitudes (where calves are born and nursed). Lactating females and yearlings tend to lead the migration from the feeding grounds, followed by immature whales of both sexes, mature males and resting females, and lastly by pregnant females (and mothers with newborn calves).[8,9] Adult breeding animals form the bulk of the migration in the middle stages. During their stay in subtropical and tropical waters they feed little and subsist on energy reserves laid down at higher latitudes.

Rorquals feed by gulping in water, and then pushing it out through their baleen plates with their tongue to strain out organisms for food. The ventral pleats expand when feeding to allow the animal to greatly increase the capacity of its mouth to hold water containing prey. Baleen whales, including humpback whales, feed primarily on planktonic first-order consumers such as euphausiids (known as krill), and on small schooling fish species such as herring and mackerel.

East Australian humpback whales are thought to feed primarily in temperate or polar waters[10] migrating to the Great Barrier Reef or adjacent waters during the Austral winter. Feeding occurs primarily around the Antarctic continental shelf break and along the transitional ice-edge zone, where they intermix to an unknown extent with the other humpback whales that also feed in circumpolar Antarctic waters but which are from separate breeding populations. Little is known about what triggers the timing of whale migrations, though it is expected that environmental changes in sea surface temperature or prey availability in the Antarctic are likely causes.[11]

During the winter months, east Australian humpback whales give birth to calves and breed in the warmer waters along the east coast of Australia. The Great Barrier Reef complex represents a critical calving habitat for the East Australian humpback whale stock previously thought to be concentrated between approximately 19°S and 21°S.[12] However, in a subsequent assessment undertaken into the distribution of humpback whales throughout the Great Barrier Reef, Chaloupka and Osmond[13] suggested the main area for breeding and calving extended from the islands and reefs of the Whitsunday group, south to Bundaberg and east to the lagoonal waters inside the Pompey/Swains Reef complex.

The location of key calving areas was modelled in 2012 by Smith and colleagues.[14] Their modelling indicated that areas of the highest habitat suitability for humpback whale wintering is between 19.5°S to 21.5°S, especially the area approximately 100 kilometres east of Mackay. This was supported by satellite telemetry work undertaken as part of the study. The Capricorn and Bunker group of islands were indicated to be an important migratory route and not necessarily habitat for breeding and calving (refer to Figure 1).

Mother and calf pairs tend to spend more time in shallow, coastal waters than males and breeding females. This is considered to be predator avoidance behaviour to minimise the risks to young calves.[15]

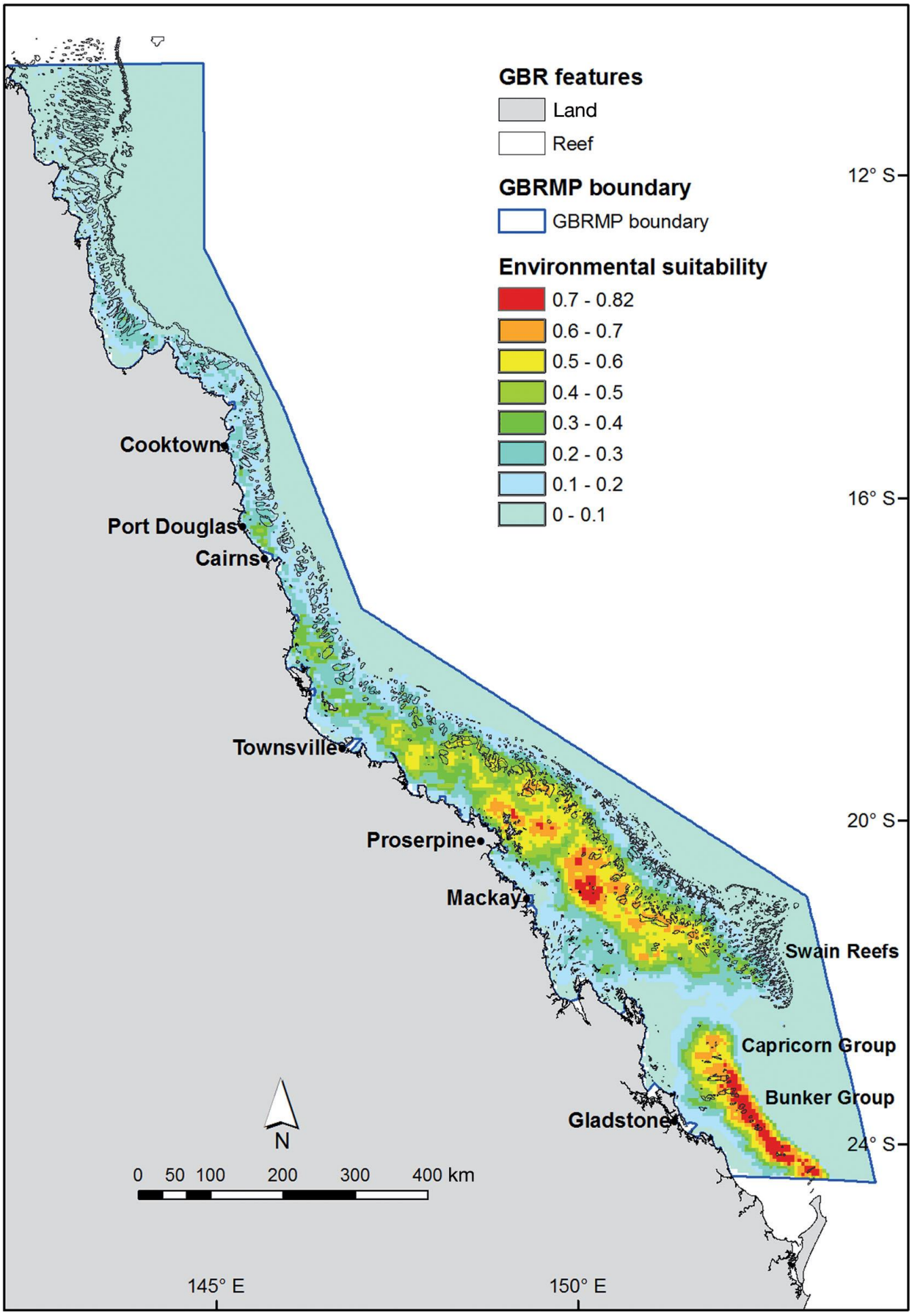

Figure 1. From Smith *et al*. 2012,[14] model prediction of average environmental suitability for humpback whales in the Great Barrier Reef Marine Park for July and August 2003 to 2007. High probability of suitable habitat and occurrence of whales are indicated by dark red.[14]

Geographical distribution

Humpback whales have a worldwide distribution. However, the southern and northern hemisphere populations are separated by temporal differences in migration patterns. During austral winter months, humpback whales are found throughout the waters of the Great Barrier Reef World Heritage Area. The forefront of the migratory herd enters Reef waters in May, with numbers peaking in August and then subsiding again. Most humpback whales have returned to southern waters by late October. During the southward migration of the east Australian stock, whales have been observed to rest in sheltered bays and in close proximity to island and cays in the World Heritage Area. Known locations include the Whitsundays, Bell Cay and the Swain Reefs complex and the Palm Island Group.

Population status in the Great Barrier Reef Marine Park

During the 19th and 20th century, humpback whales were hunted extensively and it has been estimated that the global population was reduced to five per cent of its original numbers.[16] It is estimated that when the Australian east coast whaling industry ended in 1963, the east coast population of humpbacks had been reduced to approximately 3.5 – 5 percent of pre-whaling abundance, a number potentially as low as 200 – 500 animals. As a result, humpback whales are listed as vulnerable under the EPBC Act.[16] However, in the newest compilation of the International Union for the Conservation of Nature's (IUCN) Red List of Threatened Species, humpbacks are classed as being of least concern globally. This is due to a strong recovery after the International Whaling Commission banned commercial whaling in 1966.[17] However, the Oceania sub-population (IWC stock E) of humpbacks (which includes east Australian whales) has been listed separately by the IUCN and is classed as endangered. This is based on the overall low level of recovery of whales across Oceania and the difficulty in making separate assessments.[18]

Annual recovery rates of the east Australian humpback whale stock are estimated at between 10.5 –12.3 per cent per year.[19] Noad and colleagues' updated 2010 survey provides no evidence that the rate of population growth is slowing significantly, and the re-estimation from these surveys sets growth between 10.5 and 11.3 per cent per year.[20] The estimate of absolute population abundance in 2010 was 14,500[20] (refer Figure 2). Given population growth trends, it is now expected the 2014 population could be approaching 20,000 whales.

Given the unique survey methodology used to produce population estimates for the E1 humpback whale stock, Noad and colleagues[19] state "when a change in the rate of growth occurs, it can be expected to be detected far sooner for this population than for any other population of any species in the region. As Australian humpback whales feed almost exclusively on krill in the Antarctic and are likely to do so over wide areas, the data and survey methodology provides a very sensitive diagnostic of changes in the rate of population growth that has the potential to be an indicator of changes in conditions in the Southern Ocean, particularly regarding krill abundance. East Australian humpback whales should therefore be viewed as one of the most important Antarctic sentinel populations."

Estimates of the pre-exploitation carrying capacity for the east Australian stock is 22,000-25,700 humpback whales.[20] Following the most recent survey in 2010, it was estimated at that time the stock was 50 to 75 percent recovered.[20] Using population growth trends it can be expected that in 2014 this percentage would be higher.

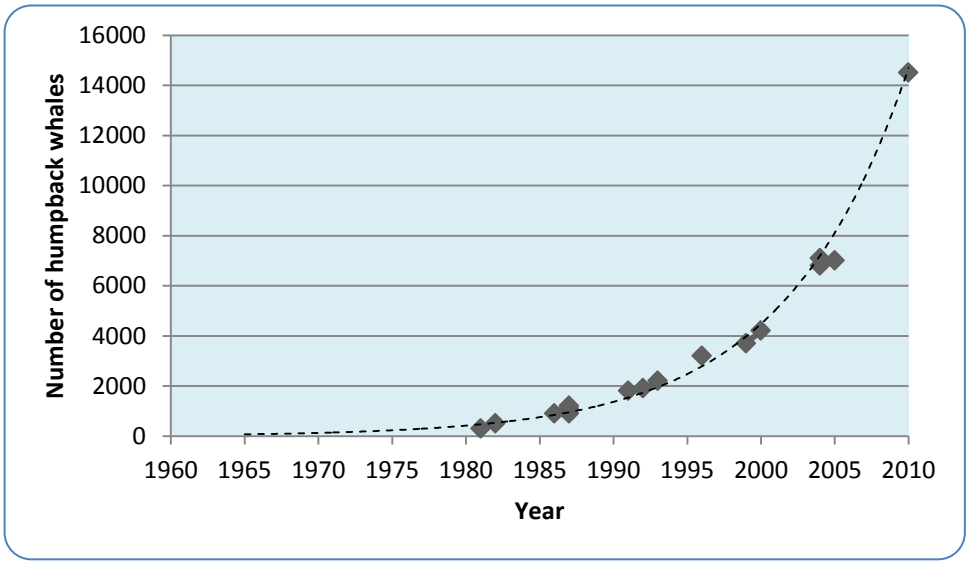

Figure 2. Recovery of the east Australian humpback whale population (E1 stock) since whaling ceased in the 1960s. Adapted from [19,20,21,22,23,24,25,26,27]

Ecosystem role/function

Being large planktivorous filter-feeding cetaceans, humpback whales are likely to play a role in nutrient cycling within oceans and in maintaining the balance of trophic order.[11] Recent research by Nicol and colleagues[28] found whales may make a significant contribution to the productivity of the surface layer of the Southern Ocean by providing iron nutrition through defecation. Iron nutrition is required by phytoplankton for growth. This increased productivity leads to greater absorption of carbon by phytoplankton during growth.[28] This carbon is then transported to the oceans depths where it is stored.[29]

Ecosystem goods and services

Ecosystem goods and services category	Services provided by the species, taxa or habitat
Provisioning services (e.g. food, fibre, genetic resources, bio-chemicals, fresh water)	Historical uses of whale products include the use of whale blubber in the manufacture of oils and lubricants; the use of baleen for such things as buggy whips or carriage springs and other applications where today plastic or tensile steel would be used. These uses have been superseded and the use of whale blubber was made illegal in 1979. Traditionally, whale meat has been eaten by various cultures around the world. In Japan, whale meat is still considered a delicacy. Following the International Whaling Committee's (IWC) 1986 moratorium on commercial whaling, Japan has continued to conduct whaling under IWC treaty provisions which allows whaling for scientific research. IWC regulation of this permission allows meat from this research to be sold in shops and restaurants within Japan.
Cultural services (e.g. spiritual values, knowledge system, education and inspiration, recreation and aesthetic values, sense of place)	Whales hold cultural significance for some coastal Indigenous Australians. Aesthetic and intrinsic conservation values provide a strong social and economic impetus for the conservation of humpback whales within the World Heritage Area. Whale (and dolphin) watching is a significant contributor to Australia's tourism-related economy. Whales (and dolphins) are iconic species that hold a special significance for many users of the Great Barrier Reef. For some Aboriginal and Torres Strait Islander groups, such as the Woppaburra people of the Keppel Islands, the humpback whale (Mugga Mugga) is the clan totem that connects them to their ancestral land and sea country as well as to their ancestors. For many people, whales are iconic and represent symbols of inspiration or have spiritual value.
Supporting services (e.g. primary production, provision of habitat, nutrient cycling, soil formation and retention, production of atmospheric oxygen, water cycling)	The supporting services of whale species within marine ecosystems are largely unknown. Whales are likely to play a significant role in nutrient cycling in marine ecosystems. Recent research[28] found whales may significantly contribute to the primary productivity of the surface layer of the Southern Ocean by providing iron nutrition by defecation. Iron nutrition is required by phytoplankton for growth. This iron is then cycled up the food web through krill production.[28] Further to this research, other studies provide evidence that the removal of large predators from marine ecosystems may well affect not only food web structure but also the seawater chemistry and physics, and thus negatively impact on the underlying primary production of the oceans.[30,31,32,33,34,35]
Regulating services (e.g. invasion resistance, herbivory, seed dispersal, climate regulation, pest regulation, disease regulation, natural hazard protection, erosion regulation, water purification)	Whales are generalist top order predators and may help to regulate populations of prey species and maintain ecosystem balance. The removal of top order predators can also have unexpected lower order effects on non-prey species in what is referred to as trophic cascading. How whales contribute to maintaining the trophic order of marine ecosystems is largely unknown. The role that whales have been shown to perform in increasing the productivity of surface layers of temperate waters may also form a significant role in the ocean's carbon cycle and thus assist in climate regulation. Cold temperate waters are where a large part of the Earth's atmospheric carbon is absorbed. This process is largely assisted by the productivity of phytoplankton[29] which requires mineral iron to support their growth.[28] During growth phytoplankton (predominantly diatoms) sequester then transport carbon to ocean depths.[29]

Pressures influencing humpback whales in the Great Barrier Reef Marine Park

Pressures

Baleen whales in the Great Barrier Reef, of which humpback whales are one species, are thought to have fairly large and stable populations that migrate in and out of the Marine Park.[13,19,27,36] As with other cetaceans, the greatest threat is predicted to come from the effects that climate change will have on their ability to source food.[11] Humpback whales migrate between the Great Barrier Reef and the Southern Ocean where they conduct most of their feeding. Therefore, climate change impacts that affect food webs on which humpback whales rely will occur outside Great Barrier Reef waters. While GBRMPA must continue to engage in processes and programs to mitigate the causes of climate change, primary focus must be given to measures that increase the resilience of humpback whales to the cumulative pressures experienced by the species within the Marine Park. A more detailed description of the range of pressures that impact on humpback whales in the Great Barrier Reef is provided in the vulnerability assessment matrix.

Vulnerability assessment matrix

According to the *Great Barrier Reef Outlook Report 2014*[1], the key pressures reducing the resilience of the Reef ecosystem are a number of commercial and non-commercial uses of the Marine Park, along with habitat loss and degradation due to climate change, coastal development and declining water quality from land-based (catchment) run-off.

The report considered these pressures are the key factors that influence the current and projected condition of environmental, economic and social values of the Great Barrier Reef. These pressures can impact directly and/or indirectly on habitats, species and groups of species to reduce their resilience to future impacts. Using the vulnerability assessment framework adapted by Wachenfeld and colleagues[37] , this vulnerability assessment aims to provide an integrated assessment of social, ecological, economic and governance information.

For each key pressure in the Marine Park, exposure and sensitivity is assessed in relation to each other to reach a level of potential impact. The potential impact is then reassessed having considered the level of natural adaptive capacity that humpback whales have to respond to the pressure and the adaptive capacity that management has, or can apply, to reduce the potential impact from the pressure. This provides managers and stakeholders with an understanding of the key elements that each pressure can impose on these species to reach a final assessment of the overall residual vulnerability of humpback whales to that particular pressure. This allows for suggested actions to be formulated to minimise the impact of the pressures which humpback whales are most vulnerable to.

A summary of the assessment of the impacts is tabled below, however, for the detailed assessment and explanatory notes refer to Appendix 1.

A recent arrival (September 2011) in the east Australian humpback whale population — an all-white calf whose genetics leave it devoid of the skin colouring, melanin. Photo courtesy W. Fewings

Vulnerability assessment matrix summary for humpback whales in the Great Barrier Reef Marine Park

		Exposed to source of pressure (yes/no)	Degree of exposure to source of pressure (low, medium, high, very high)	Sensitivity to source of pressure (low, medium, high, very high)	Adaptive capacity — natural (poor, moderate, good)	Adaptive capacity — management (poor, moderate, good)	Residual vulnerability (low, medium, high)	Level of confidence in supporting evidence (poor, moderate, good)
Pressures	**Commercial marine tourism**	Yes, regionally (with potential for wider significance)	Low	Low	Moderate	Good	Low	Moderate
	Defence activities	Yes, locally	Low	Low	Moderate	Good	Low	Good
	Commercial fishing	Yes, indirect pressure due to vessel activity	Low	Low	Moderate	Good	Low	Moderate
	Recreational fishing	Yes, indirect pressure due to vessel activity	Low	Low	Moderate	Good	Low	Moderate
	Ports and shipping	Yes, locally (with potential for wider significance)	Medium	Medium	Moderate	Good	Low	Moderate
	Recreation (not fishing)	Yes, locally (with potential for wider significance)	Low	Low	Moderate	Good	Low	Moderate
	Traditional use of marine resources	No	Low	Low	Good	Good	Low	Good
	Climate change	Yes	Low (within the Marine Park)	Low (within the Marine Park)	Moderate	Poor	Low (within the Marine Park)	Moderate
	Coastal development	Yes, predominantly south of Port Douglas	Medium	Low	Moderate	Good	Low	Poor
	Declining water quality due to catchment run-off	Yes, predominantly south of Cooktown	Low	Low	Moderate	Moderate	Low	Poor

Key concerns

The effective conservation of snapper requires the protection of key habitats and management of key threats. The following matters are of key concern:

- It is considered that the major pressure facing humpback whales comes from climate change and the related effects on their food resources in their feeding grounds in the Southern Ocean. There is considerable uncertainty over what these effects will be, but they may include reduced quantity or quality and greater spatial and temporal variability of food. This would affect the ability of humpback whales to adequately use the resource.
- Humpback whales' near shore habitat preferences for calving and breeding grounds, their rest stops during migration, and their iconic status and easy identification make them accessible and attractive to vessels

involved in tourism or recreational activities.[38] Expanding commercial whale-watching tourism and higher numbers of recreational vessel registrations[39] have the potential to expose humpback whales in the Marine Park to more incidences of vessel strike and vessel-related disturbance.

- It can also be anticipated that the risks from vessel strike will rise as larger volumes of shipping use the World Heritage Area and port facilities grow to accommodate this traffic. As regional industrial centres grow — driven in part because of port expansions — the number of recreational vessels potentially engaging in whale-watching activities may also increase.[39]
- In a number of studies in different locations around the world similar conclusions were drawn about humpback whale responses to vessel activity. In these studies, humpback whale dive times and the overall time whales spent submerged were higher in the presence of boats[40], while humpback whales changed direction when boats were within one kilometre and increased swim speeds.[41,42] In a study on southern right whales (*Eubalaena australis*), resting and socialising activities reduced, while travelling activities significantly increased in the presence of boats.[43] In this study, whales swam faster, reoriented more often, and changed their direction during these interactions. Effects were greater for mother/calf pairs than for juveniles.[43]
- Ultimately, studies of whale behaviour around boats are limited by their ability to estimate the extent to which short-term behavioural changes affect the fitness of individuals. However, researchers point out that in some locations animals can be exposed to vessel disturbance throughout several months of the year and suggest the greater use of energy employed in avoidance could have longer term implications for humpback whales.[42,44,45] In a scientific synthesis of the impacts of underwater noise on marine and coastal biodiversity and habitats commissioned by the Secretariat of the Convention on Biological Diversity,[46] it was found "there are increasing concerns about the long-term and cumulative effects of noise on marine biodiversity. The long-term consequences of chronic noise pollution for individuals and populations are still mainly unknown. Potential long-term impacts of reduced fitness and increased stress leading to health issues have been suggested. There is also growing concern of the cumulative effects of anthropogenic sound and other stressors and how this can affect populations and communities. Although there is currently little empirical evidence for noise effects on marine populations, acoustic studies for terrestrial vertebrates indicate that features such as fitness and reproductive success can be compromised. The additional threat of living in a noisy environment may push already highly stressed marine animals into population decline with subsequent effects on marine communities and biodiversity."
- The synthesis further highlighted that "a wide range of effects of increased levels of sound on marine fauna have been documented both in laboratory and field conditions. The effects can range from mild behavioural responses to complete avoidance of the affected area, masking of important acoustic cues, and in some cases serious physical injury or death. Low levels of sound can be inconsequential for many animals. However, as sound levels increase the elevated background noise can disrupt normal behaviour patterns leading to less efficient feeding for example."[46] The synthesis report[46] outlines the issues and the importance of sound to marine animals. It discusses the impacts of underwater noise on marine biodiversity and approaches to mitigation and management. The report found that:
  - the underwater world is subject to a wide array of human-made noise from activities such as commercial shipping, oil and gas exploration and the use of various types of sonar
  - human-related noise in the marine environment has increased markedly over the past 100 or so years as the human use of the oceans has grown and diversified
  - human-related noise has gained recognition as an important stressor for marine life and is now acknowledged as a global issue that needs addressing.
- Research has demonstrated that vessels produce sound which contains a set of harmonically-related tones. The fundamental frequencies (waves per second in hertz) and relative amplitudes (in decibels) at the harmonic frequencies are determined by the boat speed, propeller movements and engine types, with small, medium and large vessels all producing sound which significantly contribute to ambient underwater noise levels. Although not directly applicable to humpback whales, a study by Jensen[47] found small boats with outboard motors travelling at less than three knots did not significantly increase ambient noise levels within the frequencies detectable by bottlenose dolphin, however ,conversely, vessels moving faster had sound impacts beyond 50 metres.
- As noise produced by vessel traffic is a component of disturbance,[48,49] Wright and colleagues[50] have suggested that monitoring cumulative boat noise using passive acoustic arrays in critical whale habitat might be considered a means for triggering area closures during sensitive life history stages, such as calving. The challenge here would be to reach consensus on the noise level that triggers such a management response.
- With the continued growth in the level of pollutants in coastal waters, the possibility of direct or indirect effects of declining water quality on migrating humpback whales cannot be discounted, particularly as the migratory routes of humpback whales often lie close inshore.[51]

Management of humpback whales in the Great Barrier Reef Marine Park

Management agencies with responsibilities for managing these species or impacts on these species within the Great Barrier Reef World Heritage Area and the statutory and non-statutory tools that influence the conservation management of these species

Legislation or policy	Object as it applies to the species	Tools for conservation	Who administers it
World Heritage Convention	• Four natural heritage criteria with associated conditions of integrity. Criteria focus on: (i) geological processes and phenomena, including the evolution of the earth (ii) ongoing ecological and biological processes (iii) linked aesthetic components of the natural world (iv) the biological diversity and habitats of threatened species • Natural heritage criteria (iv) states that the natural heritage asset must contain the most important and significant natural habitats for in situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation	• Provides State Parties to the convention with definitions of natural and cultural heritage, measures for the protection of natural and cultural heritage; the means of administration and obligations of the convention; funding arrangements, educational programs and reporting obligations	United Nations Educational, Scientific and Cultural Organization (UNESCO)
Convention on Biological Diversity (CBD)	• The three main objectives of the CBD are: i. The conservation of biological diversity ii. The sustainable use of the components of biological diversity iii. The fair and equitable sharing of the benefits arising out of the utilisation of genetic resources	• Provides State Parties to the convention with global principles, objectives and obligations for the conservation of biodiversity • Guides Australia's strategic planning to achieve national priority actions for biodiversity conservation through a range of objectives and targets for each	United Nations Environment Program — CBD Secretariat
International Union for the Conservation of Nature (IUCN) Red List of Threatened Species	• Humpback whales listed as 'least concern' for the species as a whole • East Australia humpbacks as part of the Oceania sub-population listed as 'endangered'	• Establishes the conservation status of species based on the assessment of their global population and trends • Assessment information used to formulate management response	International Union for the Conservation of Nature (IUCN)
Convention on International Trade of Endangered Species of Wildlife Fauna and Flora (CITES)	• Humpback whale listed in Appendix I	• Appendix I lists species that are the most endangered among CITES-listed animals and plants. They are threatened with extinction and CITES prohibits international trade in specimens of these species except when the purpose of the import is not commercial, such as for scientific research	United Nations Environment Program — CITES Secretariat

Legislation or policy	Object as it applies to the species	Tools for conservation	Who administers it
Bonn Convention — Convention on Migratory Species	• Provides a basis for forming international agreement on the protection, conservation and management of migratory species • Humpback whale listed in Appendix I — migratory species that are endangered	• The parties to the convention agree to: a) promote, co-operate in and support research relating to migratory species b) endeavour to provide immediate protection for migratory species included in Appendix I c) endeavour to conclude agreements covering the conservation and management of migratory species included in Appendix II • Animals listed as migratory in appendices of the convention are considered as matters of national environmental significance under the EPBC Act and are protected under the Act	United Nations Environment Program — CMS Secretariat
Action Plan for Australian Cetaceans	• Humpback whale listed as vulnerable	• The plan establishes a national overview of the conservation status of Australian cetaceans and recommends conservation priorities, and research and management actions, with particular emphasis on endangered and vulnerable taxa	Commonwealth Department of the Environment
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and Environment Protection and Biodiversity Conservation Regulations 2000	• Legislative framework for environmental protection in Australia • Designates all Australian Commonwealth waters as the Australian Whale Sanctuary which provides for the protection of all cetaceans • All cetaceans are protected as threatened species under the Act under the classification of 'cetacean' • Listing of the humpback whale as vulnerable and migratory species • Part 8 of Regulations describes requirements for interactions with cetaceans including reporting of any interactions with marine mammals	• All species on the list of migratory species are matters of national environmental significance under the EPBC Act. An action will require approval if the action has, will have, or is likely to have, a significant impact on a listed migratory species. The action must be referred to the Minister and undergo an assessment and approval process • An action affecting whales or dolphins that would otherwise be in breach of the EPBC Act could be deemed to be a 'controlled action' and require a greater scrutiny of environmental impact assessment before consideration of approval • Assessment and export approval processes for all fisheries with an export component (or wildlife trade operation) that must consider interactions with threatened species • Regulates on the required reporting of any interactions with marine mammals, including cetaceans and whale-watching regulations • Penalties for non-compliance • Processes of review	Commonwealth Department of the Environment

Legislation or policy	Object as it applies to the species	Tools for conservation	Who administers it
Australian national guidelines for whale and dolphin watching	• Provide a clearly defined set of standards for activity around whales and dolphins. The guidelines provide two-tiered levels of advice for all governments in the development and review of laws regulating whale and dolphin watching	• Tier 1 — National Standards. Applies to all people watching whales and dolphins and outlines the general requirements for protecting animals • Tier 2 — provides advice for areas or activities that may require alternative levels of management and mostly apply to the commercial whale and dolphin watching industry	Commonwealth Department of the Environment
Great Barrier Reef Marine Park Act 1975 and Great Barrier Reef Marine Park Regulation 1983	• Provides for biodiversity conservation through zoning, issuing of permits and implementation of plans of management that collectively enable management of human activities • Regulation 29, Table 29 of the Regulations provides a list of protected species including all cetaceans	• Part 4A of the Regulations provides controls for human interactions with cetaceans, including whale-watching regulations (refer to http://www.gbrmpa.gov.au/about-us/legislation-regulations-and-policies/whale-and-dolphin-watching-regulations). These compliment regulations within the EPBC Act • The Regulations provide for the creation of Species Conservation (Whale or Dolphin Protection) Special Management Areas • Whale Protection Areas are also described in the Regulations and implemented in plans of management (e.g. Whitsundays Plan of Management) • Regulation of scientific research in the Marine Park • Regulation of activities within the Marine Park • Penalties for non-compliance • Review of Act and Regulation	Great Barrier Reef Marine Park Authority
Great Barrier Reef Marine Park Zoning Plan 2003	• A multiple-use marine protected area management tool that protects biodiversity by regulating activities within the Great Barrier Reef Marine Park • The Representative Area Program, which provided the basis for spatial planning decisions for the Zoning Plan, described 70 broadscale habitats (or bioregions) and as such provides the basis for ecosystem-based management in the Marine Park	• Spatial management of activities within the Great Barrier Reef based on protecting habitat type representative areas • 34 per cent of the Marine Park is dedicated as Marine National Park (green) or Preservation (pink) zones in which no extractive activities are permitted • Restricted Access Special Management Areas can be created for the protection of humpback whales and their habitats under special circumstances • Processes of review • Penalties for non-compliance	Great Barrier Reef Marine Park Authority

Marine Parks Act 2004 (Qld) and Marine Parks Regulation 2006	• The object of this Act is to provide for the conservation of the marine environment by:
	  • declaring state marine parks
	  • establishing zones, designated areas and highly protected
		• Aims to involve all stakeholders cooperatively
		• Coordinates and integrates with other conservation legislation
		• Penalties for non-compliance
		• Processes of review
			Queensland Government

Legislation or policy	Object as it applies to the species	Tools for conservation	Who administers it
	areas within marine parks • developing zoning and management plans • recognising the cultural, economic, environmental and social relationships between marine parks and other areas • applying the precautionary principle		
Marine Parks (Great Barrier Reef Coast) Zoning Plan 2004 (Qld)	• A multiple-use marine protected area management tool that protects biodiversity by regulating activities within the Great Barrier Reef Coast Marine Park • The Representative Area Program, which provided the basis for Great Barrier Reef spatial planning decisions, described 70 broadscale habitats (or bioregions) and as such provides the basis for ecosystem-based management in the Great Barrier Reef Coast Marine Park	• Spatial management of activities within state waters of the Great Barrier Reef based on protection of representative bioregions • Penalties for non-compliance • Complements spatial management zones and certain regulatory provisions established under the Great Barrier Reef Marine Park Zoning Plan 2003	Queensland Government
Strategic assessment of the Great Barrier Reef World Heritage Area and adjacent coastal zone	Assessment under the EPBC Act that provides the opportunity to achieve both conservation and planning outcomes at a much larger scale than can be reached through project-by-project assessments Two complimentary strategic assessments – a marine component undertaken by the GBRMPA and a coastal zone component undertaken by the Queensland Government	The two strategic assessments contain recommendations and inform separate Program Reports for the Great Barrier Reef Region. The Program Reports are a detailed description of the GBRMPA's and Queensland Government'smanagement arrangements and future commitments to protect and manage matters of national environmental significance, including the outstanding universal value of the Great Barrier Reef World Heritage Area over the next 25 years	Australian and Queensland governments
Reef 2050 – Long-term Sustainability Plan	The Reef 2050 Long-term Sustainability Plan will inform future development by drawing together the marine and coastal components of the comprehensive strategic assessment, providing an over-arching framework to guide protection and management of the Great Barrier Reef World Heritage Area from 2015 to 2050	It will target identified areas of action from the strategic assessments and seek to address gaps for future management of the Great Barrier Reef World Heritage Area	Australian and Queensland governments
Operational policy on whale and dolphin conservation in the Great Barrier Reef Marine Park 2007	• The objective of the policy is to provide a framework for the conservation of whales and dolphins by partnering with Reef users and managing their activities within the Great Barrier Reef Marine Park • This operational policy implements the Great Barrier Reef Marine Park Authority's obligations under the Australian Government's *Australian national guidelines for whale and dolphin*	• Provides basis for public education • Penalties for non-compliance under the *Great Barrier Reef Marine Park Act 1975* • Policy reviewed on a regular basis in line with changes to legislation and national guidelines	Great Barrier Reef Marine Park Authority

Legislation or policy	Object as it applies to the species	Tools for conservation	Who administers it
	watching 2005 • The humpback whale is identified as a priority species for conservation management in the operational policy		
Queensland Nature Conservation Act 1992 and Nature Conservation (Wildlife) Regulation 2006	• Provides for the protection of marine mammals including whales • Reporting on interactions with protected marine mammals is regulated and annual reports on cetacean strandings and mortality are compiled • Listing of the humpback whale as vulnerable	• Provides legislative requirement for developing conservation plans • Strandings mortality and interaction data are used for scientific research and to compile policies and position statements • Penalties for non-compliance • Processes of review	Queensland Government
Nature Conservation and Other Legislation Amendment and Repeal Regulation (No.1) 2013	• Development of management intent for whales and dolphins in Queensland and adjacent waters	• Management framework for cetacean watching activities, protection and conservation, population monitoring, review of management tools, research, and collaborative approaches to management • Penalties for non-compliance • Processes of review	Queensland Government
Marine Wildlife Stranding Program	• Collects and reports on stranding and mortality information of threatened marine wildlife species within Queensland	• Provides critical information to aid and inform research and management initiatives • Processes of review	Queensland Government (jointly funded by the Great Barrier Reef Marine Park Authority through the Field Management Program)
Queensland Shark Control Program	• Community education and protection policy under *Fisheries Act 1994* (Qld) • The program deploys up to 191 drumlines (Cairns, Townsville, Mackay, Capricorn coast, Gladstone district) and five nets within the World Heritage Area	• Nets designed to capture sharks greater than two metres in length. Nets are 186 metres long. Most nets have a depth of six metres and a mesh size of 500 millimetres. • Five remaining shark nets in the Great Barrier Reef off Mackay beaches • Drumline arrays consist of up to six or more shark hooks with fresh bait suspended individually from large plastic floats; (roughly, one net equals six drumlines) • Equipment checked every second day, weather permitting • The use of audible pingers on shark nets are being trialled in an effort to prevent dolphin entanglement • Other measures employed to reduce interactions with threatened species	Queensland Government

Legislation or policy	Object as it applies to the species	Tools for conservation	Who administers it
		• Processes of review	
Great Barrier Reef Biodiversity Conservation Strategy 2013	• Identifies humpback whales as an at-risk species in the Marine Park • Grades the level of risk experienced by humpback whales through a vulnerability assessment process	• The Biodiversity Conservation Strategy has a framework for action with three strategic objectives aimed at building or maintaining ecosystem resilience and protecting biodiversity: 1. Engaging communities and fostering stewardship 2. Building ecosystem resilience in a changing climate 3. Improved knowledge • Objectives are comprised of program-level outcomes with key actions and targets for measuring success • Implementation of the strategy will be undertaken through a multi–agency, multi-stakeholder collaborative approach	Great Barrier Reef Marine Park Authority
Great Barrier Reef Climate Change Adaptation Strategy and Action Plan 2012–2017	• Identifies specific measures to enhance resilience of the Great Barrier Reef ecosystem and supports adaptation by regional communities and industries that depend on it	• Allocates dedicated funding to implement actions to improve the resilience of the Great Barrier Reef ecosystem	Great Barrier Reef Marine Park Authority
Reef Water Quality Protection Plan 2009	• An overarching framework to achieve a sustainable future for the Great Barrier Reef and the industries in the Reef's catchment by improving water quality that flows into the Reef lagoon	• Improve water quality that flows into the Reef by targeting priority outcomes, integrating industry and community initiatives and incorporating new policy and regulatory frameworks	Joint Australian and Queensland government initiative
Great Barrier Reef Protection Amendment Act 2009 (Qld)	• A framework for halving the levels of dangerous pesticides and fertilisers found in the waters of the Great Barrier Reef in four years	• Mix of strict controls on farm chemicals and regulations to improve farming practices	Queensland Government
Coastal Protection and Management Act 1995 (Qld) and Coastal Protection and Management Regulation 2003	• Provides the legislative framework and Regulations for the coordinated management of the diverse range of coastal resources and values in the coastal zone. This framework includes provisions that establish the Queensland Coastal Plan.	• Queensland Coastal Plan provides guidelines for effective protection and management of the coastal zone	Queensland Government
Sustainable Planning Act 2009 (Qld) and Sustainable Planning Regulation 2009	• Establishes process for land-use planning and development assessments. Identifies state legislation that may be triggered by development assessments and the process by which developments must be assessed against each piece of legislation • Establishes the framework for the development of regional plans.	• Coastal development generally requires impact assessment and a development approval under the *Sustainable Planning Act 2009*. • Regional plans developed under the Act operate in conjunction with other state planning instruments, usually taking precedence over them • Regional plans must conform to policies established within the Queensland Coastal Plan • Regional plans identify:	Queensland Government

Legislation or policy	Object as it applies to the species	Tools for conservation	Who administers it
		• desired regional outcomes • policies and actions for achieving these desired regional outcomes • the future regional land use pattern • regional infrastructure provision to service the future regional land use pattern • key regional environmental, economic and cultural resources to be preserved, maintained or developed.	
Queensland Coastal Plan (prepared under the *Coastal Protection and Management Act 1995*)	• The Queensland Coastal Plan has two parts: State Policy for Coastal Management, and the Coastal Protection State Planning Regulatory Provision (following the suspension of the State Planning Policy 3/11 - Coastal Protection).	• Coastal activities that are not defined as development under the *Sustainable Planning Act 2009* are considered under the State policy for Coastal Management (currently under review following the change in government) • The suspended State Planning Policy 3/11 provided policy direction and assessment criteria to direct land-use planning and development assessment decision making under the *Sustainable Planning Act 2009*. The Coastal Protection State Planning Regulatory Provision now offers much less specific guidance.	Queensland Government

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Appendix 1. Vulnerability assessment matrix

	Pressures									
	Commercial marine tourism	**Defence activities**	**Commercial fishing**	**Recreational fishing**	**Ports and shipping**	**Recreation (not fishing)**	**Traditional use of marine resources**	**Climate change**	**Coastal development**	**Declining water quality due to catchment run-off**
Exposed to source of pressure **(yes/no)**	Yes*, regionally	Yes, locally	Yes, indirect pressure due to vessel activity	Yes*, indirect pressure due to vessel activity	Yes*, locally (with potential for wider significance)	Yes*, locally with implications over wider spatial scales	No	Yes	Yes*, predominantly south of Port Douglas	Yes*; predominantly south of Cooktown
Degree of exposure to source of pressure **(low, medium, high, very high)**	Low. Commercial marine tourism focusing on humpback whales in Australia is entirely vessel-based. Exposure of humpback whales to impacts from commercial tourism in the Marine Park occurs during seasonal migrations over the austral winter when pregnant females migrate to warmer waters to calve, and other adults, to breed. As a result of the growing population of humpback whales that migrate along the eastern Australian coast, whale-watching tourism has also continued to expand. The impacts from interactions with tourist operations may extend beyond the spatial area over	Low. At the local scale, humpback whales may be exposed to defence activities. (Defence activities are restricted spatially and mostly concentrated in coastal waters in the Great Barrier Reef Region). Exposure is considered low, as the species is predominantly oceanic and there is minimum overlap with where defence forces conduct their exercises.	Low. Humpback whales are not considered to be exposed to direct commercial fishing pressures within the Great Barrier Reef Region. Commercial fishing vessel movements would contribute to vessel-related impacts on humpback whales, though this is expected to be at low exposure. Although not a commercial fishing operation, the Queensland Government's Shark Control Program is a commercial operation designed to aid the safety of bathers. This program records	Low. Humpback whales are not considered to be directly exposed to fishing pressures within the Great Barrier Reef Region. The impacts from interactions with recreational fishing vessels may extend beyond the spatial area over which the pressure is applied if whales become habituated and complacent around vessels. Cumulative noise impacts from vessel traffic could affect the	Medium. Humpback whales migrate along the coasts. Mother-calf groups tend to dwell in shallow, inshore waters potentially exposing them to a greater risk of boat strike and disturbance in high traffic localities such as port entrances and shipping lanes. The exposure to this threat is largely unknown though has been shown to be increasing as shipping traffic in the Marine Park increases and may be under-reported. Exposure to pollution incident impacts is considered low risk at a	Low. Impacts from interactions with recreational users of the Marine Park are likely to be low at present, given the low density of recreational users over the area. These impacts may become greater over time as population centres grow and the numbers of vessels being used in the Marine Park increase. There is also the potential for local-scale impacts to be significant over areas considered to be suitable habitat for humpback whales.	Low. There is no known present traditional use of humpback whales in Australia.	Low (within the Great Barrier Reef Marine Park). The major pressures on humpback whales (and other baleen whales that visit the Marine Park) from climate change impacts are related to effects on their food resources outside the Great Barrier Reef Region. There is considerable uncertainty over what these effects will be, but they may include reduced quantity or quality and greater spatial and temporal variability of food.	Medium. Critical habitat areas for humpback whales within the Marine Park are only just being modelled and starting to become more clearly understood. Certain areas such as the Whitsundays and east of Mackay, which are within close proximity to population centres, high-use zones and industrial ports, are considered important. The pressure of increased coastal development and the population growth of whales and residents, combined with greater marine debris and degraded water quality, may act cumulatively to	Low. Humpback whales are expected to be exposed to the declining water quality in the Marine Park, but sensitivity is expected to be low to this pressure. This means exposure to the pressure is also low.

	Pressures									
	Commercial marine tourism	**Defence activities**	**Commercial fishing**	**Recreational fishing**	**Ports and shipping**	**Recreation (not fishing)**	**Traditional use of marine resources**	**Climate change**	**Coastal development**	**Declining water quality due to catchment run-off**
	which the pressure is applied if whales become habituated and complacent around vessels. Cumulative noise impacts from vessel traffic could affect the ability to communicate and expose animals to a higher risk of predation.		annual interactions with cetaceans, including humpback whales. As the population of East Australian stock humpback whales increase, their interactions with equipment used within the Queensland Shark Control Program is likely to increase.	ability to communicate and expose animals to a higher risk of predation.	population level.				threaten the humpback whales that visit the Marine Park.	
Sensitivity to source of pressure **(low, medium, high, very high)**	Low. Cetaceans can demonstrate altered behaviour in the presence of vessel traffic. Short-term behavioural changes could affect the fitness of individuals. Research has indicated that in some locations animals can be exposed to vessel disturbance throughout several months of the year and that the greater use of energy employed in avoidance behaviours could have longer term implications for humpback whales.	Low. If poorly managed the detonation of underwater ordnance could cause permanent damage to hearing organs leading to possible starvation and death if the animal were in the immediate vicinity. However, defence activities are well managed and spatially and temporally restricted. The likelihood of humpback	Low. Humpback whales are not considered to be directly affected by commercial fishing activities within the Great Barrier Reef Region. Humpback whales that interact with Queensland Shark Control Program equipment can become injured or drown. However, within the control program in the World Heritage Area, there are 10 remaining nets located in	Low. Humpback whales are not considered to be directly exposed or sensitive to recreational fishing pressures within the Great Barrier Reef Region.	Medium. Cetaceans can demonstrate altered behaviour in the presence of vessel traffic. Disturbance and cumulative noise impacts from vessel traffic and other sources of underwater noise are recognised as pressures that cetaceans are sensitive to, although significant knowledge gaps persist. An increase in both the humpback whale population and	Low. Cetaceans can demonstrate altered behaviour in the presence of vessel traffic. Short-term behavioural changes could affect the fitness of individuals. Research has indicated that in some locations animals can be exposed to vessel disturbance throughout several months of the year and that the greater use of energy employed in avoidance behaviours could	Low. Humpback whales are not considered to be exposed or sensitive to traditional use of marine resource pressures within the Great Barrier Reef Region.	Low. (within the Great Barrier Reef Marine Park). The effects of climate change on humpback whales that migrate to spend time within the Marine Park are considered low as they do not feed within the area.	Low. The impacts of increasing coastal development are likely to be a commensurate increase in the urban population which will lead to more use of the Marine Park and interactions with humpback whales. This will contribute to elevated levels of underwater noise (from development works and other sources) and vessel disturbance.	Low. Altered catchment flows and the dispersal of sediments, nutrients and pollutants into the Marine Park are not expected to impact on humpback whales as they do not feed while in this area.

	Pressures									
	Commercial marine tourism	**Defence activities**	**Commercial fishing**	**Recreational fishing**	**Ports and shipping**	**Recreation (not fishing)**	**Traditional use of marine resources**	**Climate change**	**Coastal development**	**Declining water quality due to catchment run-off**
	Underwater noise can mask important acoustic cues which can reduce communication between whales. Elevated background noise can also disrupt normal behaviour patterns which could have long-term implications for the population.	whales being in close proximity to detonations is considered to be very low and specific protocols are in place to minimise the risk of this occurring.	central and northern sectors. Most entanglement of humpback whales occurs either in New South Wales or in areas south of the World Heritage Area. Observations from south of the World Heritage Area indicate humpback whales drowning because of entanglement are rare and entangled whales are usually detected quickly and released by specially trained state government teams.		shipping traffic in the Marine Park will increase the probability of boat strike.	have longer term implications for humpback whales. Underwater noise can mask important acoustic cues which can reduce communication between whales. Elevated background noise can also disrupt normal behaviour patterns which could have long-term implications for the population.				
Adaptive capacity — natural **(poor, moderate, good)**	Moderate. Humpback whales can avoid tourism vessels and there are many areas within the Marine Park where whales are not exposed to any form of vessel-based tourism.	Moderate. Humpback whales can avoid defence vessels although there remains the potential for vessel strike to occur. Humpback whales would have no capacity to adapt to underwater demolitions apart from	Moderate. In Alaska, there is evidence that a significant number of humpback whales (approximately 70 per cent) display entanglement scars.[52] As the humpback whale population increases, it is likely there will be	Moderate. Humpback whales can avoid recreational fishing vessels and there are many areas within the Marine Park where whales are not exposed to this activity.	Moderate. To some degree humpback whales can avoid commercial shipping channels where vessels are active. These channels are limited in scope so there are many areas within the Marine Park where	Moderate. Humpback whales can avoid recreational vessels and there are many areas within the Marine Park where whales are not exposed to this activity.	Good. Due to no pressure from this source, humpback whales are not assessed for their adaptive capacity to traditional use.	Moderate. Pressures upon humpback whales from climate change will mostly be exerted upon their food resources that exist well outside the Great Barrier Reef. The diet of humpback whales is quite specific to	Moderate. Humpback whales can avoid areas where coastal development projects are underway and there are many areas within the Marine Park where whales are not exposed to this activity.	Moderate. Humpback whales have been recorded using a variety of habitats (e.g. inshore bays, inner mid-shelf lagoon, and outer shelf lagoon) within the Marine Park and so have the capacity to use areas not affected by

	Pressures									
	Commercial marine tourism	**Defence activities**	**Commercial fishing**	**Recreational fishing**	**Ports and shipping**	**Recreation (not fishing)**	**Traditional use of marine resources**	**Climate change**	**Coastal development**	**Declining water quality due to catchment run-off**
		avoidance behaviours. Defence activities are spatially and temporally restricted and conducted in areas rarely used by these animals (i.e. Shoalwater Bay Training Area and to a lesser extent, Cowley Beach Training Area).	an increase in entanglements.		whales would not be exposed to any shipping traffic. The underwater noise and light created by vessels moored off major ports may also interfere with migrating humpbacks, but these areas are also spatially limited so there are many areas where whales will not be exposed to this pressure.			zooplankton and small schooling fish, all of which are likely to be affected by climate change. It is unknown how well the whales will be able to adapt to source other food resources if required. With regards to their annual migrations into the Marine Park, it is unknown exactly how humpback whales will respond to water temperature changes.		catchment run-off.
Adaptive capacity — management **(poor, moderate, good)**	Good. There is a well-established policy and legislative framework that regulates interactions between Great Barrier Reef Marine Park users and whales and dolphins. This is complemented by a compliance program to investigate any breaches of legislation and an education program to ensure users are	Good. Defence activities are well managed and limited in extent, duration and geographic distribution. Further spatial and temporal management could be considered if required.	Good. Commercial fishing in the Marine Park has limited direct impact on humpback whales. It will be important for GBRMPA to work with the Queensland Government's operational agencies charged with the responsibility to	Good. There is a well-established policy and legislative framework that regulates interactions between Great Barrier Reef Marine Park users and whales and dolphins, which includes recreational fishers. Further	Good. Under the EPBC Act, the strategic assessment of the Great Barrier Reef World Heritage Area involves examining potential impacts on matters of national environmental significance, which includes cetaceans as listed migratory and threatened	Good. There is a well-established policy and legislative framework that regulates interactions between Great Barrier Reef Marine Park users and whales and dolphins, which includes recreational fishers. Further spatial and	Good. On-going low exposure to this source of pressure requires little adaptive management input. Traditional Owner groups may identify humpback whales as culturally important and may	Poor. Options for local or regional scale management of climate-related impacts on humpback whales remain limited because most impacts are directly linked to large-scale global climate phenomena rather than more local threatening	Good. The *Great Barrier Reef Marine Park Act 1975* provides limited scope to manage activities outside the Marine Park. To achieve good water quality and coastal ecosystem outcomes for the Great Barrier Reef, GBRMPA facilitates the development of partnerships with industry and the	Moderate. The *Great Barrier Reef Marine Park Act 1975* provides limited scope to manage activities outside the Marine Park. To achieve good water quality and coastal ecosystem outcomes for the Great Barrier Reef, GBRMPA facilitates the development of

	Pressures									
	Commercial marine tourism	**Defence activities**	**Commercial fishing**	**Recreational fishing**	**Ports and shipping**	**Recreation (not fishing)**	**Traditional use of marine resources**	**Climate change**	**Coastal development**	**Declining water quality due to catchment run-off**
	aware of their requirements when observing whales. These programs are well developed and can be adapted further as required.		respond to whale entanglements in the Marine Park. This will help ensure that response capabilities match the increase in entanglements expected to occur as a result of the growing population of humpback whales that migrate annually into the Marine Park.	spatial and temporal management could be considered if required.	species. Impacts of underwater noise on cetaceans will be considered as a high-risk impact. GBRMPA has strategies and statutory tools to lower the risk of vessel-related oil spills and pollution incidents. However, the risks can only be reduced, not eliminated.	temporal management could be considered if required.	wish to incorporate management activities into their sea country management programs.	processes. Current available information on climate change impacts is being used when developing management actions for whales within the World Heritage Area. The current framework for managing climate change impacts within GBRMPA has been developed to act on new information as it becomes available.	community, as well as local, state and commonwealth government agencies to influence the management and planning of catchment and coastal pressures. This is undertaken by providing input into State Coastal Management Plan policies and statutory regional plans which will provide strategic direction for coastal development in Queensland. Under the EPBC Act, the strategic assessment of the Great Barrier Reef World Heritage Area involves examining potential impacts on matters of national environmental significance, which include cetaceans as listed migratory and threatened species. Impacts of underwater noise on cetaceans will be considered as a high-risk impact.	partnerships with industry and the community, as well as local, state and commonwealth government agencies to influence the management and planning of catchment and coastal pressures. This is undertaken by fostering partnerships through the Reef Water Quality Protection Plan 2013 and Reef 2050.

	Pressures									
	Commercial marine tourism	**Defence activities**	**Commercial fishing**	**Recreational fishing**	**Ports and shipping**	**Recreation (not fishing)**	**Traditional use of marine resources**	**Climate change**	**Coastal development**	**Declining water quality due to catchment run-off**
Residual vulnerability **(low, medium, high)**	Low	Low	Low	Low	Low	Low	Low	Low (within the Marine Park)	Low	Low
Level of confidence in supporting evidence **(poor, moderate, good)**	Moderate. Corkeron 1995[41] Scheidat *et al*. 2004[42] Lusseau and Bejder 2007[45] Stamation *et al.* 2010[40]	Good. O'Neill 2009[53]	Moderate — direct pressure from commercial fishing. Poor — indirect pressures. Prideaux 2012[38]	Moderate. Prideaux 2012[38] Nowacek *et al*. 2007[48] Convention on Biological Diversity[46] Great Barrier Reef Marine Park Authority 2011[54]	Moderate. Rolland *et al*. 2012[49] Convention on Biological Diversity[46] Nowacek et al. 2007[48]	Moderate. Prideaux 2012[38] Great Barrier Reef Marine Park Authority 2011[39,46]	Good. There is no traditional owner take of cetaceans in the Marine Park.	Moderate. Lawler *et al*. 2007[11] Learmonth *et al.* 2006[46]	Poor. Nowacek *et al*. 2007[48] Convention on Biological Diversity[46] Great Barrier Reef Marine Park Authority 2011[39,46]	Poor. There is good information on water quality condition in the Marine Park, though limited understanding of the impact of reduced water quality on migrating humpback whales.

The pressures addressed in this vulnerability assessment were identified in the *Great Barrier Reef Outlook Report 2014.*[1]

* Coastal habitats (rivers, estuaries, seagrasses, mangroves and wetlands) are under increasing pressure from human activities. More than 85 percent of Queensland's population live on the coastal fringe. Predicted strong population growth means the intensity of activity and development in coastal zones is likely to persist.[55]

The purpose of the vulnerability assessment s to provide a mechanism to highlight key concerns and make assessments of the vulnerabilities that species, groups of species or habitats (or elements of biodiversity) have to known sources of pressure within the Great Barrier Reef World Heritage Area using a standardised and transparent process. This was undertaken using a standard approach to assess the exposure and sensitivity and adaptive capacity to these pressures (Figure 3) based on the best-available information on that particular element of biodiversity.

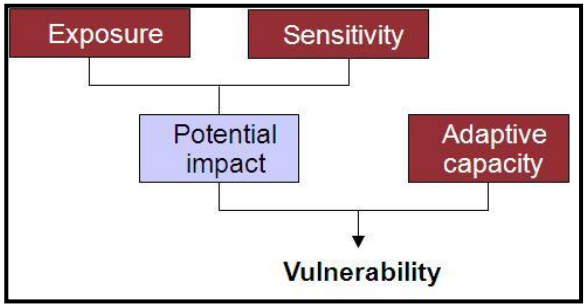

Figure 3. The key components of vulnerability assessments (Adapted from Wachenfeld *et al*., 2007)

To achieve this objective it has been necessary to apply a linear relationship to comparisons that are sometimes non-linear by nature. For example, when applying the potential impact matrix[b] to create a combined score for exposure and sensitivity, if an element of biodiversity has a very high level of exposure to a pressure but low sensitivity to it, it is scored as having a medium-high potential impact score. This medium-high score may be the same as determined for another assessment where there may be a low level of exposure but a very high level of sensitivity. This implies a linear relationship for the sensitivity a species or habitat has to a given level of exposure, which may not necessarily be the case. However, it does provide managers with the required level of resolution on these relationships for the purpose of the vulnerability assessments that inform the *Great Barrier Reef Biodiversity Conservation Strategy 2013*.

The natural capacity of humpback whales to adapt to pressures in the World Heritage Area, and the capacity of management to intervene (which in turn may assist humpback whales to adapt to these pressures), are considered as two dynamics that affect their residual vulnerability to any of the identified pressures. These two dynamics are then combined to produce an overall rating for adaptive capacity and then applied to the potential impact rating to provide a score for the residual vulnerability that humpback whales may be expected to experience due to the given pressure.

An explanation of the procedure by which the vulnerability assessment process (represented in Figure 3) has been applied, and qualifying statements for the assessment of exposure, sensitivity and adaptive capacity (natural and management) scores are provided within the vulnerability assessments page of the GBRMPA website.

[b] The potential impact matrix is described within the vulnerability assessments page of the GBRMPA website.

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