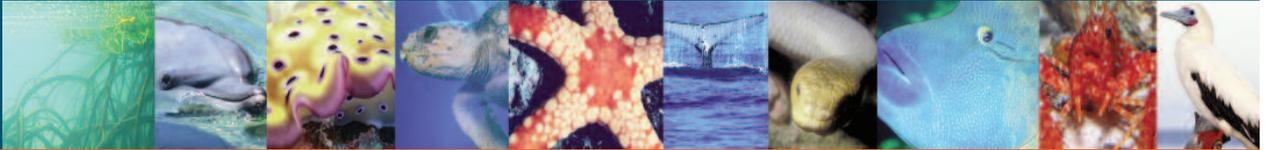


A Vulnerability Assessment for the Great Barrier Reef



Indo-Pacific (inshore) bottlenose dolphin

Information valid as of Feb 2012

Summary

Diversity

Indo-Pacific (inshore) bottlenose dolphin – *Tursiops aduncus*

Susceptibility

Life-history traits of Indo-Pacific bottlenose dolphins make them susceptible to a number of pressures occurring in the World Heritage Area. These traits include being long-lived; having slow growth rate; mature late; low reproduction rate; low relative abundance and small group sizes; moderate habitat and trophic specificity and consuming large quantities of food relative to body size. Their habitat requirements and behaviour make them prone to incidental capture in mesh nets set for commercial fishing and bather safety.

Major pressures

Habitat loss and degradation; incidental capture in mesh nets set for bather safety and the commercial net fishery; disturbance and displacement from vessel activity and underwater noise.

Cumulative pressures

Cumulative impacts are of great concern as they act over space and time to apply a combined effect that is often difficult to quantify. Such impacts include catchment run-off (creating greater bioaccumulation of toxins through the food web and delivering bacterias), coastal development, habitat loss and degradation, climate change impacts (and the combined effects of these); and depletion of food resources through commercial fishing.

Management in the Great Barrier Reef and adjacent areas in Queensland

Legislated management tools for the conservation of Indo-Pacific bottlenose dolphins that occur in the Great Barrier Reef World Heritage Area (the World Heritage Area) include the *Great Barrier Reef Marine Park Act 1975*; *Environment Protection and Biodiversity Conservation Act 1999*; *Nature Conservation Act 1992* (Qld); *Nature Conservation (Whales and Dolphins) Conservation Plan 1997* (Qld); *Fisheries Act 1994* (Qld); spatial-use regulation via the *Great Barrier Reef Marine Park Zoning Plan 2003* (34 per cent of the Great Barrier Reef Marine Park closed to extractive use), the *Marine Parks (Great Barrier Reef Coast) Zoning Plan 2004* (Qld) (providing complementary protection of coastal and some estuarine waters), Dugong Protection Areas under the *Fisheries Act 1994* (Qld) (with complimentary provisions within Species Conservation (dugong protection) Special Management Areas under the *Great Barrier Reef Marine Park Zoning*



Tursiops aduncus, the Indo-Pacific (inshore) bottlenose dolphin

Plan 2003) and Fish Habitat Areas under the *Fisheries Act 1994* (Qld) provide protection for bottlenose dolphins and their supporting habitat; other additional tools (refer Management table, p. 8)

Existing management actions

A number of management actions are in place in the World Heritage Area that 'operationalise' legislative management tools and/or provide additional guidance or strategic direction for Marine Park management operations. These include:

- *Operational Policy on Whale and Dolphin Conservation in the Great Barrier Reef Marine Park 2007*
- *Conservation and management of whales and dolphins in Queensland 1997-2001*
- Queensland Marine Wildlife Stranding Program
- *Great Barrier Reef Biodiversity Conservation Strategy 2012*
- *Great Barrier Reef Climate Change Action Plan 2007-2012*
- *Reef Water Quality Protection Plan 2009*
- *the Reef Rescue Land and Sea Country Indigenous Partnerships Program that enables collaborative management arrangements with Traditional Owners in the Marine Park to be developed*
- *Guidelines for commercial operators in the East Coast Inshore Fin Fish Fishery*
- Queensland Government's Back on Track Actions for Biodiversity documents 2010.^{1,2,3,4,5,6}

Great Barrier Reef Outlook Report 2009 assessment: Good, with little information available on which to base the grade (assessment for dolphins in the Great Barrier Reef Marine Park as a group of species).

Vulnerability assessment: Medium

There are a suite of anthropogenic (human-related) threats throughout the range of the Indo-Pacific bottlenose dolphin

in the Great Barrier Reef World Heritage Area (World Heritage Area) which include:

- incidental capture in shark nets set for bather safety and set mesh net fisheries
- competition for prey species targeted by commercial fisheries
- habitat degradation and loss through increased coastal development
- declines in water quality impact on Indo-Pacific bottlenose dolphin health and the productivity of the ecosystems they depend on
- increased noise pollution for this species that rely upon echo-location in the turbid waters that form part of the habitats they depend on
- increased boating activities can result in boat strike and disruption of dolphin behaviour
- entanglement and ingestion of discarded fishing gear/marine debris.
- Anthropogenic pressures that influence the Indo-Pacific bottlenose dolphin and their supporting habitats must be considered with an understanding that climate change may exacerbate the magnitude of those pressures.^a
- More information is required on the biology and ecology of Indo-Pacific bottlenose dolphins to support management decisions. As a lower priority to similar work required for other higher-risk inshore dolphin species (Indo-Pacific humpback and Australian snubfin dolphins), research is required to establish the distribution and abundance of the Indo-Pacific bottlenose dolphin population along the Great Barrier Reef coast.



A stranded Indo-Pacific bottlenose dolphin, *Tursiops aduncus* showing intense spotting that can characterise the species

Suggested actions to address vulnerabilities

- Continue to support the marine wildlife stranding and mortality program delivered through the Field Management Program jointly funded by the Great Barrier Reef Marine Park Authority (GBRMPA) and the Queensland Government.
- GBRMPA's ongoing collaboration with Queensland Government is important to improve conservation outcomes for Indo-Pacific bottlenose dolphin within the East Coast Inshore Fin Fish Fishery (ECIFFF). There is a need for more relevant, accurate and timely data of where and how often interactions occur

between inshore dolphins and this fishery, in particular set mesh net operations, in order to develop confidence in the management response.

- Continue to work with government agencies and communities to establish partnerships that improve habitat and water quality protection for inshore dolphins through the development and implementation of best-practice land and water management across the coast and its catchments. This work should parallel collaboration with the Queensland Government to continually improve Queensland state planning processes and policies to help improve coastal and inshore habitat and water quality protection for the Indo-Pacific bottlenose dolphin.
- Continue to work with researchers and other stakeholders to develop better understanding of the potentially serious threat that underwater noise and activity from increased vessel traffic, surveying, construction, dredging and maritime operations pose to Indo-Pacific bottlenose dolphin and consider developing a policy framework to inform the management of these impacts.
- Within the Queensland Shark Control Program (QSCP), replacement of the remaining shark control nets in the Great Barrier Reef Marine Park (the Marine Park) with drumlines should be investigated with appropriate consideration given to bather safety. (This formed part of the Great Barrier Reef Ministerial Council's recommendations from their June 1997 meeting).
- Work to prevent rubbish entering the Marine Park; support the removal of discarded fishing gear/marine debris; raise public awareness and compliance activities to encourage the responsible disposal of fishing gear/rubbish; and investigate the origins of fishing gear/marine debris. Guidance should also be taken from the national Threat Abatement Plan for the impacts of marine debris on vertebrate marine life.
- Work collaboratively with state agencies and wider stakeholder groups to identify where boating activities impact on Indo-Pacific bottlenose dolphins in the Marine Park; encourage the establishment of 'go slow' areas where impacts occur; and raise public awareness of 'go slow' areas.
- Long-term monitoring and research on the Indo-Pacific bottlenose dolphin population is required to provide information on its distribution, population structure and dispersal patterns (including site fidelity), behavioural ecology, health status and dietary and habitat requirements.
- Ecological studies on the dietary requirements of Indo-Pacific bottlenose dolphin should be developed within the World Heritage Area to better understand the influences that Queensland fisheries have on their prey species.

^a For example, impacts on Indo-Pacific bottlenose dolphin populations from habitat degradation and loss due to increased coastal development may be exacerbated by health impacts from increased bioaccumulation of toxins and bacteria^{51,25} as a result of high rainfall and catchment discharge events linked to climatic changes.^{7,53}

Background

Brief description of the Indo-Pacific (inshore) bottlenose dolphin

Dolphins (family Delphinidae) represent a unique component of marine biodiversity. They are the most diverse and widespread of marine mammals, consisting of 36 species worldwide, 17 of which are known to exist in the Great Barrier Reef.⁷ Dolphins represent one of the most socially diverse and complex groups of mammals and are known to maintain hierarchical group structures.⁸

Both *Tursiops* species are found within the waters of the Great Barrier Reef (*T. aduncus* and *T. truncatus*), although the taxonomy of *Tursiops* species is said to remain muddled.^{9,10,11} Of these two species, it is the inshore Indo-Pacific bottlenose dolphin (*T. aduncus*) that is most at risk in the Great Barrier Reef (and throughout their global distribution).^{11,12}

Tursiops species are best described as opportunistic, generalist-feeder top level predators.⁷ Their distribution and abundance is closely correlated with availability of suitable prey and the threat of predation.¹³

Distribution and abundance studies of Indo-Pacific bottlenose dolphin in Australia and elsewhere in the world have shown that the species appears to maintain many relatively small, localised populations that are fairly isolated from each other.^{11,14} *Tursiops* species that reside in more protected coastal and estuarine habitats, tend to belong to small groups within localised populations that show higher site fidelity and feed primarily on dispersed prey.^{14,15} Conversely, in more open coastal waters, bottlenose dolphins (more notably *T. truncatus*) most often associate in larger groups or aggregations, display low site fidelity, and forage on large prey aggregations separated by large expanses of water.^{12,15,16} However, in the vicinity of Point Lookout, North Stradbroke Island in Moreton Bay, Queensland, a large population of Indo-Pacific bottlenose dolphin resides which occur in large groups showing high site fidelity.¹⁷

Chilvers and Corkeron¹⁷ suggest that differences between *Tursiops* populations of coastal North America and those studied offshore of Moreton Bay may be the result of greater levels of inter-specific competition for resources, levels of human influences, differences in prey availability, or natural habitat carrying capacity. They suggest that low levels of human impact in the immediate vicinity of Point Lookout, coupled with relatively low levels of competition for resources from other cetaceans, may provide the conditions that are suitable to such high, resident populations.¹⁷

In Queensland waters group sizes of Indo-Pacific bottlenose dolphin vary from one to 45, with most group sizes being less than 10.¹⁸ In a study by Chilvers and colleagues,¹⁸ there was distinct social organisation where the territory of two distinguishable groups overlapped, though feeding habits were strongly mutually exclusive which indicated different management implications for the two groups within the Moreton Bay population. Such community dynamics are expected to play a role in the behaviour and habitat use of sympatric populations of Indo-Pacific bottlenose dolphin inhabiting the Marine Park.

Dolphins are long-lived animals with low maximum rates of reproduction. Female Indo-Pacific bottlenose dolphins reach sexual maturity at 12 to 15 years and give birth to calves after a gestation period of one year. Males mature at 10 to 15 years. Females give birth at intervals of three to six years which correlate with the nursing period which last from three to five years. Individuals can live to 40 to 50 years.¹¹

Although there is little information on the diet of Indo-Pacific bottlenose dolphins in the Great Barrier Reef, dolphin species in this area generally feed on patchy resources of fishes and cephalopods found throughout the water column in estuarine and marine environments.⁷ This is supported by a study¹⁹ of the stomach contents of 26 Indo-Pacific bottlenose dolphins incidentally captured in gill net fisheries of Zanzibar, Tanzania. This study found that this species foraged on a relatively large number of prey species, but that only a few small- and medium-sized shelf-dwelling fish and cephalopods contribute substantially to the diet. Further, the ecology and behaviour of the preferred fish prey species indicate that the dolphins forage over reef or soft bottom substrata and near the shore.¹⁹

For most dolphin species occurring in the Great Barrier Reef, including Indo-Pacific bottlenose dolphin, some of the most basic ecological information (distribution, abundance, site fidelity, movement patterns, diet, feeding habits) and biological life history traits are lacking.⁷ Research to improve the understanding of Indo-Pacific bottlenose dolphin in these areas is essential to inform management.

Geographical distribution

The likely distribution of the Indo-Pacific (inshore) bottlenose dolphin is throughout the coastal waters of the Indian and western Pacific oceans from the Solomon Islands and New Caledonia in the east to the southern tip of South Africa in the west and from central Japan to Australia on both the east and west side.^{11,20} The level of continuity of the distribution is unknown, though the species appears to be comprised of many relatively small localised populations that are fairly isolated from each other.¹¹

Although the species distribution does not appear to be severely fragmented in Australia, in the south east there is evidence of semi-isolation, year-round residency and natal philopatry (returning to birthplace to breed), with

males being more dispersive than females.^{21,22} Mitochondrial DNA studies in Shark Bay, Western Australia, indicated an isolation-by-distance model, with females also tending to be more philopatric than males.²³ These population characteristics are yet to be confirmed for other populations, such as those that live in the Great Barrier Reef World Heritage Area.

Population status in the Great Barrier Reef Marine Park

The population status of Indo-Pacific bottlenose dolphins in the Marine Park is unknown, though is considered to be reasonably healthy.⁹

This knowledge gap both is widely recognised within the literature and the *Great Barrier Reef Outlook Report 2009*. Wang and Yang¹¹ highlight Indo-Pacific bottlenose dolphin are classified by the IUCN Red List as 'Data Deficient'. They stress this should not be seen as a more favourable status than any of the threatened categories, as once adequate information allows for an assessment, this species may well meet one of the categories of threat. Wang and Yang¹¹ qualify this by stating that there are serious concerns about the depletion of local populations because the species appears to be resident (likely to have limited exchange with adjacent populations) and exists in relatively small numbers in many areas.

There are indications that Indo-Pacific bottlenose dolphins have experienced serious population declines in others parts of the world.¹¹ Bedjer and colleagues²⁴ have recorded a decline in the Shark Bay population primarily due to the activities of tour operators targeting the dolphins. This observation further emphasises the particular vulnerability of the nearshore species to ecotourism and feeding activities.

The current lack of knowledge on *Tursiops* species in the Great Barrier Reef would suggest application of the precautionary principal when determining management outcomes for *Tursiops* species in Queensland waters. This is an approach advocated by Lawler and colleagues⁷ in their assessment of the vulnerability of dolphins to climate change.

Ecosystem role/function

In Lawler and colleagues⁷ assessment of the vulnerability of marine mammals in the Great Barrier Reef to climate change, they state given the lack of ecological and biological information regarding inshore dolphins, it is difficult to assess and quantify the importance of their ecological role and the consequences of anthropogenic impacts on their populations and the environment.⁷ However, they continue by saying that, "given increasing evidence of the importance of large marine predators, it is reasonable to infer that substantial changes to the distribution and abundance of dolphins in the Great Barrier Reef could have strong consequences for the structure and functioning of coastal and open ocean ecosystems."⁷

Lawler and colleagues⁷ also note that some interactions between dolphins and their environment, and their follow-on consequences, have only become known because of substantial, long-term research effort in other locations. They point out that similar research has not yet been undertaken in the Great Barrier Reef and an inability to demonstrate such effects should not be taken to imply that they have not, or will not occur, and suggest that the precautionary principle should be applied under such circumstances where information is lacking.⁷

Lawler and colleagues state that, "as large, mobile marine vertebrates and apex predators, dolphins have the potential to profoundly affect their prey populations, which may in turn result in significant effects on food-web interactions (i.e. trophic cascades), and ecosystem function and structure."⁷ Similarly, decreases in the availability or abundance of dolphin prey may have strong influences on their own distribution and abundance.⁷

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).	Dolphins are not known to provide any provisioning services within Australia.
Cultural services (e.g. spiritual values, knowledge system, education and inspiration, recreation and aesthetic values, sense of place).	Dolphins hold cultural significance for some coastal Indigenous peoples within the Marine Park. Aesthetic and intrinsic conservation values provide a strong social and economic impetus for the conservation of dolphins. Cetacean watching provides significant input into the Australian economy. For many people dolphins 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 dolphin species within marine ecosystems are largely unknown. Dolphins may play a significant role in nutrient cycling in marine ecosystems.
Regulating services (e.g. invasion resistance, herbivory, pollination, seed dispersal, climate regulation, pest regulation, disease regulation, natural hazard protection, erosion regulation, water purification)	Dolphins are generalist top predators and may help to regulate populations of prey species and maintain ecosystem balance. The removal of apex predators can also have unexpected lower order effects on non-prey species in what is referred to as trophic cascading. Quantifiable knowledge on how dolphins contribute to maintaining the trophic order of marine ecosystems is largely unknown.

Pressures influencing the Indo-Pacific (inshore) bottlenose dolphin in the Great Barrier Reef Marine Park

Pressures

Indo-Pacific bottlenose dolphins are exposed to a range of pressures including loss of habitat, coastal development, declining water quality,²⁵ and anthropogenic disturbance and displacement from a range of activities.^{24,26} Many of these pressures may be exacerbated in inshore habitats with the onset of climate change.⁷ A more detailed description of the range of pressures that impact on Indo-Pacific bottlenose dolphin in the Great Barrier Reef is provided in the vulnerability assessment matrix at Appendix 1.

Vulnerability assessment matrix

The *Great Barrier Reef Outlook Report 2009*²⁷ identified a number of commercial and non-commercial uses of the Marine Park, along with habitat loss and degradation as a result of climate change, coastal development and declining water quality due to catchment run-off as the key priority issues reducing the resilience of the ecosystem.

From the *Great Barrier Reef Outlook Report 2009*²⁷ it was considered that pressures such as climate change, coastal development, catchment run-off and direct use are the key factors that influence the current and projected future 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. Using the vulnerability assessment framework adapted by Wachenfeld and colleagues,²⁸ 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 Indo-Pacific bottlenose dolphins 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 Indo-Pacific bottlenose dolphins to that particular pressure. This allows for the formulation of suggested actions to minimise the impact of the pressures which Indo-Pacific bottlenose dolphins 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.

Vulnerability assessment matrix summary for Indo-Pacific (inshore) bottlenose dolphin

		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; locally	Low	Low	Poor	Good	Low	Good
	Defence activities	Yes; locally	Low	Low	Poor	Good	Low	Good
	Commercial fishing	Yes	High (ECIFFF, QSCP)	Medium	Moderate	Moderate	Medium	Poor
	Recreational fishing	Yes; predominantly south of Cooktown	Low (potentially significant for local populations)	Medium	Moderate	Moderate	Medium	Poor
	Ports and shipping	Yes; locally (with potential for wider significance)	Medium (locally)	Medium (locally)	Poor (locally)	Moderate	Medium (locally)	Poor
			Low (reef-wide)	Low (Reef-wide)	Medium (Reef-wide)		Low (Reef-wide)	
	Recreation (not fishing)	Yes; predominantly south of Cooktown	Low (potentially significant for local populations)	Medium	Poor (locally)	Moderate	Medium	Poor
	Traditional use of marine resources	No	Low	Low	Moderate	Moderate	Low	Good
	Climate change	Yes	High	High	Moderate	Poor	High	Poor
	Coastal development	Yes; predominantly south of Port Douglas	High	High	Poor	Moderate	High	Poor
Declining water quality due to catchment run-off	Yes; predominantly south of Cooktown	High	High	Poor	Moderate	High	Poor	

Key concerns

- There is a lack of ecological and biological information for Indo-Pacific bottlenose dolphins.⁷ Long-term monitoring and research of inshore Indo-Pacific bottlenose dolphin populations is required to provide information on their distribution, population structure and dispersal patterns (including site fidelity), behavioural ecology, health determinants, dietary and habitat requirements. There is also a requirement to understand trophic interplays between Indo-Pacific bottlenose dolphin and their prey species.
- There are considerable concerns regarding interactions between netting apparatus licensed within the ECIFFF and protected species such as Indo-Pacific bottlenose dolphin. There is a need for more relevant, accurate and timely data of where and how often interactions occur between Indo-Pacific bottlenose dolphin and this fishery in order to improve conservation outcomes for this species and others.
- Queensland's Marine Wildlife Strandings Program has recorded numerous dolphin deaths in the Queensland Shark Control Program over the years, including some bottlenose dolphin.^{29,30,31,32} Further study and management collaboration should determine whether there are alternative effective bather safety methods available. Studies should include evaluating the effectiveness of by-catch mitigation measures currently under trial in this program, such as acoustic pingers, and investigation of alternative bather protection methods to further reduce the risk to Indo-Pacific bottlenose dolphin (and other marine species).

- It is difficult to identify tangible ways in which current approaches to coastal development and planning provide significant outcomes for the conservation of Indo-Pacific bottlenose dolphin in Queensland waters. Further work should be progressed to account for the ecosystem services provided by coastal and inshore ecosystems under increasing pressure from development, with a thorough account of quadruple bottom line considerations (culture, society, environment and economy). It will be important for the GBRMPA to continue fostering partnership arrangements with state government agencies to improve planning provisions and policy development that can provide protection for important coastal habitats.
- Further research is needed to better understand the relationships between declines in water quality and subsequent impacts on Indo-Pacific bottlenose dolphins. An example of water quality impacts that affect dolphins has been demonstrated by recent research³³ showing increased water temperatures and low salinity that accompanies high rainfall and catchment run-off periods can cause chronic dermal infectious disease. These poor environmental conditions can cause physiological stress that causes outbreaks of dermal diseases such as lobomycosis and poxvirus. Outbreaks of lobomycosis have been implicated in dolphin mortality and chronic exposure to these environmental stressors may also cause impairment of adaptive immunity.³³
- With predicted increases in coastal development and maritime activity, the GBRMPA needs to support and facilitate research into understanding the potentially serious threat underwater noise and activity from increased vessel traffic, surveying, construction, dredging and maritime operations poses to Indo-Pacific bottlenose dolphin. On the basis of existing knowledge, the GBRMPA should consider developing a best practice approach for managing and minimising the impacts of underwater noise in areas inhabited by Indo-Pacific bottlenose dolphin and other marine animals.
- *Tursiops* dolphins appear to conform to lower levels of habitat specificity than other inshore species such as the Australian snubfin and Indo-Pacific humpback dolphins, and therefore possibly have a greater adaptive capacity to some environmental determinants.^{14,15,16,17} However, research also suggests some populations of Indo-Pacific bottlenose dolphin in Australia show significant levels of residency, site fidelity and philopatry.^{21,22,23} Knowledge of local population structures of Indo-Pacific bottlenose dolphins that inhabit the Great Barrier Reef are required in order to inform management responses at a spatial scale appropriate to the species' conservation.^{14,17}
- The Marine Wildlife Stranding Program provides a great information resource to researchers and managers of the Marine Park, however resources to increase the capacity to undertake necropsies to determine cause of death and gather biological information of inshore dolphins may improve the program's utility. Greater public awareness of the program may also create improvements.
- Although there are few records of boat strike to Indo-Pacific bottlenose dolphins, these species are very vulnerable to boat strike as they come to the surface to breathe, putting them directly in the path of boats and other watercraft. Boats travelling at speed pose the greatest threats. Management of these species needs to identify areas where impacts from boating activities occur, and in these areas implement approaches to reduce the risk of boat strike.
- Although there is limited data to quantify the level of Indo-Pacific bottlenose dolphin mortality caused by marine debris in the Marine Park, the *Action plan for Australian cetaceans*³⁴ identifies entanglement in derelict fishing gear and ingestion of plastics at sea as a current threat to a number of threatened cetacean species in Australia. World-wide, marine debris is recognised as a major threatening process to be considered for the conservation of dolphins and all marine life.³⁵ Actions to mitigate the generation of marine debris are constrained by the difficulty in identifying its source. Fishing gear can be discarded by local fishers, or drift in from international waters (such as ghost nets). Storm water drains are another source, as they can bring debris from urban areas into the ocean. In order to ensure actions to reduce marine debris are targeted on the correct sources, clarification of the sources needs to precede community engagement actions. Nationally, the *Threat abatement plan for the impacts of marine debris on vertebrate marine life*³⁶ provides guidance for marine managers and users.
- Small animal populations are more prone to extinction than larger populations,^{37,38} particularly for long-lived animals with a small reproductive output such as dolphins, which are therefore potentially at higher risk. The likely outcome of the combination of cumulative impacts on Indo-Pacific bottlenose dolphin in the World Heritage Area is expected to be increased pressure and higher levels of human-related mortality. Localised events such as disease outbreak or a significant reduction in fish stocks from over-fishing or a fish kill have the potential to reduce the population size of dolphins,^{37,39} leaving fewer dolphins in the region to maintain or restock the local population.^{14,40} Pressures being exerted on Indo-Pacific bottlenose dolphin in the World Heritage Area must be viewed in combination and with regard to their cumulative and ecosystem-based impacts.
- The lack of knowledge on Indo-Pacific bottlenose dolphin would suggest the need to apply the precautionary principal when determining management outcomes for this species in Queensland. This is an approach advocated by Lawler and colleagues⁷ in their assessment of the vulnerability of dolphins to climate change. In reference to the Australian snubfin and Indo-Pacific humpback dolphins, Parra⁴¹ (citing Wilson *et al.* 1999⁴² and Thompson *et al.* 2000³⁹), reinforces the assertions from other marine mammal studies that scientific proof

of population decline or incline should not be necessary criteria for enacting conservation measures for those two species of dolphin that are highly vulnerable to the pressures they face. This reasoning can logically be applied to Indo-Pacific bottlenose dolphin, which although perhaps have a somewhat greater distribution and abundance than other inshore dolphin species in the World Heritage Area, still display a significant level of population residency, site fidelity and philopatry and face the same set of pressures.

Management of Indo-Pacific (inshore) bottlenose dolphin 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	<ul style="list-style-type: none"> • 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)	<ul style="list-style-type: none"> • The three main objectives of the CBD are: <ul style="list-style-type: none"> • The conservation of biological diversity • The sustainable use of the components of biological diversity • The fair and equitable sharing of the benefits arising out of the utilisation of genetic resources. 	<ul style="list-style-type: none"> • 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 (UNEP) – CBD Secretariat
International Union for the Conservation of Nature and Natural Resources (IUCN) Redlist of Threatened Species	<ul style="list-style-type: none"> • Indo-Pacific bottlenose dolphin (<i>T. aduncus</i>) listed as 'Data Deficient'. 	<ul style="list-style-type: none"> • Establishes the conservation status of species based on the assessment of their global population and trends • Assessment information used to formulate management direction. 	International Union for the Conservation of Nature and Natural Resources (IUCN)
Convention on International Trade of Endangered Species of wildlife fauna and flora (CITES).	<ul style="list-style-type: none"> • <i>T. aduncus</i> listed in Appendix II • The species is not necessarily threatened with extinction, but trade must be controlled in order to avoid utilisation incompatible with their survival. 	<ul style="list-style-type: none"> • International trade of animals listed under Appendix II is allowed under permit for the exclusive purpose of international trade in live animals to appropriate and acceptable aquaria for primarily conservation purposes. 	UNEP – CITES Secretariat

<p>Bonn Convention – Convention on Migratory Species (CMS)</p>	<ul style="list-style-type: none"> • Provides a basis for forming international agreement on the protection, conservation and management of migratory species • <i>T. aduncus</i> listed as a migratory species in Appendix II. 	<ul style="list-style-type: none"> • The Parties to the Convention agree to: <ol style="list-style-type: none"> 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; and 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 CMS are considered as matters of 'National Environmental Significance' under the <i>EPBC Act 1999</i> and are protected under the Act. 	<p>UNEP – CMS Secretariat</p>
<p><i>Action Plan for Australian Cetaceans</i>³⁴</p>	<ul style="list-style-type: none"> • <i>T. aduncus</i> not listed (common bottlenose dolphin, <i>T. truncatus</i>, listed as 'No category assigned because of insufficient information' with special mention of concerns of incidental take in northern waters. This listing may require clarification of taxonomy). 	<ul style="list-style-type: none"> • 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. 	<p>Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC)</p>
<p><i>Environment Protection and Biodiversity Conservation Act 1999</i> (EPBC Act) and <i>Environment Protection and Biodiversity Conservation Regulations 2000</i></p>	<ul style="list-style-type: none"> • Legislative framework for environmental protection in Australia • The Great Barrier Reef Marine Park is one of eight matters of national environmental significance in Australia • Provides means of assessment of 'actions' (often called a proposal or project) within Australian marine and terrestrial environments that are likely to impact on a matter of national environmental significance protected under the EPBC Act • 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' • Regulates on the required reporting of any interactions with marine mammals • Listing of <i>T. aduncus</i> as a migratory species. 	<ul style="list-style-type: none"> • 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 • The Significant Impact Guidelines have been developed as a resource for the support of assessment and approval process for actions referred under the EPBC Act • An action likely to have a significant impact on whales or dolphins could be deemed to be a 'controlled action' under the EPBC Act and require a greater level of scrutiny through an environmental impact assessment before consideration of approval • Strategic assessment is an alternative to a case by case approach and is considered a better way to address cumulative impacts over a landscape scale which may stem from a policy, plan or program or multiple projects providing combined impact • Assessment and export 	<p>DSEWPaC</p>

		<p>approval processes for all fisheries with an export component (or Wildlife Trade Operation) that must consider interactions with threatened species</p> <ul style="list-style-type: none"> • Regulates on the required reporting of any interactions with marine mammals • Threat Abatement Plans guide industry regulation and outline the necessary research and management actions required to address these threats: Threat abatement plan for the impacts of marine debris on vertebrate marine life – 2009 • Penalties for non-compliance • Processes of review. 	
<p><i>Great Barrier Reef Marine Park Act 1975 and Great Barrier Reef Marine Park Regulations 1983</i></p>	<ul style="list-style-type: none"> • 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 Regulation provides a list of protected species including all dolphins • Parts 9, 10, 11, 12 of the Regulations establish provisions for the Shoalwater Bay (dugong), Cairns, Whitsundays and Hinchinbrook Plans of Management respectively • All whales and dolphins listed as protected species under Regulation 29. 	<ul style="list-style-type: none"> • Part 4A of the Regulations provides controls for human interactions with cetaceans, including whale-watching regulations • The Regulations provide for the creation of Species Conservation (Whale or Dolphin Protection) Special Management Areas • Whale Protection Areas are also described in 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 Regulations. 	GBRMPA
<p><i>Great Barrier Reef Marine Park Zoning Plan 2003</i></p>	<ul style="list-style-type: none"> • A multiple-use marine protected area management tool that protects biodiversity by the regulation of activities within the Great Barrier Reef Marine Park • The Representative Area Program that provided the basis for the Zoning Plan spatial planning decisions, described 70 broad-scale habitats, or bioregions, and as such provides the basis for ecosystem-based management in the Marine Park. 	<ul style="list-style-type: none"> • Spatial management of activities within the Great Barrier Reef based on protection of habitat type representative areas • Thirty-four 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 (SMA) can be created for the protection of inshore bottlenose dolphins and their habitats under special circumstances • Penalties for non-compliance • Processes of review. 	GBRMPA
<p><i>Operational Policy on Whale and Dolphin Conservation in the Great Barrier Reef</i></p>	<ul style="list-style-type: none"> • The objective of the policy is to provide a framework for the conservation of whales and dolphins by partnering with Reef 	<ul style="list-style-type: none"> • Policy implements the Great Barrier Reef Marine Park Authority's obligations under the Australian Government's 	GBRMPA

<p><i>Marine Park 2007</i></p>	<p>users and managing their activities within the Great Barrier Reef Marine Park.</p>	<p><i>Australian National Guidelines for Whale and Dolphin Watching 2005.</i></p> <ul style="list-style-type: none"> • Policy reviewed on regular basis in line with changes to legislation and national guidelines • Provides basis for public education • Penalties for non-compliance under the <i>Great Barrier Reef Marine Park Act 1975.</i> 	
<p><i>Great Barrier Reef Biodiversity Conservation Strategy 2012</i></p>	<ul style="list-style-type: none"> • Identifies <i>T. aduncus</i> as a species 'at risk' in the Marine Park • Grades the level of risk experienced by <i>T. aduncus</i> through a vulnerability assessment process. 	<ul style="list-style-type: none"> • The Biodiversity Conservation Strategy outlines a Framework for Action with three strategic objectives aimed at building or maintaining ecosystem resilience and protecting biodiversity: <ol style="list-style-type: none"> 1. Engage communities and foster stewardship 2. Building ecosystem resilience in a changing climate 3. Improved knowledge • Objectives are comprised of program-level outcomes with key actions and contain targets for measuring success • Implementation of the Strategy will be undertaken through a multi-agency, multi-stakeholder collaborative approach. 	<p>GBRMPA</p>
<p><i>Great Barrier Reef Climate Change Action Plan 2007-2012</i></p>	<ul style="list-style-type: none"> • Identification of specific measures to enhance resilience of the Great Barrier Reef ecosystem and support adaptation by regional communities and industries that depend on it. 	<ul style="list-style-type: none"> • Allocation of dedicated funding to implement actions to improve the resilience of the Great Barrier Reef ecosystem. 	<p>GBRMPA</p>
<p><i>Reef Water Quality Protection Plan 2009</i></p>	<ul style="list-style-type: none"> • 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 Great Barrier Reef lagoon. 	<ul style="list-style-type: none"> • Improve water quality that flows into the Reef by targeting priority outcomes, integrating industry and community initiatives and incorporating new policy and regulatory frameworks. 	<p>Queensland Government (jointly funded by the Commonwealth Government and the State of Queensland)</p>
<p><i>Great Barrier Reef Protection Amendment Act 2009 (Qld)</i></p>	<ul style="list-style-type: none"> • A framework for reducing the levels of dangerous pesticides and fertilisers found in the waters of the Great Barrier Reef by 50 per cent in four years. 	<ul style="list-style-type: none"> • Mix of strict controls on farm chemicals and regulations to improve farming practices. 	<p>Queensland Government</p>
<p><i>Marine Parks Act 2004 (Qld) and Marine Parks Regulation 2006</i></p>	<ul style="list-style-type: none"> • The object of this Act is to provide for the conservation of the marine environment by: <ul style="list-style-type: none"> • declaring State marine parks • establishing zones, designated areas and highly protected areas within marine parks • developing zoning and management plans • recognising the cultural, economic, environmental and 	<ul style="list-style-type: none"> • Aims to involve all stakeholders cooperatively • Coordination and integration with other conservation legislation • Penalties for non-compliance • Processes of review. 	<p>Queensland Government</p>

	<p>social relationships between marine parks and other areas</p> <ul style="list-style-type: none"> • applying the precautionary principle. 		
<p><i>Marine Parks (Great Barrier Reef Coast) Zoning Plan 2004 (Qld)</i></p>	<ul style="list-style-type: none"> • A multiple-use marine protected area management tool that protects biodiversity by the regulation of activities within the Great Barrier Reef Coast Marine Park • The Representative Area Program that provided the basis for Great Barrier Reef spatial planning decisions, described 70 broad-scale habitats, or bioregions and as such provides the basis for ecosystem-based management in the Great Barrier Reef Coast Marine Park. 	<ul style="list-style-type: none"> • 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 <i>Great Barrier Reef Marine Park Zoning Plan 2003</i>. 	<p>Queensland Government</p>
<p><i>Nature Conservation Act 1992 (Qld) and Nature Conservation (Wildlife) Regulation 2006</i></p>	<ul style="list-style-type: none"> • Legislative framework for the conservation of nature in Queensland • Protecting native wildlife and its habitat • Providing for the ecologically sustainable use of protected wildlife and areas • Provides a list of threatened and protected species in Queensland • <i>Tursiops aduncus</i> protected as least concern wildlife. 	<ul style="list-style-type: none"> • Prescribes protected native wildlife, their management principles and the management intent • Provides for the preparation of Conservation Plans for native wildlife and their habitat under Ministerial discretionary powers • No Conservation Plan for any species of dolphin currently in force • Reporting on interactions with protected marine mammals is regulated and annual reports on cetacean strandings and mortality are compiled • Penalties for non-compliance • Review of Act and Regulation. 	<p>Queensland Government</p>
<p><i>Nature Conservation (Whales and Dolphins) Conservation Plan 1997 and Conservation and management of whales and dolphins in Queensland 1997–2001⁴³</i></p>	<ul style="list-style-type: none"> • Development of management intent for whales and dolphins in Queensland and adjacent waters. 	<ul style="list-style-type: none"> • Management framework for cetacean watching activities, protection and conservation, monitoring of populations, review of management tools, research, and collaborative approaches to management • Penalties for non-compliance • Processes of review. 	<p>Queensland Government</p>
<p>Marine Wildlife Stranding Program</p>	<ul style="list-style-type: none"> • Collects and reports on stranding and mortality information of threatened marine wildlife species within Queensland, including all dolphins. 	<ul style="list-style-type: none"> • Provides critical information to aid and inform research and management initiatives 	<p>Queensland Government (jointly funded by the GBRMPA through the Field Management Program)</p>
<p>Back on Track Biodiversity Action Plans</p>	<ul style="list-style-type: none"> • The Back on Track Species Prioritisation Framework identifies priority species for conservation management, regional threats, and suggested recovery actions. • <i>Tursiops aduncus</i> identified as a low priority for conservation management. 	<ul style="list-style-type: none"> • Identifies regionally-appropriate management actions to mitigate the risks to these species • Processes of review. 	<p>Queensland Government (with regional Natural Resource Management groups and other stakeholders for implementation of identified management actions)</p>
<p><i>Fisheries Act 1994 (Qld) and Fisheries</i></p>	<ul style="list-style-type: none"> • Provides the legislative 	<ul style="list-style-type: none"> • Dolphins listed as Species of 	<p>Queensland</p>

<p><i>Regulation 2008</i></p>	<p>framework and regulatory controls for managing fisheries in all Queensland waters and Commonwealth waters subject to the Offshore Constitutional Settlement for the state of Queensland.</p>	<p>Conservation Interest (SOCi)</p> <ul style="list-style-type: none"> • Dugong Protection Areas regulate and restrict the use of commercial set mesh nets within designated areas, which provides spatial protection for animals susceptible to incidental capture • Net attendance rules in set mesh net fisheries • Rules (N₁, N₂, N₄, N₁₁, S mesh net regulations) for net operation and apparatus parameters designed to limit interactions with SOCi, including dolphins • SOCi logbook reporting requirements • Fish Habitat Areas help protect inshore habitats from impacts of coastal development. These areas provide nursery grounds and habitat for fish species which are likely to be prey for nearshore dolphin species • Penalties for non-compliance • Review of the Act in 2011. 	<p>Government</p>
<p>East Coast Inshore Fin Fish Fishery (ECIFFF) management arrangements</p>	<ul style="list-style-type: none"> • Regulations are established under the <i>Fisheries Act 1994</i> (Qld) and <i>Fisheries Regulation 2008</i> • Accredited Wildlife Trade Operation (WTO) under <i>Environment Protection and Biodiversity Conservation Act 1999</i> managed by the Queensland Government. • Commonwealth regulation requires reporting on management arrangements and conditions of the WTO through an annual status report. • Reports on interactions with Species of Conservation Interest (SOCi) including all dolphins. SOCi data is gathered through logbooks and the Queensland Shark Observer Program. 	<ul style="list-style-type: none"> • Published <i>Guidelines for commercial operators in the East Coast Inshore Fin Fish Fishery</i> to provide commercial fishers with a summary of management arrangements • <i>Looking after protected species in Queensland – a comprehensive guide for commercial fishers</i> published to assist fishers in interactions with dolphins and other protected species • Review of the Fishery under the <i>Environment Protection and Biodiversity Conservation Act 1999</i>. Review completed February 2012. New WTO with conditions issued; valid to 2015. 	<p>Queensland Government</p>
<p>Queensland Shark Control Program (QSCP)</p>	<ul style="list-style-type: none"> • Community Education and Protection Policy under <i>Fisheries Act 1994</i> (Qld) • Thirty-five nets at localities in Cairns, Mackay, Rainbow Beach, Sunshine Coast, and the Gold Coast • Three hundred and forty-four drumlines at localities across Cairns, Townsville, Mackay, Capricorn Coast, Gladstone, Bundaberg, Rainbow Beach, Sunshine Coast, North Stradbroke Island and the Gold Coast.⁴⁴ 	<ul style="list-style-type: none"> • Nets designed to capture sharks greater than 2 m in length. Nets are 186 m long. Most nets have a depth of 6 m and a mesh size of 500 mm • Ten remaining shark nets in the Great Barrier Reef Marine Park: Five off Cairns beaches; five 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 = six drumlines) • The use of audible 'pingers' on shark nets are being trialled in 	<p>Queensland Government</p>

		<p>an effort to prevent dolphin entanglement</p> <ul style="list-style-type: none"> • Equipment checked every second day, weather permitting • Other measures employed to reduce interactions with threatened species. 	
<p><i>Coastal Protection and Management Act 1995 (Qld) and Coastal Protection and Management Regulation 2003</i></p>	<ul style="list-style-type: none"> • 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. 	<ul style="list-style-type: none"> • Queensland Coastal Plan outlines directions for effective protection and management of the coastal zone. 	<p>Queensland Government</p>
<p><i>Queensland Coastal Plan</i> (prepared under the <i>Coastal Protection and Management Act 1995</i> and includes a state planning policy under the <i>Sustainable Planning Act 2009</i>)</p>	<ul style="list-style-type: none"> • The Queensland Coastal Plan has two parts: State Policy for Coastal Management and the State Planning Policy 3/11: Coastal Protection (SPP). 	<ul style="list-style-type: none"> • The State Policy for Coastal Management provides policy direction for natural resource management decision-makers about land on the coast, such as coastal reserves, beaches, esplanades and tidal areas • The SPP provides policy direction and assessment criteria to direct land-use planning and development assessment decision making under the <i>Sustainable Planning Act 2009</i>. 	<p>Queensland Government</p>
<p><i>Sustainable Planning Act 2009 (Qld) and Sustainable Planning Regulation 2009</i></p>	<ul style="list-style-type: none"> • 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. 	<ul style="list-style-type: none"> • Regional plans 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: <ul style="list-style-type: none"> • 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. 	<p>Queensland Government</p>

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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; locally	Yes; locally	Yes	Yes; predominantly developing coast south of Cooktown	Yes; locally (with potential for wider significance)	Yes; predominantly developing coast south of Cooktown	No	Yes	Yes; developing coast south of Port Douglas	Yes; predominantly developing coast south of Cooktown
Degree of exposure to source of pressure (low, medium, high, very high)	Low. Exposure at local scale could become high as dolphins may be targeted by tourism operators and this may disturb or displace the animals. Current information indicates very low level of interest in commercial dolphin watching. At Great Barrier Reef-wide scale, exposure is very low.	Low. As a coastal species there is the potential for exposure to defence activities at the local scale, but Great Barrier Reef-wide exposure is considered low. Impacts defined by noise and activity which creates disturbance/displacement behaviour within dolphin communities.	High. <i>Tursiops</i> species are incidentally captured and drowned in nets set for bather safety within the QSCP (although not commercial fishing, it is a commercial operation) and there are limited reports of these species being incidentally captured and drowned in commercial set mesh net fisheries. Indo-Pacific bottlenose dolphin population abundance is partly a function of prey availability and fishing is likely to reduce the availability of prey over time. Set mesh net fisheries in	Low. There is limited understanding on the level of impact that recreational fishing and bait collection has on the prey of Indo-Pacific bottlenose dolphins and most impacts of this pressure are presently considered to be mostly vessel-related (boat strike, noise, disturbance/displacement from habitat). Fishing gear that becomes marine debris when discarded is a growing impact. At a Reef-wide scale there is low exposure	Medium (locally). Exposure at local scale is high as Indo-Pacific bottlenose dolphin may be disturbed and displaced by underwater noise and activity from shipping, port development and maintenance programs. At Great Barrier Reef-wide scale, exposure is currently considered medium to low.	Low. Low exposure to risk of strike from watercraft and behavioural disturbance and displacement due to noise and activity.	Low. Dolphins hold totemic/symbolic significance rather than a resource taken for traditional use. Exposure to accidental capture during traditional netting is largely unknown though considered low.	High. Nearshore dolphin species, such as Indo-Pacific bottlenose dolphin, are at risk to climate change impacts that increase their exposure to bio-accumulated toxins and infectious disease (exposure will be greater with increased catchment run-off events) and cumulative impacts that affect the abundance of their prey.	High. Increased development and impact on coastal ecosystems and the risk of increased marine debris and pollutants associated with increasing human population provides Indo-Pacific bottlenose dolphin with high exposure to this pressure. The increasing extent of underwater noise generated from coastal and marine development and activity associated with human population increase is of considerable concern for inshore dolphin species such as Indo-Pacific bottlenose dolphin.	High. Discharge and run-off into the lagoon can impact inshore dolphin species through bioaccumulation of toxins, and exposure to parasites such as <i>Toxoplasma gondii</i> and infectious dermal disease such as lobomycosis. Poor water quality is also expected to reduce the productivity of habitats that underpin the food web supporting Indo-Pacific bottlenose dolphin. Exposure to these risks increase when there is increased high catchment run-off events or land-based processes are not managed. High rainfall events are predicted to increase with an increase in the intensity and frequency of storm

	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
			Queensland may target species significant in the diet of Indo-Pacific bottlenose dolphin. Otter trawl fisheries may also claim some of the same species as by-product. Quantifiable effects on dolphin prey from commercial fisheries are currently undetermined.	to recreational fishing and vessel-related impacts. However, these impacts within the preferred habitat of Indo-Pacific bottlenose dolphins could be significant at the local scale given the resident, localised nature of their populations.						and flood events associated with a changing climate.
Sensitivity to source of pressure (low, medium, high, very high)	Low. Indo-Pacific bottlenose dolphins demonstrate altered behaviour in the presence of vessel traffic. Research also suggests echolocation of prey can also be affected by underwater noise produced by vessel activity. Indo-Pacific bottlenose dolphin may become tolerant of vessels	Low. Indo-Pacific bottlenose dolphin demonstrate altered behaviour in the presence of vessel traffic. Explosion of underwater ordnance could cause permanent damage to hearing organs leading to starvation and death. However, any use would be non-extractive and therefore sensitivity is	Medium. Indo-Pacific bottlenose dolphin habitat use and behaviour mean they are highly sensitive to certain commercial fishing pressures. Prey species of Indo-Pacific bottlenose dolphin may be targeted within the ECIFFF and form part of by-product within the East Coast Otter Trawl Fishery (ECOTF) and catch and effort within these fisheries may eventually impact	Medium. Indo-Pacific bottlenose dolphins are not directly impacted by recreational fishing activity. However, disturbance from increased boating activity associated with fishing [refer to Recreation (not fishing)] in addition to impacts from discarded fishing tackle have indirect impacts on dolphins. The cumulative	Medium (locally). Indo-Pacific bottlenose dolphins demonstrate altered behaviour in the presence of vessel traffic. Research also suggests echolocation of prey can also be affected by underwater noise produced by vessel activity and port development and maintenance. Inshore dolphins may become tolerant of vessels exposing them to greater	Medium. Increasing human population growth along the Queensland coast and significant increase in boat registrations indicate that vessel traffic associated with recreational fishing and boating activity is increasing. This is evident with the rising incidents of boat strike on dolphins and other protected species within the Marine Park. Indo-Pacific	Low. The low degree of exposure to this pressure determines the sensitivity.	High. Food webs that Indo-Pacific bottlenose dolphins rely on have been shown to rely on a supply of water that is of good quality. Inshore dolphins such as Indo-Pacific bottlenose dolphin are also exposed to toxic compounds and bacteria that are more greatly concentrated in these habitats. The level of toxins that enter the Great Barrier Reef lagoon may be expected to increase with increased rainfall events under projected climate change scenarios.	High. Species such as Indo-Pacific bottlenose dolphin that occur in somewhat small and isolated populations and have a low reproductive output, are vulnerable to impacts associated with increased coastal development and human population. These life history traits and behaviours predispose Indo-Pacific bottlenose dolphin to be very highly sensitive to coastal development and associated impacts (such as increased recreational and	High. Dolphins are known to be sensitive to increased levels of organochlorins and heavy metals that can cause early mortality or decreased reproductive output. Low salinity levels and increased water temperatures that persist with increased catchment run-off can cause physiological stress in dolphins that lead to chronic dermal infectious disease and in the long term may cause impairment in adaptive immunity. There is evidence 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
	<p>exposing them to greater risk of boat strike. Alternatively continuous vessel activity may cause dolphins to be displaced from preferred habitat.</p> <p>However, any use would be non-extractive and therefore sensitivity is assumed to be low.</p>	<p>assumed to be low.</p>	<p>on the availability of these species or disturb the trophic balance within the foodweb that supports the provisioning requirements of inshore Indo-Pacific bottlenose dolphin.⁴⁵</p>	<p>effects of this impact with others need to be considered.</p>	<p>risk of boat strike. Alternatively continuous vessel activity may cause dolphins to be displaced from preferred habitat.</p> <p>At Great Barrier Reef-wide scale, sensitivity is currently considered medium to low.</p>	<p>bottlenose dolphin occurring in key habitats adjacent to population centres, such as Cleveland and Halifax Bays and the port of Gladstone, are most sensitive to vessel traffic impacts, including noise disturbance. This localised pressure becomes significant for isolated populations of Indo-Pacific bottlenose dolphin that tend to show relatively high levels of residency and site fidelity.</p> <p>The cumulative effects of this impact with others need to be considered.</p>		<p>These toxins can cause early mortality or affect the reproductive output of dolphins. Increased water temperatures and low salinity levels can cause physiological stress in dolphins that lead to chronic dermal infectious disease and in the long term may cause impairment in adaptive immunity.</p> <p>Although the extent of climate related impacts on Indo-Pacific bottlenose dolphin are largely unknown, the combined effects of climate change with other pressures faced by inshore dolphins makes them sensitive to impacts known to exist within the Great Barrier Reef.</p>	<p>transport vessel traffic)</p>	<p>Indo-Pacific bottlenose dolphin being displaced from estuaries during high influxes of freshwater from flood events.⁴⁰ It is considered that their delayed return post-flood may be due to a combination of physiological health considerations and following the return of prey as water salinity levels increase.⁴⁰</p> <p>Indo-Pacific bottlenose dolphin occur in relatively small and isolated populations. They are therefore vulnerable to population decline when experiencing impacts from poor water quality that impact upon their food webs and health.</p>

	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
<p>Adaptive capacity – natural (poor, moderate, good)</p>	<p>Poor. Indo-Pacific bottlenose dolphin populations are relatively small and isolated. Their life history traits determine that they are long lived and spend large amounts of energy raising few young. These characteristics mean that they have a limited capacity to cope with pressures that disturb their behaviour or displace them from preferred habitat.</p>	<p>Poor. Indo-Pacific bottlenose dolphin populations are relatively small and isolated. Their life history traits determine that they are long lived and spend large amounts of energy raising few young. These characteristics mean that they have a limited capacity to cope with pressures that disturb their behaviour or displace them from preferred habitat.</p>	<p>Moderate. Indo-Pacific bottlenose dolphin populations are relatively small and isolated. Their life history traits determine that they are long lived and spend large amounts of energy raising few young. These characteristics mean that they are not well adapted to cope with pressure that depletes their source of food, disturbs their behaviour or displaces them from preferred habitat. However, Indo-Pacific bottlenose dolphin have broader habitat and dietary requirements than other inshore dolphins in the Great Barrier Reef and this may provide them with greater adaptive capacity to cope with changes to prey availability.</p>	<p>Moderate. Indo-Pacific bottlenose dolphin populations are relatively small and isolated. Their life history traits determine that they are long lived and spend large amounts of energy raising few young. These characteristics mean that they are not well adapted to cope with pressure that disturbs their behaviour, displaces them from preferred habitat or from increased levels of human-induced mortality (such as boat strike).</p>	<p>Poor (locally). Indo-Pacific bottlenose dolphin populations are relatively small and isolated. Their life history traits determine that they are long lived and spend large amounts of energy raising few young. These characteristics mean that they are not well adapted to cope with pressure that disturbs their behaviour, displaces them from preferred habitat, or from increased levels of human-induced mortality. At Great Barrier Reef-wide scale, natural adaptive capacity of bottlenose dolphins to ports and shipping pressure is currently considered moderate to low.</p>	<p>Poor. Indo-Pacific bottlenose dolphin populations are relatively small and isolated. Their life history traits determine that they are long lived and spend large amounts of energy raising few young. These characteristics mean that they are not well adapted to cope with pressure that disturbs their behaviour, displaces them from preferred habitat or from increased levels of human-induced mortality (such as boat strike).</p>	<p>Moderate. Some traditional use of set mesh nets occurs, a practice for which inshore dolphins have no natural adaptive capacity. Exposure to this source of pressure is largely undetermined though expected to be limited thus requiring little application of an assessment of natural adaptive capacity.</p>	<p>Moderate. Indo-Pacific bottlenose dolphin populations are relatively small and isolated. Their life history traits determine that they are long lived and spend large amounts of energy raising few young. These characteristics mean that they are not well adapted to cope with pressure on their populations from the impacts of climate change. Should the extent of habitat loss and prey depletion due to climate change, coastal development, catchment run-off and other cumulative impacts be substantial, the adaptive capacity of Indo-Pacific bottlenose dolphin may be challenged. However, Indo-Pacific bottlenose dolphins have broader habitat and dietary requirements than other inshore dolphins in the Great Barrier Reef and this may provide them with</p>	<p>Poor. Indo-Pacific bottlenose dolphin populations are relatively small and isolated. Their life history traits determine that they are long lived and spend large amounts of energy raising few young. These characteristics mean that they are not well adapted to cope with pressure that depletes food resources or increases levels of human-induced mortality. Should the extent of habitat loss and prey depletion due to climate change, coastal development, catchment run-off and other cumulative impacts be substantial, the adaptive capacity of Indo-Pacific bottlenose dolphin may be challenged. However, Indo-Pacific bottlenose dolphin have broader habitat and dietary requirements than other inshore dolphins in the Great Barrier Reef and this may provide them with greater adaptive</p>	<p>Poor. The preference of Indo-Pacific bottlenose dolphin for coastal and estuarine habitats provides very high exposure to run-off pressures. Dolphins have no adaptive capacity to toxins and disease. The concentration at which toxins become detrimental to inshore dolphins is currently undetermined. However, detrimental effects to dolphin health from bio-accumulation of toxins have been documented.³³ Lobomycosis is a chronic dermal infectious disease that has been implicated in outbreaks which lead to mortality and may cause chronic impairment of their immune system.³³</p>

	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
								greater adaptive capacity to cope with localised changes to prey availability or habitat degradation.	capacity to cope with localised changes to prey availability or habitat degradation.	
Adaptive capacity – management (poor, moderate, good)	Good. There is a well established policy and legislative framework that regulates interactions between Marine Park users and whales and dolphins. These management tools have been developed based on national guidelines and reviews of the status of cetacean species of conservation concern. These processes are dynamic and are open for review as new information on best practice is developed in line with new information from targeted	Good. Defence activities are well managed and limited in extent, duration and geographic distribution. Consultation on and ongoing management of defence activities is undertaken between the Department of Defence and the Great Barrier Reef Marine Park Authority.	Moderate. The <i>Great Barrier Reef Marine Park Zoning Plan 2003</i> provides some spatial protection of the food resources and habitat required by Indo-Pacific bottlenose dolphin. The Queensland <i>Marine Parks (Great Barrier Reef Coast) Zoning Plan 2004</i> provides complementary protection of coastal waters and some estuarine waters. However, the capacity to adapt these Zoning Plans to meet changing spatial management requirements is limited due to legislative constraints. ECIFFF regulations require that interactions with Species Of Conservation	Moderate. The <i>Great Barrier Reef Marine Park Zoning Plan 2003</i> provides some spatial protection of the food resources and habitat required by Indo-Pacific bottlenose dolphin. The Queensland <i>Marine Parks (Great Barrier Reef Coast) Zoning Plan 2004</i> provides complementary protection of coastal waters and some estuarine waters. However, the capacity to adapt these Zoning Plans to meet changing spatial management requirements is limited due to legislative constraints.	Moderate. Cross-jurisdictional complexities exist with regards to coastal planning, ports and shipping. These need to be managed with a greater focus on habitat and species conservation for at-risk species such as Indo-Pacific bottlenose dolphin. GBRMPA has strategies and statutory tools to lower the risk of vessel-related oil spills and pollution incidents. However, the risks can only be lowered and not eliminated. Projected vessel traffic growth associated with ports projects creates greater challenges for the management	Moderate. There is a well established policy and legislative framework that regulates interactions between Marine Park users and whales and dolphins. These management tools have been developed based on national guidelines and reviews of the status of cetacean species of conservation concern. These processes are dynamic and are open for review as new information on best practice is developed in line with new information from targeted science. GBRMPA public education programs are well developed and can be adapted as	Moderate. On-going low exposure to this source of pressure. Queensland Government regulations exist for permitting Traditional Owner use of commercial-type set nets to capture fish. These nets have the potential to incidentally capture protected species. Compliance of these regulations is difficult to enforce and issues require further attention to improve conservation outcomes.	Poor. Options for local or regional scale management of climate impacts on Indo-Pacific bottlenose dolphin remain very limited because most impacts are directly linked to large-scale global climate phenomena rather than more local threatening processes. Current available information on climate change impacts on inshore dolphins is being implemented into developing management actions within the World Heritage Area. The current framework for managing climate change impacts within the GBRMPA has been developed to implement new information as it becomes available.	Moderate. The <i>Great Barrier Reef Marine Park Act 1975</i> 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, the community, local and state government and other Australian Government agencies to influence the management and planning of catchment and coastal pressures, developing and maintaining a culture of mutual obligation. This is undertaken by providing input into the Queensland Coastal Plan policies and statutory Regional Plans, which plan for coastal development in Queensland. Projected vessel	Moderate. The <i>Great Barrier Reef Marine Park Act 1975</i> 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, the community, local and state government and other Australian Government agencies to influence the management and planning of catchment and coastal pressures, developing and maintaining a culture of mutual obligation. This is undertaken by fostering partnerships through the <i>Reef Water Quality Protection Plan 2009</i> and <i>Reef</i>

	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
	<p>science. GBRMPA public education programs are well developed and can be adapted as required.</p>		<p>Interest are to be reported and recorded in logbooks. However, validation of reporting needs greater resourcing to provide confidence in information being provided to management.</p> <p>The then Queensland Department of Employment and Economic Development produced a guide for commercial fishers on how to look after protected species, which includes dolphins.</p> <p>To date, single frequency acoustic pingers used to deter marine mammals from interacting with mesh nets have proved to be mostly ineffective in this objective⁴⁶. However, current trials in the Queensland Shark Control Program⁴⁴ using multi-frequency pingers may</p>		<p>of their associated impacts.</p>	<p>required. However, the projected vessel traffic growth associated with population growth and coastal development projects creates greater challenges for the management of their associated impacts and cumulative impacts on inshore dolphins are not yet well understood.</p>			<p>traffic growth associated with coastal development projects and population growth creates greater challenges for the management of their associated impacts.</p>	<p><i>Rescue Program.</i></p>

	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
			provide better results.							
Residual vulnerability (low, medium, high)	Low	Low	Medium (in consideration of impacts from the QSCP and ECIFFF)	Medium	Medium (locally) Low (Reef-wide)	Medium	Low	High	High	High
Level of confidence in supporting evidence (poor, moderate, good)	Good - exposure and adaptive capacity of management to pressure. Poor – sensitivity and natural adaptive capacity to pressure. Bejder <i>et al.</i> 2006, ²⁴ Van Parijs & Corkeron 2001, ⁴⁷ Mattson <i>et al.</i> 2005. ⁴⁸	Good - exposure and adaptive capacity of management to pressure. Poor – sensitivity and natural adaptive capacity to pressure. O'neill 2009; ⁴⁹ Van Parijs and Corkeron 2001. ⁴⁷	Poor. More information required on sensitivity and natural adaptive capacity to commercial fishing. Hodgson <i>et al.</i> 2007; ⁴⁶ Gribble <i>et al.</i> 1998; ⁵⁰ QDPI 2006; ⁴⁴ Van Parijs and Corkeron 2001; ⁴⁷ Ross 2006; ⁵¹ Marine wildlife stranding and mortality database Annual Report 2007 – Cetaceans. ³²	Poor. More information required on sensitivity and natural adaptive capacity to recreational fishing. Hale 1997; ⁵² Van Parijs and Corkeron 2001; ⁴⁷ Marine wildlife stranding and mortality database Annual Report 2007 – Cetaceans. ³²	Poor. More information required on sensitivity and natural adaptive capacity to ports and shipping. Hale 1997 ⁵² Van Parijs and Corkeron 2001; ⁴⁷ Ross 2006. ⁵¹	Poor. More information required on sensitivity and natural adaptive capacity to recreation (not fishing). Hale 1997; ⁵² Van Parijs and Corkeron 2001; ⁴⁷ Mattson <i>et al.</i> 2005. ⁴⁸	Good. Strandings mortality data, compliance records and anecdotal evidence suggest good supporting evidence of low pressure from Traditional use or incidental capture of dolphins.	Poor. Lawler <i>et al.</i> 2007; ⁷ Lough 2007. ⁵³	Poor. Lawler <i>et al.</i> 2007; ⁷ Parra <i>et al.</i> 2006 ⁵⁴ Wang & Yang 2009; ¹¹ Lukoschek and Chilvers 2008; ²⁶ Chilvers <i>et al.</i> 2005; ¹⁸ Ross 2006. ⁵¹	Poor. Lawler <i>et al.</i> 2007; ⁷ Lough 2007; ⁵³ Cockcroft <i>et al.</i> 1989; ⁵⁵ Bowater <i>et al.</i> 2003; ²⁵ Jefferson <i>et al.</i> 2006; ⁵⁶ Ross 2006; ⁵¹ Fury and Harrison 2011; ⁴⁰ Murdoch <i>et al.</i> 2008. ³³

The pressures addressed in this Vulnerability Assessment were identified in the *Great Barrier Reef Outlook Report 2009*.²⁷

■ Coastal habitats (rivers, estuaries, seagrasses, mangroves and wetlands) are under increasing pressure from human activities. More than 85 per cent 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.⁵⁷

The purpose of the vulnerability assessment process is to provide a mechanism to highlight key concerns and make assessments of the vulnerabilities that species, groups of species or habitats have to known sources of pressure within the Great Barrier Reef World Heritage Area (the World Heritage Area) using a standardised and transparent process. This was undertaken using a standard approach to assess exposure and sensitivity and adaptive capacity to potential impacts (Figure 1) based on the best-available information on that particular habitat, species or group of species.