Australian Government
Great Barrier Reef Marine Park Authority

Indo-Pacific humpback and Australian snubfin dolphins

Information valid as of Feb 2012

Summary

Diversity

Indo-Pacific humpback dolphin – *Sousa chinensis*
Australian snubfin dolphin – *Orcaella heinsohni*
Hereafter referred to collectively as 'inshore dolphins'.[a]

Susceptibility

Life-history traits of inshore dolphins that make inshore dolphins susceptible to a number of pressures occurring in the World Heritage Area include:

- Being long-lived
- Slow growth rate
- Late maturing
- Low reproduction rate
- *S. chinensis* philopatric and *O. heinsohni* considered to be philopatric[b]
- Low relative abundance, small group sizes and occupying small home ranges (both species therefore vulnerable to adult female mortality)
- High habitat and diet specificity
- Habitat requirements and behaviour make them prone to incidental capture in mesh nets set for commercial fishing and bather safety
- Consume large quantities of food relative to body size in comparison to fishes and invertebrates.

Major pressures

Habitat loss and degradation from cumulative pressures; 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 and are usually compounding. Such impacts include catchment run-off (creating greater bioaccumulation of toxins through the food web and delivering bacterias), coastal development (and vessel-related impacts with population growth), climate change impacts and depletion of food resources through commercial fishing. These pressures are likely to impact on the species directly, on their habitats and available prey species.

Management in the Great Barrier Reef and adjacent areas in Queensland

Legislative management tools for the conservation of inshore 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 protection via the *Great Barrier Reef Marine Park Zoning Plan 2003* (33 per cent of the Great Barrier Reef Marine Park closed to extractive use); *Marine Parks (Great Barrier Reef Coast) Zoning Plan 2004* (Qld) (provides complementary protection of coastal and some estuarine waters) and inshore habitat conservation areas such as the Queensland Gonernment's Dugong Protection Areas and Fish Habitat Areas; and others (refer Management table, p. 13).

Existing management action

A number of management actions are in place in the World Heritage Area that 'operationalise' legislative management tools and provide additional guidance and/or strategic direction to Marine Park management operations. These include the *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; Great Barrier Reef Biodiversity Conservation Strategy 2012; Great Barrier Reef Marine Park Authority Climate Change Action Plan 2007-2012; Reef Water Quality Protection Plan 2009*; Marine Wildlife Strandings Program (for recording

The Indo-Pacific humpback dolphin, *Sousa chinensis*; a specialist inshore species.
Photo coutesy of Michael Waite.

[a] Please note that there is a separate Vulnerability Assessment for the Indo-Pacific (inshore) bottlenose dolphin.

[b] Behaviour of remaining in, or returning to, an individual's birthplace.

and reporting stranded marine animals in Queensland); *Guidelines for commercial operators in the East Coast Inshore Fin Fish Fishery*; the 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).

An Indo-Pacific humpback dolphin, *Sousa chinensis*, hunting barramundi (*Lates calcarifer*) in its inshore habitat. Photo courtesy of Michael Waite.

Vulnerability assessment: High

- Inshore dolphins in the Great Barrier Reef World Heritage Area (the World Heritage Area) face many human-related threats:
  - Incidental capture in shark nets set for bather safety and in set mesh net fisheries
  - Competition for prey species targeted by commercial fisheries
  - Habitat degradation and loss through increased coastal development
  - Declines in water quality that impact on inshore dolphin health and the productivity of the ecosystems on which they depend
  - Increased noise pollution for these species that rely heavily upon echo-location in the turbid waters they occupy
  - Increased boating activities that can result in boat strike and disruption of dolphin behaviour
  - Entanglement and ingestion of discarded fishing gear/marine debris.
- Studies indicate populations are relatively small and maintain fairly small, discrete home ranges geographically remote from each other. With consideration of their conservative life-history traits, this makes them vulnerable to localised depletion as a result of human-induced mortality. These species are particularly at risk due to the range of pressures they face within the inshore habitats on which they depend. Anthropogenic pressures that impact inshore dolphins and their supporting habitats must be considered with an understanding that climate change may exacerbate the magnitude of those pressures.[c]
- More information is required on the biology and ecology of inshore dolphins to support management decisions. Work is required to establish the distribution and abundance of inshore dolphin populations along the Great Barrier Reef coast as a research priority.

Suggested actions to address vulnerabilities

- The Great Barrier Reef Marine Park Authority's (GBRMPA) ongoing collaboration with the Queensland Government is important to improve conservation outcomes for inshore dolphins that inhabit areas 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.
- Support the Queensland Government to further improve their fisheries-independent observer program to a point where it can broadly be considered sufficiently robust to validate commercial logbook Species of Conservation Interest data, providing statistically representative coverage of vessel effort from the ECIFFF and East Coast Trawl Fishery (including those vessels operating in remote/less-accessible regions north of Cooktown). This fisheries-independent data is vital ecological risk assessment work.
- Long-term monitoring and research on inshore dolphin populations is required to provide information on their distribution, population structure and dispersal patterns (including site fidelity), behavioural ecology, health status and dietary and habitat requirements. Research on the genetic isolation of geographically separate populations of inshore dolphins will need to be further

[c] For example, impacts on inshore 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[51,44] as a result of high rainfall and catchment discharge events linked to climatic changes.[7,48]

Indo-Pacific humpback dolphin, *Sousa chinensis*.
Photo courtesy of G. Parra.

Australian snubfin dolphin, *Orcaella heinsohni*.
Photo courtesy of G. Parra

investigated to determine their conservation status and inform their management.

- Further programs to determine the distribution and abundance of localised populations of inshore dolphins along the Great Barrier Reef coast should be supported as a research priority.
- Continue to use the latest information on the population ecology of inshore dolphins to inform management when conducting assessments of port expansions and new development proposals within the World Heritage Area.
- Ecological studies that determine the dietary requirements of inshore dolphins require support within the World Heritage Area to better understand the influences that Queensland fisheries have on the prey species of inshore dolphins.
- Continue to support the Marine Wildlife Strandings Program delivered through the Field Management Program jointly funded by the Great Barrier Reef Marine Park Authority (GBRMPA) and the Queensland Government. This provides managers with long-term information on the mortality experienced by inshore dolphins, which is required to inform decision making.
- 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 inshore dolphins.
- Work with researchers and other stakeholders to better understand the potentially serious threat that underwater noise and activity from increased vessel traffic, surveying, construction, dredging and maritime operations pose to inshore dolphins and consider developing a policy framework to inform the management of these impacts.
- Replacing the remaining shark control nets in the Great Barrier Reef Marine Park (the Marine Park) with drumlines should be investigated within the Queensland Shark Control Program 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 collaboratively with state agencies and wider stakeholder groups to identify where boating activities impact on Indo-Pacific humpback and Australian snubfin dolphin; encourage the establishment of ‘go slow’ areas where impacts occur; and, raise public awareness of ‘go slow’ areas.
- Work to prevent rubbish entering the marine environment; 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*.

Background

Brief description of Indo-Pacific humpback and Australian snubfin dolphins

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 maintain hierarchical group structures.[8]

Based on the available data, both humpback and snubfin dolphins appear to have a relatively broad diet and feed opportunistically and eat a wide variety of coastal, estuarine and reef-associated fishes (and occasionally crustaceans and cephalopods) both on the bottom and within the water column.[9,10,11] There are a number of prey species represented in the diets of Indo-Pacific humpback and Australian snubfin dolphin that are targeted within the ECIFFF and present as by-catch within the East Coast Trawl Fishery (ECTF).[11] These include: spotted grunter bream (*Pomadasys kaakan*); mullet (*Mugil sp.*), whiting (*Sillago sp.*), and flathead (*Platycephalus sp.*).[11] Indo-Pacific humpback dolphins also prey on barramundi (*Lates calcarifer*), the key target species within the ECIFFF, and silver batfish (or sickle fish or butter bream), *Monodactylus argenteus*, which is a species taken within the recreational fishery.

Habitat selection in dolphins has been directly related to the distribution of their prey and predators,[12] and to physiographic and hydrographic features that may indirectly affect prey availability or reflect prey specialisations by individual species[13,14]. The considerable overlap and correlation in habitat use between snubfin and humpback dolphins may be a result of preference for areas where critical resources are abundant, or predation risks from shared predators are lowest, or both.[13]

Though key habitats vary geographically, humpback dolphins exhibit a preference for shallow waters of less than 20 m, close to the coast and associated with river mouths, mangroves, tidal channels and inshore reefs.[13,15] Most populations of humpback dolphins studied associate with areas receiving freshwater inputs.[16] The core range of snubfin dolphins are also known to occur close to river mouths in Australian waters.[17] Comparisons in Cleveland Bay, Queensland, suggest that the core range of snubfin dolphins is more concurrent with river mouths than that of humpback dolphins.[13,17]

Research by Parra[13] supports previous evidence that indicates humpback and snubfin dolphins are strongly sympatric (different species occupying the same range.[17,18] Although their representative home ranges overlap considerably, snubfin dolphins prefer slightly shallower (1– 2 m) waters than humpback dolphins (2 – 5 m) where there is distinguishable habitat differentiation. Parra[13] found fine-scale variance in habitat selection allowed them to coexist throughout this range, and suggested this difference in habitat selection is in part due to fine-scale diet partitioning where the two species target somewhat different prey. In Heinsohn's 1997 study investigating the diet of Australian inshore dolphins, the stomach contents of all specimens of snubfin dolphins included cephalopods, whereas humpback dolphin specimens only contained fish and some crustaceans.[10] The most recent study on the diet of inshore dolphins of Queensland's east coast confirms that humpback dolphins appear to feed primarily on fish, while snubfin dolphins also included cephalopods in their diet.[11] Decapods and bivalves represented only a small fraction of the prey items identified in the stomach contents of both species.[11] From Jackson's work,[19] the species of cephalopod found to be preferred by snubfin dolphins are known to be abundant in shallow water (≤ 1 m deep) close to the coast, and along breakwaters of Cleveland Bay, Queensland, and this may partly explain the snubfin's preference for that habitat.[13] However, Parra[13] found habitat preference may also be influenced by the aggressive exclusion of snubfin dolphins by humpback dolphins. As a result, shallow waters, close to river mouths and seagrass meadows, may act as refuges for snubfin dolphins, places where encounters with dominant and aggressive humpback dolphins will be less likely.[13]

Populations of Indo-Pacific humpback dolphins in the Great Barrier Reef have been found to be philopatric (the behaviour of remaining in, or returning to, an individual's birthplace). Indications are this is also the case for snubfin dolphins.[20] Research indicates Indo-Pacific humpback and Australian snubfin dolphin in Queensland live in small, largely geographically-isolated populations.[18,21,22] These populations are generally composed of relatively few adults and, consequently, they are more susceptible to stochastic events, potential inbreeding, and genetic bottlenecks, which can increase their risk of extirpation.[22] A better understanding of the philopatry of these species is important, as the impact of the loss of reproductive females from such small, philopatric groups is potentially greater than that for species that live in larger groups.[21,23]

For most dolphin species occurring in the Great Barrier Reef, information on the most basic aspects of their ecology (distribution, abundance, movement patterns, community dynamics, diet, feeding habits) and biology is lacking.[7] Research to improve the understanding of inshore dolphins in these areas is essential to inform management.

Species specific information

Sousa chinensis – Indo-Pacific humpback dolphin

Taxonomy

The taxonomy of the genus *Sousa* remains under debate and a revision is required to determine whether the two forms that occur in the Indo-Pacific are in fact two species (*S. chinensis* and *S. plumbea*).[24] Preliminary results seem to support the current understanding that there are morphological and genetic distinctions between *S. chinensis* and *S. teuszii*, the nominal *Sousa* species that occurs in the Atlantic Ocean.[25] However, uncertainty remains on distinctions between the dark form *S. plumbea* and lighter *S. chinensis*, where *plumbea* is thought to occur from South Africa to India, and *chinensis* thought to range east from the eastern coast of India, with an area of sympatry believed to exist off Bangladesh.[26] Further studies on the molecular genetics of the genus are underway. It is also suspected that the Australian humpback form may be a different species to the *chinensis* forms found further to the north in Asia,[24] and this has been flagged as a point of importance by Reeves and colleagues in their assessment of *S. chinensis* for the IUCN Redlist of Threatened Species.[25] Aside from obvious implications for conservation and management, this would make the Australian form of *S. chinensis* Australia's first known endemic cetacean[27] (there is evidence that the Australian snubfin dolphin, *O. heinsohni*, is distributed across the Sahul shelf to Papua New Guinea[28]).[d]

Life history and ecology

Most of the information available on the life history of humpback dolphins comes from populations in South Africa[29] and Hong Kong.[30] South African Indo-Pacific humpback dolphins reach sexual maturity at 10 years of age for females and 12 – 14 years for males. They have a gestation period that lasts for 10 – 12 months and lactation may extend beyond 2 years, with a suggested three year calving interval.[29] In Hong Kong, females reach sexual maturity at 9 – 10 years at around 235cm length and have a presumed gestation period of 11 months. For this population maximum length is 260cm and just under 250kg in weight.[30] There appears to be no sexual dimorphism in maximum size and weight.[30] However this is not the case in South African populations where adult males are significantly long and heavier than females.[29] The calf length at birth is thought to be about 100cm. Births can occur year-round, though there is evidence of seasonality.[30] Group size of Indo-Pacific humpback dolphins in Cleveland Bay, Queensland have been found to range from one to 12 animals, with a mean of 3.5.[20]

Indo-Pacific humpback dolphins have been observed foraging for hours behind trawlers.[13,31] It is unclear whether they are foraging on prey caught in the nets, prey that have escaped from the nets or prey that have been disturbed by the trawling activity.

Bannister[32] highlighted that 36 per cent of Indo-Pacific humpback dolphins in Moreton Bay, Queensland, showed signs of shark attack, suggesting mortality from shark predation may be high.

Orcaella heinsohni – Australian snubfin dolphin

Taxonomy

The population of Australian snubfin dolphin that occurs throughout northern Australia, with some evidence for occurrence in Papua New Guinea, was previously considered to be a population of Irrawaddy dolphin (*O. brevirostris*). However, clear and consistent differences between Asian and Australian *Orcaella* specimens have now been determined to be consistent with species-level differences.[33] The Australian snubfin dolphin was formally recognised as a separate species in 2005.[33]

Life history and ecology

Very little is known about the life history of *O. heinsohni*. Most of the information available on the life history of *Orcaella* is based on the Asian species, the Irrawaddy dolphin, *O. brevirostris*. It is thought that the life history parameters of the Australian snubfin and Irrawaddy dolphins may be very similar. A small number of snubfin dolphins from north eastern Australia have been aged using dentinal growth layer groups in teeth. It was estimated that these dolphins reached adult size (2.1m) at 4 – 6 years. A maximum life span was considered to be about 30 years.[28] Total lengths are 230cm[34] for females and 270cm[35] for males.

Previous studies conducted on the Irrawaddy dolphin in northern Australian waters are now assumed to have been on the recently defined *O. heinsohni*. Parra and colleagues[17] observed relatively small group sizes of 1 – 10 animals, with occasional aggregations observed of up to 14 animals. This was later reinforced by Parra[20] in his study in Cleveland Bay, Queensland, where group size varied between 1 – 15 animals, with a mean size of 5.3.

[d] Cagnazzi and colleagues[22] make the recommendation that revising the conservation status of humpback dolphins in Queensland and nationally to a more appropriate Vulnerable category based on the new IUCN Red List Guidelines is an important first step to enhance the protection of humpback dolphins and their habitat in Australian waters (this would also apply to the Australian snubfin dolphin).

Unlike Indo-Pacific humpback dolphins, snubfin dolphins are not known to forage behind trawlers.[13,20]

Geographical distribution

Sousa chinensis

For the purposes of this assessment, *S. plumbea* will be considered as distinct from the *chinensis* form, which is a distinction tentatively recognised by key authors.[25,36]

S. chinensis is distributed from the east and west coasts of northern Australia, to southern China, throughout the Indo-Malay Archipelago, and westward around the coastal rim of the Bay of Bengal to at least the Orissa coast of eastern India.[25] They regularly occur in some enclosed seas, such as the Gulf of Thailand. Their distribution appears to be limited to waters of the continental shelf, and the only places where they range far offshore are those where the water remains shallow (<100m).[25] In Australia, humpback dolphins are generally only distributed through inshore tropical and subtropical waters from northern New South Wales around to Shark Bay in Western Australia.[18,37,38] In Parra's Cleveland Bay study in northeast Queensland,[21] he identified that *S. chinensis* had a representative range of 190 km^2 and a core area of 17 km^2 at the population level, demonstrating the small nature of their home range. Results of Cagnazzi and colleague's study,[22] and subsequent survey work conducted across the entire Central Queensland coastline, provides further support to Parra's findings[21] that Indo-Pacific humpback dolphins live in small, geographically isolated populations.

Orcaella heinsohni

The current distribution of the Australian snubfin dolphin occurs on the Sahul shelf of Australia and Papua New Guinea, whereas the Irrawaddy dolphin occurs on the Sunda shelf of South and South-East Asia. These areas are separated by deep oceanic waters and remained separated during periods of lowered sea levels during Pleistocene Ice Ages, which is likely to account for the speciation between *O. brevirostris* and *O. Heinsohni.*[28]

In Australia, the snubfin dolphin only occurs in shallow coastal waters across northern Australia between Broome on the west coast, to the Brisbane River on the east coast.[17] In Parra's Cleveland Bay study in northeast Queensland,[21] he identified that *O. heinsohni* had a representative range of 197 km^2 with two core areas of 16 and 27 km^2 at the population level, demonstrating that this species also live in small, geographically isolated populations.

Population status in the Great Barrier Reef Marine Park

Currently, there are no overall population estimates for Indo-Pacific humpback or Australian snubfin dolphins in the Marine Park and their status cannot be assessed due to the lack of data.[20] However, populations of these two species of turbid-water inshore dolphin species are likely to be in decline in Queensland waters. This has been identified as being partly due to the vulnerabilities inherent in the small size of their localised distributions,[17,22,37] which predispose these species to be particularly vulnerable to extirpation.[20,39,22]

Corkeron and colleagues[37] suggest that the sparse human population of Cape York Peninsula in northern Queensland may provide undisturbed habitats to support more viable populations of inshore dolphins than elsewhere in Queensland. Parra[20] however, makes the valid point that the remoteness of the area makes enforcement of regulations for commercial inshore netting operations, which are the greatest threat to inshore dolphin populations in the area, very difficult.

Sousa chinensis

Based on information from elsewhere in their range, it is likely that the Indo-Pacific humpback dolphin occurs as one population within Australia. In South Africa, for example, the distribution of individuals is characterised by occasional hotspots which exhibit higher local densities.[40] In northern Queensland there is a known hotspot for humpback dolphins around Bathurst Heads and the eastern side of the Flinders Group Islands,[20] on the eastern side of Princess Charlotte Bay.

Abundance estimates in Australian waters have found that at the time of survey, there were approximately 100 animals inhabiting Moreton Bay, southern Queensland,[37] approximately 50 animals in Cleveland Bay (actual numbers ranged from 34 to 54 with coefficients of variance from 14-19 per cent[20]), northeast Queensland,[21] and approximately 150 animals within the Great Sandy Strait Marine Park to the south of the Great Barrier Reef Marine Park[22]

Approximations of regional humpback dolphin numbers in Queensland have been put at the thousands rather than the tens of thousands.[18] Cagnazzi's doctorate research (D. Cagnazzi 2011, pers. comm.) across Central Queensland, from Gladstone to Shoalwater Bay, shows mark-recapture estimates indicating that humpback dolphins live in localised populations of multiples of tens rather than hundreds of individuals. Keppel Bay, with a total estimate of 107 humpback dolphins (coefficient of variance of five per cent, i.e. N=107, CV=0.05), was the highest use area within the study period. In comparison, both Port Curtis (N=85, CV=0.05) and the Northern Region (N=64, CV=0.08) had smaller populations of humpback dolphins.

Orcaella heinsohni

No overall population estimate is available for this species.[41] The limited information available suggests that populations are small, fragmented and localised, and probably declining.[20,37]

Parra[20] and De Biasi Cagnazzi provide the only comprehensive assessment of population size of snubfin dolphins at a local level in Australian waters. Parra found less than 100 animals used the Cleveland Bay study area of north Queensland between 1999 and 2002 (actual estimates ranged from 64 to76, with coefficients of variance from eight to 14 per cent).[20] There is also a hotspot of occurrence of snubfin dolphins in Princess Charlotte Bay, Bathurst Bay and Ninian Bay in far northern Queensland, with the greatest occurrence being around Bathurst Head.[20]

Cagnazzi's study extended across Central Queensland, from Gladstone to Shoalwater Bay (D. Cagnazzi 2011, pers. comm.). Snubfin dolphin were only sighted in Keppel Bay/Fitzroy River localities within the study area. The total population estimate for snubfin dolphin was 74 (N=74.03, Standard Error=4.14, 95 per cent confidence interval=65.91-82.09). Cagnazzi remarks, the "snubfin dolphin population (*in Central Queensland*) is limited." (D. Cagnazzi 2011, pers. comm.)

Previous estimates of snubfin dolphins in the Gulf of Carpentaria of 1000 individuals have since been questioned due to the unreliability of the survey methodology.[17]

Ecosystem role/function

In Lawler and colleagues' assessment of the vulnerability of marine mammals in the Great Barrier Reef to climate change, they state the lack of ecological and biological information on inshore dolphins makes it 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 colleagues[7] 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 with Sea Country 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 dolphins 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, 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. The role that dolphins play in maintaining the trophic order of marine ecosystems is largely unknown.

Pressures influencing the Indo-Pacific humpback and Australian snubfin dolphins in the Great Barrier Reef Marine Park

Pressures

Indo-Pacific humpback and Australian snubfin dolphins are particularly at risk due to the pressures they face within the inshore habitats on which they depend. Anthropogenic threats throughout their range include incidental capture in gillnet fisheries and nets set for bather safety,[38,42,43] competition for prey species targeted by commercial net and trawl fisheries[11]; habitat degradation and loss through increased coastal development and increasing human population;[27] declines in water quality that affect the health of Indo-Pacific humpback and Australian snubfin dolphin and their habitats;[44] increased noise pollution for these species that heavily rely upon echolocation in the turbid waters they occupy;[45] and anthropogenic disturbance and displacement from a range of activities.[46,47] The impacts of many of these pressures on inshore dolphins may be exacerbated by climate change.[7,48] A more detailed description of the range of pressures that impact on these two species of inshore 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*[49] 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 pressures reducing the resilience of the ecosystem.

From the *Great Barrier Reef Outlook Report 2009*[49] 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. Using the vulnerability assessment framework adapted by Wachenfeld and colleagues,[50] 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 humpback and Australian snubfin 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 humpback and Australian snubfin dolphins to that particular pressure. This allows for the formulation of suggested actions to minimise the impact of the pressures which these dolphins are most vulnerable to.

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

Vulnerability assessment matrix summary for Indo-Pacific humpback and Australian snubfin dolphins

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

* Sensitivity to these pressures comes from vessel-related impacts (boat strike, noise, disturbance/displacement from habitat), particularly in areas adjacent to population growth centres.

Key concerns

- Through the risk-based approach established in the Great Barrier Reef Marine Park Authority's *Great Barrier Reef Outlook Report 2009,*[49] and in consideration of obligations and risks determined from a number of other sources, Indo-Pacific humpback and Australian snubfin dolphin are considered to be the most at-risk dolphin species in the Great Barrier Reef World Heritage Area.
- Given their population ecology and life-history traits, inshore dolphins are under critical threat from coastal development that includes port facilities and increased shipping activity. Isolated populations of snubfin and Indo-Pacific humpback dolphins in localities such as the Fitzroy River estuary are examples of populations that are under particular threat of being significantly impacted upon directly and indirectly through proposed developments within their home range.
- Queensland's marine wildlife strandings program has recorded a number of dolphin deaths in the Queensland Shark Control Program each year, including Indo-Pacific humpback and Australian snubfin dolphins.[51,52,53,54] 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 humpback and Australian snubfin dolphin (and other threatened marine species).
- Some of the most critical vulnerabilities of Indo-Pacific humpback and Australian snubfin dolphin come from sources that threaten the ability of these inshore species to source sufficient prey. As the drivers of these food-web interactions are numerous and complex, an ecosystem-based management approach needs to address the anthropogenic pressures that combine to directly affect the abundance of inshore dolphins, their prey, and the health of their supporting habitat. This management approach must be undertaken with an understanding that climate change is creating impacts that makes this challenge more critical.
- The negative effects of local food resource depletion are likely to be experienced by coastal populations of marine mammals over the next century.[55] The majority of the Australian fisheries catch is taken close to the coast in waters less than 50 metres deep,[56] and commercial fisheries are at or near full exploitation.[57] Because of their coastal distribution and feeding ecology, snubfin and humpback dolphins are therefore at greater risk of directly or indirectly interacting with commercial fisheries operating in coastal waters.[11] Some prey species of these inshore dolphin are targeted by trawl and inshore fisheries in Queensland, and could become depleted to levels that could impact on inshore dolphin foraging requirements if not managed appropriately.[11]
- Understanding the community dynamics throughout the range of Great Barrier Reef populations of inshore dolphins is critical in order to provide the necessary management response for these species that are strongly sympatric (occur in the same habitat) and interspecific (competing for the same resources). This will undoubtedly require a greater management focus if, as a result of habitat degradation and loss and resource depletion from the overexploitation of fisheries, competition for diminishing resources amongst inshore dolphins increases.
- Population studies of Indo-Pacific humpback and Australian snubfin dolphin in the Great Barrier Reef have been limited to Cleveland Bay, Townsville[20,21] and central and southern Queensland[22](D. Cagnazzi, 2010, pers. comm.). These studies indicate populations are relatively small and maintain fairly small, discrete home ranges and are vulnerable to anthropogenic mortality and potentially rapid population declines due to life history traits unfavourable to recovery. However, there is currently a paucity of information on their distribution, population structure and dispersal patterns (including philopatry/site fidelities), behavioural ecology, health determinants, dietary and habitat requirements. There is also a lack of understanding about the trophic interplays between Indo-Pacific humpback and Australian snubfin dolphin and their prey species, making it difficult to predict cascading effects that may result from trophic imbalances.
- Although there are no data from Fisheries Queensland's ECIFFF Species of Conservation Interest logbooks or observer program recording mortality of Indo-Pacific humpback and Australian snubfin dolphin within the fishery, there is circumstantial evidence that this occurs. In June 2011, two snubfin dolphins were found gutted and anchored down in Two-mile Creek, near Townsville in Queensland, which is a practice known to have been used by net fishers who find protected species drowned in their set mesh nets. These incidents suggest that interactions with Indo-Pacific humpback and Australian snubfin dolphin are likely to occur within the ECIFFF and agencies should work collaboratively towards adaptive management that reduces the risk of inshore dolphin interactions within the ECIFFF (especially important with the consideration that these species occur in very small and isolated populations, and the loss of an adult female could have detrimental consequences for that local population).[20]
- At current resourcing levels, it is likely that Fisheries observer programs within the ECIFFF are insufficient to ensure rigorous reporting of interactions with Species of Conservation Interest (SOCI) such as inshore dolphins. This means that an appropriate response through management actions is less likely to be prioritised due to under-reporting.

- Population studies have been carried out in parts of the range of *S. chinensis* around the world, but there is no overall estimate of the population size. Reeves and colleagues[25] assessed the global conservation status for *S. chinensis* to be 'Near Threatened'. However, taxonomic uncertainty means that currently both *chinensis* forms are considered in combination for the assessment. On this basis it is thought that there are more than 10,000 mature individuals of *chinensis*-form humpback dolphins world-wide, although the species has suffered a decline of at least 30 per cent over the last 60 years and should the two *chinensis* forms be verified through taxonomic review, they would almost certainly qualify for a classification of 'Vulnerable'.[25] This status is likely to be conferred in the near future regardless of taxonomical clarity, as it is expected that throughout much of their range, pressures such as incidental capture through increased gill net effort (through-out their world-wide distribution) and further reduction in the quantity and quality of their coastal habitat will cause further population declines.[25]
- Further research is needed to better understand the relationships between declines in water quality and subsequent impacts on Indo-Pacific humpback and Australian snubfin dolphin. An example of water quality impacts that affect dolphins has been demonstrated by recent research[58] showing that increased water temperatures and low salinity that accompanies high rainfall and catchment run-off periods can cause chronic dermal infectious disease. These depleted environmental conditions can cause physiological stress that causes outbreaks of dermal diseases such as lobomycosis and poxvirus. Outbreaks of lobomycosis have been implicated in bottlenose dolphin mortality and chronic exposure to these environmental stressors may also cause impairment of adaptive immunity.[58]
- 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 humpback and Australian snubfin 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 triple bottom line considerations. 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.
- 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 humpback and Australian snubfin dolphin. On the basis of existing knowledge, the GBRMPA should work towards developing a best practice approach for managing and minimising the impacts of underwater noise in areas inhabited by inshore dolphins and other marine animals.
- Although there are few records of boat strike to Indo-Pacific humpback and Australian snubfin dolphins within Queensland's Marine wildlife strandings program, 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 humpback and Australian snubfin dolphin mortality caused by marine debris in the Marine Park, the *Action plan for Australian cetaceans*[32] 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.[59] 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*[60] provides guidance for marine managers and users.
- The Marine Wildlife Strandings 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.
- Small animal populations are more prone to extinction than larger populations,[39,61] 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 being exerted on inshore dolphins in the World Heritage Area is expected to be increased pressure and 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,[61,62] leaving fewer conspecific dolphins in the region to maintain or re-stock the local population.[63,64] Pressures being exerted on inshore dolphins 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 humpback and Australian snubfin dolphin would suggest the need to apply the precautionary principal when determining management outcomes for these species in Queensland. This is an approach advocated by Lawler and colleagues[7] in their assessment of the vulnerability of dolphins to climate change. Parra[20] (citing Wilson *et al*. 1999;[65] and Thompson *et al*. 2000[62]), 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 these two species of dolphin that are highly vulnerable to the pressures they face.

Management of Indo-Pacific humpback and Australian snubfin dolphins 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: • 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.	• 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	• *S. chinensis* listed as 'Near Threatened' • *O. heinsohni* listed as 'Near Threatened'.	• 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 and Natural Resources (IUCN)

Convention on International Trade of Endangered Species of wildlife fauna and flora (CITES).	• *S. chinensis* and *O. heinsohni* listed in Appendix I.	• The species are threatened with extinction and CITES prohibits international trade in specimens of these species except when the purpose of the import is not commercial, for instance for scientific research.	UNEP – CITES Secretariat

Bonn Convention – Convention on Migratory Species (CMS)	• Provides a basis for forming international agreement on the protection, conservation and management of migratory species
	• *S. chinensis* and *O. heinsohni* listed in Appendix II.
		• 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; 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 EPBC Act and are protected under the Act.
			UNEP – CMS Secretariat

Action Plan for Australian Cetaceans. 1996	• *S. chinensis* and *O. heinsohni* listed as K - 'Insufficiently known' • *O. heinsohni* listed as *O. brevirostris* prior to reclassification.	• 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.	Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC)
Review of the Conservation Status of Australia's Smaller Whales and Dolphins[23] 2006	• *S. chinensis* and *O. heinsohni* remain listed as K - 'Insufficiently known'.	• Reviews descriptions, conservation status, threatening process and future research recommendations for smaller whales and dolphins.	DSEWPaC
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and *Environment Protection and Biodiversity Conservation Regulations 2000*	• 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 • All cetaceans are protected under the Act under the classification of	• Cetaceans in Australian waters cannot be killed, injured or interfered with. 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 • Significant Impact Guidelines	DSEWPaC

	'Cetacean' • Designates all Australian Commonwealth waters, from the three nautical mile (nm) state waters limit out to 200 nm boundary of the Exclusive Economic Zone (EEZ), as the Australian Whale Sanctuary which provides for the protection of all cetaceans • Regulates on the required reporting of any interactions with marine mammals • *S. chinensis* listed as 'Migratory'. Prior to 2005 the Australian snubfin dolphin, *Orcaella heinsohni*, was known in Australia as the Irrawaddy dolphin, *O. brevirostris*, but it is now acknowledged that previously published studies on the Irrawaddy dolphin are considered to be studies of the Australian snubfin dolphin. The *EPBC Act 1999* listing of this species as 'Migratory' remains consistent with this naming history and primarily lists the species as *O. brevirostris*, though it is also listed using its new nomenclature (i.e. as the Australian snubfin dolphin, *O. heinsohni*) (refer to the Australian government environment web pages, whales, dolphins and porpoises legislation and migratory species list).	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 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 • 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.	
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 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	• Part 4A of the Regulations provides controls for human interactions with cetaceans, including whale-watching regulations • The Regulation provides 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	Great Barrier Reef Marine Park Authority (GBRMPA).

	Regulation 29.	the Marine Park • Penalties for non-compliance • Review of Act and Regulation.	
Great Barrier Reef Marine Park Zoning Plan 2003	• 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.	• 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 dolphins and their habitats under special circumstances • Dugong Protection Areas (spatial restrictions on commercial mesh netting) also provide subsequent protection for inshore dolphins (e.g. Hinchinbrook Island Area Dugong Protection Area) • Processes of review • Penalties for non-compliance.	GBRMPA
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 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.	• Aims to involve all stakeholders cooperatively • Coordination and integration with other conservation legislation • Penalties for non-compliance • Processes of review.	Queensland Government
Marine Parks (Great Barrier Reef Coast) Zoning Plan 2004 (Qld)	• 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.	• 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
Operational Policy on	• The objective of the policy is to	• Indo-Pacific humpback and	GBRMPA

Whale and Dolphin Conservation in the Great Barrier Reef Marine Park 2007	provide a framework for the conservation of whales and dolphins by partnering with other agencies, researchers and reef users to manage activities and impacts and fill knowledge gaps that exist for priority whale and dolphin species within the Great Barrier Reef Marine Park • Identifies priority species on which the Authority will focus management efforts • The operational policy implements the Great Barrier Reef Marine Park Authority's obligations under the Australian Government's *Australian National Guidelines for Whale and Dolphin Watching 2005.*	Australian snubfin dolphin identified as priority species • 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 *Great Barrier Reef Marine Park Act 1975.*	
Great Barrier Reef Biodiversity Conservation Strategy 2012	• Identifies *S. chinensis* and *O. heinsohni* as species 'at risk' in the Marine Park • Grades the level of risk experienced by *S. chinensis* and *O. heinsohni* through a vulnerability assessment process.	• The Biodiversity Conservation Strategy outlines a Framework for Action with three strategic objectives aimed at building or maintaining ecosystem resilience and protecting biodiversity: 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.	GBRMPA
Great Barrier Reef Climate Change Action Plan 2007-2012	• 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.	• Allocation of dedicated funding to implement actions to improve the resilience of the Great Barrier Reef ecosystem	GBRMPA
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 Great Barrier 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 Government and State of Queensland initiative
Great Barrier Reef Protection Amendment Act 2009 (Qld)	• Provides the legislative 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.	• Mix of strict controls on farm chemicals and regulations to improve farming practices.	Queensland Government
Nature Conservation	• Act provides for the conservation	• Prescribes protected native	Queensland

Act 1992 (Qld) and *Nature Conservation (Wildlife) Regulation 2006*	of nature, including wildlife, in Queensland jurisdiction • Provides for the protection of marine mammals including dolphins • Both *S. chinensis* and *O. heinsohni* listed as 'Near threatened' under the wildlife regulation.	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 specific species of dolphin currently in force • Penalties for non-compliance • Processes of review.	Government
Nature Conservation (Whales and Dolphins) Conservation Plan 1997 and *Conservation and management of whales and dolphins in Queensland 1997–2001*[66]	• Development of management intent for whales and dolphins in Queensland and adjacent waters.	• 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.	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 GBRMPA through the Field Management Program)
Back on Track Biodiversity Action Plans	• The Back on Track Species Prioritisation Framework identifies priority species for conservation management, regional threats, and suggested recovery actions. *S. chinensis* and *O. heinsohni* are identified as critical priorities for conservation management.	• Identifies regionally-appropriate management actions to mitigate the risks to these species • Processes of review.	Queensland Government (with regional Natural Resource Management groups and other stakeholders for implementation of identified management actions)
Fisheries Act 1994 (Qld) and *Fisheries Regulation 2008*	• Provides the legislative 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.	• Dolphins listed as Species of Conservation Interest (SOCI) • 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 (must be in attendance at all times) • Rules (N_1, N_2, N_4, N_{11}, 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	Queensland Government

		development. These areas provide nursery grounds and habitat for fish species which are likely to be prey for inshore dolphin species • Review of the Act in 2011 • Penalties for non-compliance.	
East Coast Inshore Fin Fish Fishery (ECIFFF) management arrangements	• Management arrangements are established under the *Fisheries Act 1994* (Qld) and *Fisheries Regulation 2008* • Accredited WTO under *Environment Protection and Biodiversity Conservation Act 1999* 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.	• Published *Guidelines for commercial operators in the East Coast Inshore Fin Fish Fishery* to provide commercial fishers with a summary of management arrangements • *Looking after protected species in Queensland – a comprehensive guide for commercial fishers* published to assist fishers in interactions with dolphins and other protected species • Review of the Fishery under *Environment Protection and Biodiversity Conservation Act 1999*. Review completed February 2012. New WTO with conditions issued; valid to 2015.	Queensland Government
Queensland Shark Control Program (QSCP)	• Community Education and Protection Policy under *Fisheries Act* (Qld) *1994* • 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.[67]	• 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) • 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 • Processes of review.	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	• Queensland Coastal Plan outlines directions for effective protection and management of the coastal zone.	Queensland Government

	the Queensland Coastal Plan.		
Queensland Coastal Plan (prepared under the *Coastal Protection and Management Act 1995* and includes a state planning policy under the *Sustainable Planning Act 2009*)	• The Queensland Coastal Plan has two parts: State Policy for Coastal Management and the State Planning Policy 3/11: Coastal Protection (SPP).	• 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 *Sustainable Planning Act 2009*.	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.
		• 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:
		  • 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.
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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 populated coast south of Cooktown	Yes*; locally, with potential for population-scale significance	Yes*; predominantly populated coast south of Cooktown	No	Yes	Yes*; developing coast south of Port Douglas	Yes*; predominantly populated 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 in the Marine Park, especially in the inshore turbid waters that inshore dolphins inhabit. At Great Barrier Reef-wide scale exposure to	Low. As inshore species there is potential for inshore dolphins to be exposed to defence activities at the local scale. At a Great Barrier Reef-wide scale, exposure is considered low.	High. Inshore dolphins are incidentally captured and drowned in nets set for bather safety within the Queensland Shark Control Program (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. The population abundances of inshore dolphins are partly a function of prey availability and fishing is likely to reduce availability of prey. Set mesh net fisheries in Queensland target species significant in the diet of inshore dolphins.	Low. There is limited understanding on the level of impact that recreational fishing and bait collection has on the prey of inshore 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 to recreational fishing and vessel-related impacts.	High. Exposure at local scale is high as inshore dolphins may be disturbed and displaced by underwater noise and activity from shipping, port development and maintenance programs. Although shipping facility activities do not operate on a Great Barrier Reef-wide scale, inshore dolphin populations are small and isolated and are under high exposure to shipping activities in critical localities that form their home range.	Low. Most impacts of this pressure are presently considered to be mostly vessel-related (boat strike, noise, disturbance/ displacement from habitat). At a Reef-wide scale there is low exposure to vessel-related impacts. However, vessel-related impacts within the preferred habitat of inshore dolphins could be significant at the local scale given the resident, localised nature of their populations.	Low. Dolphins hold totemic/ symbolic significance rather than a resource taken for traditional use. Exposure to incidental capture during traditional netting for fish is largely unknown though considered low.	High. Inshore dolphin species 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 provide inshore dolphins 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.	High. Discharge and run-off into the lagoon can impact inshore dolphin species through bioaccumulation of toxins, and exposure to parasites such as *Toxoplasma gondii* 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 inshore dolphins. 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 and flood events

	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**
	this pressure is low.		Otter trawl fisheries claim some of the same species as by-product. Quantifiable effects on dolphin prey from commercial fisheries are currently undetermined and require research.	However, these impacts within the preferred habitat of inshore dolphins could be significant at the local scale given the resident, localised nature of their populations.						associated with a changing climate.
Sensitivity to source of pressure **(low, medium, high, very high)**	Low. Inshore 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. Inshore dolphins may become tolerant of vessels exposing them to greater risk of boat strike. Alternatively	Low. Inshore dolphins 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 assumed to be low.	High. Inshore dolphins' diet, habitat use and behaviour mean they are highly sensitive to commercial fishing pressures. Key prey species of inshore dolphins are 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 significantly impact on the availability of these species with regards to the provisioning requirements of inshore dolphins.	Medium. Inshore dolphins are not directly impacted by recreational fishing activity. However, increasing human population growth along the Queensland coast and significant increase in boat registrations indicate that vessel traffic associated with recreational fishing activity is increasing. This is evident with the rising incidents of boat strike on dolphins and other protected species within the Marine Park. Inshore	High. Inshore 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 risk of boat strike. Alternatively continuous vessel activity may cause dolphins to be displaced from	Medium. Motorised vessel traffic has associated disturbance, displacement and boat strike risks that inshore dolphins are sensitive to. With increasing human population growth along the Queensland coast, the significant increase in boat registrations indicate that vessel traffic associated with recreational boating activity is increasing in high-growth regions. Sensitivity of inshore dolphins, which are shown to have localised,	Low. The low degree of exposure to this pressure determines the sensitivity.	High. Food webs that inshore dolphins rely on have been shown to rely on a supply of water that is of good quality. Inshore dolphins 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. These toxins can cause early mortality or affect the reproductive output of dolphins. Increased water temperatures and low salinity levels can cause	Very high. Species such as inshore dolphins that occur in relatively small and isolated populations, have a low reproductive output, and demonstrate high habitat specificity are vulnerable to impacts associated with increased coastal development and human population. These life history traits and behaviours predispose inshore dolphins to be very highly sensitive to coastal development and associated impacts.	Very 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 Indo-Pacific bottlenose dolphins being displaced from estuaries during high influxes of freshwater from

	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**
	continuous vessel activity may cause dolphins to be displaced from preferred habitat. However, any use would be non-extractive and therefore sensitivity is assumed to be low.			dolphins occurring in key habitats adjacent to population centres, such as Cleveland and Halifax Bays, are most sensitive to vessel-related impacts. This localised pressure becomes significant for the relatively small, resident, localised populations of inshore dolphins. The cumulative effects of this impact with others need to be considered.	preferred habitat.	resident populations, may be significant regarding these impacts where there are also high levels of recreational vessel traffic. The cumulative effects of this impact with others need to be considered.		physiological stress in dolphins that lead to chronic dermal infectious disease and in the long term may cause impairment in adaptive immunity. Although the extent of climate related impacts on inshore dolphins 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.		flood events[64]. 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.[64] Inshore dolphins 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.
Adaptive capacity – natural **(poor, moderate, good)**	Poor. Inshore dolphin populations are relatively small and isolated. Their diet is quite specific and their life history traits determine that they are long lived and spend large amounts of energy	Poor. Inshore dolphin populations are relatively small and isolated. Their diet is quite specific and their life history traits determine that they are long lived and spend large amounts of energy	Poor. Inshore dolphin populations are relatively small and isolated. Their diet is quite specific and 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	Poor. Inshore dolphin populations are relatively small and isolated. Their diet is quite specific and their life history traits determine that they are long lived and spend large amounts of energy raising few young. These characteristics	Poor. Inshore dolphin populations are relatively small and isolated. Their diet is quite specific and their life history traits determine that they are long lived and spend large amounts of energy raising few young. These characteristics mean that they	Poor. Inshore dolphin populations are relatively small and isolated. Their diet is quite specific and their life history traits determine that they are long lived and spend large amounts of energy raising few young. These characteristics	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	Poor. Inshore dolphin populations are relatively small and isolated. Their diet is quite specific and 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	Poor. Inshore dolphin populations are relatively small and isolated. Their diet is quite specific and 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	Poor. The preference of inshore dolphins 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,

	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**
	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.	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.	that depletes their source of food, disturbs their behaviour or displaces them from preferred habitat.	mean that they are not well adapted to cope with pressure that disturbs their behaviour, displaces them from preferred habitat or increased levels of human-induced mortality pressures (such as boat strike).	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.	mean that they are not well adapted to cope with pressure that disturbs their behaviour, displaces them from preferred habitat or increased levels of human-induced mortality (such as boat strike).	limited thus requiring little application of an assessment of natural adaptive capacity.	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 inshore dolphins will be challenged.	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 inshore dolphins will be challenged.	detrimental effects to dolphin health from bio-accumulation of toxins have been documented.[58] Lobomycosis is a chronic dermal infectious disease that has been implicated in outbreaks which led to mortality in bottlenose dolphins and may cause chronic impairment of their immune system.[58] It is not currently known whether these water quality-related impacts also affect inshore dolphins or if they have developed a natural adaptive capacity that reduces their vulnerability to them.
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.	Good. Defence activities are well managed and limited in extent, duration and geographic distribution.[49] Consultation on and ongoing management	Moderate. The *Great Barrier Reef Marine Park Zoning Plan 2003* provides some spatial protection of the food resources and habitat required by inshore dolphins. The Queensland *Marine Parks (Great Barrier Reef Coast) Zoning*	Moderate. The *Great Barrier Reef Marine Park Zoning Plan 2003* provides some spatial protection of the food resources and habitat required by inshore dolphins. The Queensland *Marine Parks*	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	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	Moderate. On-going low exposure to this source of pressure. Queensland Government regulations exist for permitting Traditional Owner use of commercial-type set nets	Poor. Options for local or regional scale management of climate impacts on inshore dolphins remain very limited because most impacts are directly linked to large-scale global climate phenomena rather than more local threatening	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	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**
	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 required.	of defence activities is undertaken between the Department of Defence and the Great Barrier Reef Marine Park Authority.	*Plan 2004* 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 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. The Queensland Department of Employment and Economic Development produced a guide for commercial fishers on how to look after protected species, which includes	*(Great Barrier Reef Coast) Zoning Plan 2004* 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.	at-risk species such as inshore dolphins. 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.	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 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	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.	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.	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.	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 *Reef Water Quality Protection Plan 2009* and *Reef Rescue* Program.

	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**
			dolphins. To date, single frequency acoustic pingers used to deter marine mammals from interacting with mesh nets have proved to be mostly ineffective in this objective.[68] However, current trials in the Queensland Shark Control Program[67] using multi-frequency pingers may provide better results.			inshore dolphins are not yet well understood.				
Residual vulnerability **(low, medium, high)**	Low	Low	High (in consideration of impacts from the QSCP and commercial fishing)	Medium	High	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 *et al.* 2006;[46] Van Parijs and Corkeron 2001;[69]	Good – exposure and adaptive capacity of management to pressure. Poor – sensitivity and natural adaptive capacity to pressure. O'neill 2009;[71] Van Parijs and Corkeron 2001.[69]	Moderate. More information required on sensitivity and natural adaptive capacity. Parra *et al*. 2002;[17] Parra *et al*. 2004;[18] Parra and Jedensjö 2009;[11] Hodgson *et al*. 2007;[68] Gribble *et al.* 1998; QDPI 2006;[67] Van Parijs and Corkeron 2001;[69]	Poor. More information required on sensitivity and natural adaptive capacity. Hale 1997;[38] Van Parijs and Corkeron 2001;[69] Marine wildlife stranding and mortality database Annual Report 2007 –	Poor. More information required on sensitivity and natural adaptive capacity. Hale 1997;[38] Van Parijs and Corkeron 2001;[69] Ross 2006[23]	Poor. More information required on sensitivity and natural adaptive capacity. Hale 1997;[38] Van Parijs and Corkeron 2001.[69]	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 *et al.* 2007;[7] Lough 2007.[48]	Poor. Lawler *et al*. 2007;[7] Parra *et al.* 2006;[21] Parra & Ross 2009;[45] Lukoschek and Chilvers 2008;[47] Chilvers *et al*. 2005;[27] Ross 2006.[23]	Poor. Lawler *et al.* 2007;[7] Lough 2007;[48] Cockcroft *et al*. 1989;[72] Bowater *et al*. 2003;[44] Jefferson *et al*. 2006;[73] Ross 2006;[23] Fury and Harrison 2011;[64] Murdoch *et al.* 2008.[58]

	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**
	Mattson *et al.* 2005.[70]		Ross 2006 Marine wildlife stranding and mortality database Annual Report 2007 – Cetaceans[51]	Cetaceans.[51]						

The pressures addressed in this Vulnerability Assessment were identified in the *Great Barrier Reef Outlook Report 2009*.[49]

* 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 that the intensity of activity and development in coastal zones is likely to persist.[74]

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.

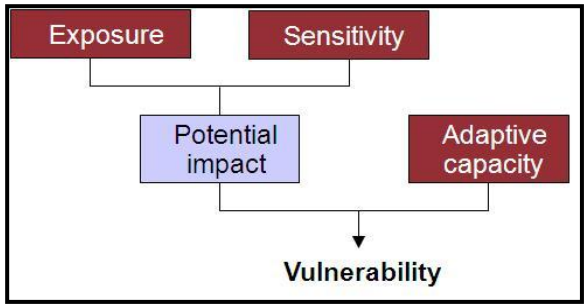

Figure 1. The key components of vulnerability assessments (Adapted from Wachenfeld *et al*., 2007)

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[e] to create a combined score for exposure and sensitivity, if a species, group of species or habitat 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 2012*.

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

The methods used to determine the degree of exposure or sensitivity of inshore dolphins of the World Heritage Area against each source of pressure are described within the vulnerability assessments page of the GBRMPA website.

The natural capacity of inshore dolphins to adapt to pressures in the Great Barrier Reef, and the capacity of management to intervene (which in turn may assist inshore dolphins 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 inshore dolphins may be expected to experience for the given pressure. An explanation of the procedure by which this process has been applied and qualifying statements for the assessment of adaptive capacity (natural and management) scores are provided within the vulnerability assessments page of the GBRMPA website.

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