[1] "\r\n\r\n\t\r\n\r\n\r\n \r\n \r\n \r\n Dugong dugon\r\n — Dugong\r\n \r\n \r\n \r\n \r\n \r\n Glossary\r\n \r\n\r\n\r\n\r\n\r\n\r\n \r\n SPRAT\r\n Profile\r\n \r\n\r\nFor information to assist regulatory considerations, refer to Policy Statements and Guidelines, the Conservation Advice, the Listing Advice and/or the Recovery Plan. \r\n\r\n\r\n\r\n \r\n EPBC Legal Status and Documents\r\n \r\n \r\n Top\r\n \r\n\r\n\r\nEPBC Act Listing Status\r\n \r\n\t \r\n\t\t\t\r\n\t\t\t Listed marine\r\n\t\t\t \r\n\t\t\t \r\n\t\t\t \r\n\t\t\t\r\n\t\t\t\r\n\t\t\t Listed migratory -\r\n\t\t\t \r\n\t\t\t\tEPBC Act, \r\n\t\t\t \r\n\t\t\t\tBonn\r\n\t\t\t \r\n\t\t\t\r\n\t\t\t\r\n\t\t\t\r\n\t\t\r\n\t\t\r\n \r\n \r\n\t\t Approved Conservation Advice\r\n\t\t\r\n\t\t\r\n\t\t \r\n\t\t\tThere is no approved Conservation Advice for this species\r\n\t\t \t \r\n\t\t\r\n \r\n\t\t Listing Advice\r\n\t\t\r\n\t\t\r\n\t\t\r\n\t\t\r\n\t\t\tThere is no Listing Advice for this species\r\n\t\t\r\n\t\t\r\n\t\t\r\n \r\n\t\t Adopted/Made Recovery Plans\r\n\t\t\r\n\t\t\r\n\t\t \r\n\t\t\tThere is no adopted or made Recovery Plan for this species\r\n \r\n\t\r\n \r\n\t\t Adopted/Made Threat Abatement Plans\r\n\t\t\r\n\t\t\r\n\t\t\r\n\t\t \r\n\t\t\r\n\t\t\tDepartment of the Environment and Energy (2018). 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In effect under the EPBC Act from 27-Aug-2012.\r\n\t\t\t\r\n\t\t\r\n\t\t\r\n \r\n\t\r\n \r\n\t\tOther Commonwealth Documents\r\n\t \r\n\t \r\n\t\t\tTop\r\n\t \r\n\t\r\n\r\n\r\n\t\r\n\t\r\n\t Policy Statements and Guidelines\r\n\t\r\n\t\r\n\t \r\n\t \r\n\t Seagrass - A Vulnerability Assessment for the Great Barrier Reef (Great Barrier Reef Marine Park Authority (GBRMPA), 2011) [Admin Guideline].\r\n\t \r\n\t \r\n\t\r\n \r\n\t Federal Register of Legislative Instruments\r\n\t\r\n\t\t\r\n\t\t\tMarine:Declaration under section 248 of the Environment Protection and Biodiversity Conservation Act 1999 - List of Marine Species (Commonwealth of Australia, 2000c) [Legislative Instrument]Migratory:List of Migratory Species (13/07/2000) (Commonwealth of Australia, 2000b) [Legislative Instrument]Threat Abatement Plan:Instrument under section 270B of the Environment Protection and Biodiversity Conservation Act 1999 to make a Threat Abatement Plan (Commonwealth of Australia, 2018i) [Legislative Instrument]\r\n \r\n\t State Government Documents and Websites\r\n\t\r\n\t\r\n\t QLD:Dugong (Department of Environment and Heritage Protection (DEHP), 2013n) [Database].\r\n State Listing Status\r\n\t \r\n\t NSW:\r\n\t\t\t\r\n\t\t\t\tListed as Endangered\r\n\t\t\t\t (Biodiversity Conservation Act 2016 (New South Wales): February 2021 list)\r\n\t\t\t\t\r\n\t\t\t \r\n\t\t\t QLD:\r\n\t\t\t\r\n\t\t\t\tListed as Vulnerable\r\n\t\t\t\t (Nature Conservation (Animals) Regulation 2020 (Queensland): August 2020 list)\r\n\t\t\t\t\r\n\t\t \r\n\t\t WA:\r\n\t\t\t\r\n\t\t\tListed as Other protected fauna\r\n\t\t\t\t (Biodiversity Conservation Act 2016 (Western Australia): September 2018 list)\r\n\t\t\t\t\r\n\t\t \r\n\t\t \r\n Non-statutory Listing Status\r\n\t \r\n\t IUCN:\r\n\t\t\t\r\n\t\t\t\tListed as Vulnerable\r\n\t\t\t\t (Global Status: IUCN Red List of Threatened Species: 2020.2 list)\r\n\t\t\t\r\n\t\t\t\r\n\t\t NGO:\r\n\t\t\t\r\n\t\t\tListed as Near Threatened\r\n\t\t\t\t (The action plan for Australian mammals 2012)\r\n\t\t\t\r\n\t\t\t\r\n\t\t \r\n \r\n \r\n Naming\r\n \r\n \r\n Top\r\n \r\n\r\n\r\nScientific name\r\n \r\n Dugong dugon [28]\r\n \r\n Family\r\n \r\n Dugongidae:Sirenia:Mammalia:Chordata:Animalia\r\n \r\n \r\n Species author\r\n (Müller,1776)\r\n \r\n Infraspecies author\r\n \r\n Reference\r\n \r\n \r\n \r\n Distribution Map\r\n \r\n \r\n Top\r\n \r\n\r\n\r\nDistribution map\r\n \r\n \r\n\t\tThe distribution shown is generalised from the Departments Species of National Environmental Significance dataset. This is an indicative distribution map of the present distribution of the species based on best available knowledge. Some species information is withheld in line with sensitive species polices. See map caveat for more information.\r\n\r\n \r\n \r\n \r\n \r\n Illustrations\r\n \r\n \r\n Top\r\n \r\n\r\n\r\n\r\nIllustrations\r\n \r\n Google Images\r\n \r\n \r\n Other Links, Including Superseded Commonwealth Documents\r\n \r\n \r\n Top\r\n \r\n \r\n \r\n \r\n

Commonwealth of Australia (2000b). List of Migratory Species (13/07/2000). F2007B00750. Canberra: Federal Register of Legislative Instruments. Available from: http://www.comlaw.gov.au/Details/F2007B00750.\r\n \r\n Commonwealth of Australia (2000c). Declaration under section 248 of the Environment Protection and Biodiversity Conservation Act 1999 - List of Marine Species. F2008B00465. Canberra: Federal Register of Legislative Instruments. Available from: http://www.comlaw.gov.au/Details/F2008B00465.\r\n \r\n Department of the Environment and Heritage (DEH) (2006hw). Dugong dugon in Species Profile and Threats (SPRAT) database. Unpublished species profile. Canberra, ACT: DEH. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=28.\r\n \r\n Department of the Environment, Water, Heritage and the Arts (2009t). Threat abatement plan for the impacts of marine debris on vertebrate marine life. Department of the Environment, Water, Heritage and the Arts. Available from: http://www.environment.gov.au/marine/publications/threat-abatement-plan-impacts-marine-debris-vertebrate-marine-life. In effect under the EPBC Act from 01-Jul-2009. Ceased to be in effect under the EPBC Act from 21-Jul-2018.\r\n \r\n \r\n\r\n\r\n\t\r\n\r\n\r\n \r\n Newsletters\r\n \r\n \r\n Top\r\n \r\n\r\n\r\n\r\n\r\n\r\nEPBC Act email updates can be received via the Communities for Communities newsletter and the EPBC Act newsletter.\r\n\r\n\r\n\r\n\r\n\r\n \r\n Caveat\r\n \r\n \r\n Top\r\n \r\n\r\n\r\n\r\nThis database is designed to provide statutory, biological and ecological\r\ninformation on species and ecological communities, migratory species, marine\r\nspecies, and species and species products subject to international trade and\r\ncommercial use protected under the Environment Protection and Biodiversity\r\nConservation Act 1999 (the EPBC\r\nAct). It has been compiled from a range of sources including\r\nlisting advice, recovery plans, published literature and individual experts.\r\nWhile reasonable efforts have been made to ensure the accuracy of the\r\ninformation, no guarantee is given, nor responsibility taken, by the\r\nCommonwealth for its accuracy, currency or completeness. The Commonwealth\r\ndoes not accept any responsibility for any loss or damage that may be\r\noccasioned directly or indirectly through the use of, or reliance on, the\r\ninformation contained in this database. The information contained in this\r\ndatabase does not necessarily represent the views of the Commonwealth. This\r\ndatabase is not intended to be a complete source of information on the\r\nmatters it deals with. Individuals and organisations should consider all the\r\navailable information, including that available from other sources, in\r\ndeciding whether there is a need to make a referral or apply for a permit or\r\nexemption under the EPBC\r\nAct.\r\n\r\n\r\nCitation: Department of the Environment\r\n(2022).\r\nDugong dugon in Species Profile and Threats Database,\r\nDepartment of the Environment,\r\nCanberra.\r\nAvailable from:\r\nhttps://www.environment.gov.au/sprat.\r\nAccessed Tue, 18 Jan 2022 20:59:51 +1100.\r\n\r\n\r\n\r\n\r\nWhere available the sections below provide a biological profile for the species. Biological profiles vary in age and content across species, some are no longer being updated and are retained as archival content. These profiles are still displayed as they contain valuable information for many species. The Profile Update section below indicates when the biological profile was last updated for some species. For information to assist regulatory considerations, please refer to Conservation Advice, the Recovery Plan, Policy Statements and Guidelines.\r\n\r\n\r\n\r\n \r\n \r\n \r\n Profile Update\r\n \r\n \r\n Top\r\n \r\n \r\n \r\n The following detailed profile was last updated on 6 November 2015.\n\r\n \r\n \r\n \r\n \r\n Taxonomy\r\n \r\n \r\n Top\r\n \r\n \r\n \r\n The dugong is the only species in the Family Dugongidae and one of four species in the Order Sirenia. It is most closely related to Steller's Sea Cow (Hydrodamalis gigas), which is extinct (Marsh et al. 2002). No subspecies is recognised.\nGenetic information on dugong stocks is mostly limited to the Australian region. Recent work based on mitochondrial DNA indicates that the Australian dugong population is not panmictic (random mating between individuals of a population) (Blair et al. 2014). There is clear evidence of two maternal lineages, which apparently reflect Pleistocene sea-level fluctuations. The Australian dugong population has high genetic diversity, indicating that recent losses are not yet reflected in the genetic makeup of the population. Seddon and colleagues (2014) used microsatellite markers (short segments of DNA) to demonstrate a low but significant population differentiation at a regional level in southern Queensland, despite frequent movement between locations in this region (Sheppard et al. 2006; Cope et al. 2015; Zeh 2015, pers comm.).\n\r\n \r\n \r\n \r\n \r\n Description\r\n \r\n \r\n Top\r\n \r\n \r\n \r\n The dugong is a large herbivorous marine mammal with paddle-like forelimbs and no hind limbs or dorsal fin. Its tail is broad, triangular in shape, and horizontally flattened, which it moves up and down to swim. Adult dugongs have a head and body length of up to 3.3 m, and weigh up to 570 kg (Jefferson et al. 2008). Adults are grey-brown in colour, and older animals may have white scars on their backs. Its ears are small bilateral openings. The dugong has nostrils near the top of its snout and surfaces only to breathe. The tusks of mature males, and some old females, erupt on either side

of the upper jaw, but do not extend beyond the end of the premaxilla. The dugong has two mammary glands, each opening via a single teat situated in the 'armpit' or axilla.\n\r\n \r\n \r\n \r\n \r\n Australian Distribution\r\n \r\n \r\n Top\r\n \r\n \r\n \r\n Dugongs occur in coastal and island waters from Shark Bay in Western Australia (25° S) across the northern coastline to Moreton Bay in Queensland (27° S) (Marsh et al. 2002, 2011a). The winter range includes about 24 000 km of Australia's coast, which represents about 19% of the global extent of occurrence along coastline habitats (Marsh et al. 2011a). Stranded dugongs have been recorded as far south as ~36.5° S on the east coast, with occasional sightings south to 32–33.5° S (Newcastle region) in summer (Allen et al. 2004). A single individual has been recorded in the Cocos (Keeling) Islands (Hobbs et al. 2007). Dugongs spend most of their time in the neritic zone, especially near tidal and subtidal seagrass meadows.\nFigure 1 – Distribution of dugongs in Australia. Open detailed image in browser.\n\nWestern Australia\nSpecific areas supporting dugongs in Western Australia include: Shark Bay; Ningaloo and Exmouth Gulf; the Pilbara coast (Exmouth Gulf to De Grey River (Marsh et al. 2002)); and Eighty Mile Beach and Kimberley Coast Region, including Roebuck Bay (Brown et al. 2014).\nNorthern Territory and Gulf of Carpentaria\nSpecific areas supporting dugongs in the Northern Territory include: the northern coast (Daly River to Millingimbi, including Melville Island and Vernon Islands and the Darwin region); and the Gulf of Carpentaria, including the Sir Edward Pellew Group of Islands, the mouth of the Limmen Bight River, and the waters between Blue Mud Bay and Groote Eylandt (Marsh et al. 2008; Grech et al. 2011). Specific areas supporting dugongs along the Queensland coast of the Gulf of Carpentaria include: the Wellesley Islands (Mornington and Bentick Islands), the mouth of the Norman River, and Albatross Bay (Marsh et al. 2008; Grech et al. 2011). Within the Gulf of Carpentaria, the Sir Edward Pellew and Wellesley Islands are the most important dugong habitats (Marsh et al. 2002, 2008, 2011a; Grech et al. 2011).\nTorres Strait and northern Great Barrier Reef\nThe Torres Strait region between mainland Australia and Papua New Guinea supports the largest recorded single continuous seagrass meadow in Australia (Carter et al. 2014) and is the most important dugong habitat in the world (Marsh et al. 2011a). Dugongs primarily occur in a large, central area that extents south of Boigu Island to north of Badu and Moa Islands; and west of Badu and Muralug Islands (Grech et al. 2011; Sobtzick et al. 2014).\nThe northern Great Barrier Reef region also supports globally significant populations of dugongs (Sobtzick et al. 2014). Specific areas supporting dugongs along the northern Great Barrier Reef coast include: Shelburne Bay, Temple Bay, Lloyd Bay, the waters between Friendly Point and Port Stewart, Princess Charlotte Bay, Bathurst Bay and the waters between Cape Bowen and Cape Flattery (Grech et al. 2011; Marsh et al. 2011a; Sobtzick et al. 2014). The region is the most important dugong habitat within the Great Barrier Reef World Heritage Area, and one of the most important locations in Australia (Marsh et al. 2002; Grech et al. 2011).\nQueensland urban coast\nThe urban coast of Queensland extends from Cooktown to the border of New South Wales. Specific areas supporting dugongs along the urban coast of the Great Barrier Reef World Heritage Area include: Hinchinbrook Island (Missionary Bay), Cleveland Bay, Upstart Bay, Shoalwater Bay and Port Curtis (Grech et al. 2011; Sobtzick et al. 2012). In Moreton Bay, the eastern Amity Banks, Moreton Banks and areas adjacent to these sandbanks are considered the most important habitats (Grech et al. 2011; Sobtzick et al. 2012), with Rous Channel and east of South Passage (up to 10 m offshore from Moreton Island) also important in cooler months (Preen 1992; Lanyon and Morrice 1997; Marsh et al. 2002). In Hervey Bay, the most important dugong habitats are located between Burrum Heads and Fraser Island and along the Great Sandy Strait (Grech et al. 2011; Sobtzick et al. 2012), with the northernmost tip of Sandy Cape, Fraser Island also important in cooler months (Sheppard et al. 2006).\nNew South Wales (NSW)\nDugongs were sighted in coastal and estuarine waters around Wallis Lake, Port Stephens, Lake Macquarie and Brisbane Water in the summer of 2002/2003 (Allen et al. 2004). These areas are associated with some of the largest seagrass beds in New South Wales, some of which contain the Halophila seagrass species. The presence of dugongs in these areas at this time coincided with warm water temperatures (>18 °C) (Allen et al. 2004).\n\r\n \r\n \r\n \r\n \r\n Global Distribution\r\n \r\n \r\n Top\r\n \r\n \r\n \r\n The dugong has a very large and fragmented Indo-West Pacific range that extends between about 26-27° north and south of the equator (Nishiwaki and Marsh 1985), encompassing some 860 000 km² of shallow marine habitat across 128 000 km of coastline (Marsh et al. 2011a). Their range includes the coastal waters of between 38-44 nations and territories (Marsh et al. 2011a). In the South Pacific, dugongs are found in Papua New Guinea, Solomon Islands, Vanuatu, New Caledonia, Palau and Australia (Gillespie 2005). It also occurs in parts of East Africa, the Red Sea and Gulf of Aden, Arabian/Persian Gulf, Andaman and Nicobar Islands, East and South-east Asia, India and Sri Lanka (Marsh et al. 2002, 2011a). The dugong's historic distribution was broadly coincident with the tropical Indo-Pacific distribution of its food plants, the phanerogamous (flowering) seagrasses of the families Potamogetonaceae (pondweed) and Hydrocharitaceae (Husar 1978). It is now believed to be extinct in the waters of several

islands including Laccadives, Nicobars, most of the Ryukus, and Rodgrigues\n\r\n \r\n \r\n \r\n \r\n Surveys Conducted\r\n \r\n \r\n Top\r\n \r\n \r\n \r\n Over most of its range, the dugong is known only from incidental sightings, accidental drownings, and the anecdotal reports of fishermen. However, within northeast Australia, systematic aerial surveys have been used to monitor the abundance and distribution of dugong populations over an area > 136 000 km². Aerial surveys have also been used to monitor dugongs in Western Australia (Shark Bay, Exmouth and the Pilbara).\nAerial surveys of northeast Australia have been conducted in seven survey regions (Moreton Bay, Hervey Bay, northern and southern Great Barrier Reef, Torres Strait, and the Queensland and Northern Territory Gulf of Carpentaria) approximately every five years from 1985–2013. The surveys use the strip transect technique developed for environments with heterogeneous (different) water visibility and described by Marsh and Sinclair (1989b) and Pollock and colleagues (2006). Pollock and colleagues (2006) found that strip transects are more appropriate for estimating dugong abundance in heterogeneous environments than line transect methods. The seven survey regions were divided into blocks containing systematic transects of varying length. These transects were typically perpendicular to the coast across the depth gradient and 200 m wide at the water's surface on either side of the aircraft. Most aerial surveys were conducted in late spring or early summer when weather and sea states provide optimum survey conditions.\nA summary of dugong aerial surveys across Australia is shown in Table 1 below (Sobtzick et al. 2015a). A database containing outputs of dugong aerial surveys is available at: https://dugongs.tropicaldatahub.org/\nTable 1 – Summary of aerial surveys undertaken for dugongs across Australia\nSurvey Region\r\nSurvey Years \r\nShark Bay\r\n1989\r\n1994\r\n2007\r\n \r\n \r\n \r\n \r\n \r\n \r\n \r\n \r\n \r\nExmouth\r\n1989\r\n1994\r\n2000\r\n2007\r\n \r\n \r\n \r\n \r\n \r\n \r\n \r\n \r\nPilbara\r\n2000\r\n \r\n \r\n \r\n \r\n \r\n \r\n \r\n \r\n \r\n \r\n \r\nGulf of Carpentaria\r\n1991\r\n1994\r\n1997\r\n2006\r\n2007\r\n \r\n \r\n \r\n \r\n \r\n \r\n \r\nTorres Strait\r\n1987\r\n1991\r\n1994\r\n1996\r\n2001\r\n2005\r\n2006\r\n2011\r\n2013\r\n \r\n \r\nNorthern GBR\r\n1984\r\n1985 (April)\r\n1985 (Nov)\r\n1990\r\n1995\r\n2000\r\n2006\r\n2013\r\n \r\n \r\n \r\n \r\nSouthern GBR\r\n1986\r\n1987\r\n1992\r\n1994\r\n1999\r\n2005\r\n2011\r\n \r\n \r\n \r\n \r\n \r\nHervey Bay\r\n1988\r\n1992\r\n1993\r\n1994\r\n1999\r\n2001 (April)\r\n2001 (Nov)\r\n2005\r\n2006\r\n2011\r\n2013\r\nMoreton Bay\r\n1999\r\n2000\r\n2001 (April)\r\n2001 (Nov)\r\n2005\r\n2011\r\n2013\r\n \r\n \r\n \r\n \r\n \r\n \r\n \r\n \r\n \r\n Population Information\r\n \r\n \r\n Top\r\n \r\n \r\n \r\n A summary of the distribution and relative abundance of dugongs in nine survey regions is shown in Table 2 below (Marsh et al. 2011a). The estimates developed using the Pollock and colleagues (2006) are likely to be more robust then the estimates developed using the Marsh and Sinclair (1989b) method (Marsh et al. 2011a). All these population estimates are almost certainly underestimates, despite the attempts to correct for detectability biases (see Survey Guidelines). Nonetheless, these surveys indicate that the dugong is the most abundant marine mammal in the coastal waters of northern Australia. The 2011 survey of the southern Great Barrier Reef occurred in response to severe weather events affecting the urban coast of Queensland in the summer of 2010/11, including the strongest La Niña weather pattern since 1973, major floods and Tropical Cyclones Tasha, Anthony and Yasi. The low abundance relative to previous years is likely explained by animals moving out of the survey area and increased mortality (Sobtzick et al. 2012).\nTable 2: Population estimates for dugongs in different regions of Australia. The Shark Bay, Exmouth and Torres Strait surveys used the Pollock and colleagues (2006) method. The other surveys used the Hagihara and colleagues (2014) method. Sobtzick and colleagues (2015b) explains the difference between the methods.\nSurvey Region\r\nArea (km²)\r\nDate of last survey\r\nPopulation estimate ±SE\r\nStatus of population suggested by surveys\r\nReference\r\nShark Bay\r\n13 000\r\n2007\r\n9347 ± 1204\r\nStable\r\nHodgson and colleagues (2008)\r\nExmouth\r\n3180\r\n1999 (July)\r\n704 ± 354\r\nStable\r\nHodgson and colleagues (2008)\r\nPilbara\r\nN/A\r\n2000 (April)\r\n-\r\nUnknown\r\nPrince and colleagues (2001)\r\nGulf of Carpentaria\r\n35 592\r\n2007\r\n9438 (± 1419)\r\nUnknown\r\nSobtzick and colleagues (2015b)\r\nTorres Strait\r\n30 560\r\n2013\r\n15 727 ± 2942\r\nStable\r\nSobtzick and colleagues (2014)\r\nNorthern GBR\r\n25 440\r\n2013\r\n4517 (± 789)\r\nStable\r\nSobtzick and colleagues (2015b)\r\nSouthern GBR\r\n26 892\r\n2011\r\n537 (± 223)\r\nDeclining\r\nSobtzick and colleagues (2015b)\r\nHervey Bay\r\n4936\r\n2011\r\n1438 (± 438)\r\nStable\r\nSobtzick and colleagues (2015b)\r\nMoreton Bay\r\n1627\r\n2013\r\n759 (± 181)\r\nStable\r\nSobtzick and colleagues (2015b)\r\nThe catch per unit effort data collected by the Queensland Shark Control Program indicate that the dugong population on the urban coast of Queensland (southern Great Barrier Reef and Hervey and Moreton Bays) declined precipitously between the 1960s and early 1980s (Marsh et al. 2005). Aerial surveys since the mid-1980s indicated that the population had stabilised, presumably as a result of significant management interventions

by the Commonwealth and Queensland governments. However, the aerial survey estimates in 2011 after the extreme weather events of the summer of 2010-11 were the lowest since the surveys began in 1986 (Sobtzick et al. 2012, 2015b). In contrast, aerial surveys since the mid-1980s suggest that dugong populations are now stable at a regional scale in Shark Bay, the Exmouth/Ningaloo Reef region of Western Australia, Torres Strait and the northern Great Barrier Reef (Marsh et al. 2007, 2008, 2011b; Hodgson et al. 2008). However, the power of these surveys to detect declines, especially local declines, is weak unless the declines are very large.\nThe surveys suggest that dugong numbers in several regions such as the urban coast of Queensland south of Cooktown fluctuate over time (Sobtzick et al. 2012; 2015b). These fluctuations are partially attributable to dugongs moving between bays or from shallow to deeper water within bays, especially after seagrass is lost as a result of extreme weather events, but there are indications of a declining trend in the southern Great Barrier Region, although whether this is the result of temporary emigration is not known.\nDue to the extensive international, cultural, environmental and scientific significance of dugongs, there is a growing body of biological and ecological information. However, data deficiency is currently an issue for conservation. Marsh and colleagues (2011a) subdivided their informal assessment of the status of the dugong in Australia because of the size of the species' range, the spatial variability of impacts and the availability of information. They assigned a conservation status to dugongs ocurring five regions as follows:\nurban coast of Queensland: Critically Endangered;\r\nnorthern Great Barrier Reef: Vulnerable;\r\nTorres Strait: Least Concern;\r\nthe northern tip of Cape York west to the Northern Territory border; Data Deficient; and\r\nnorth-west Cape to Shark Bay in Western Australia: Least Concern.\r\nPopulation estimates are unavailable, not publically available or out-dated for large regions of Australia including the Western Australian coast north of Exmouth Gulf, most of the Northern Territory coast outside of the Gulf of Carpentaria, Ashmore Reef and offshore territories such as Cocos (Keeling) Islands.\n\r\n \r\n \r\n \r\n \r\n Habitat\r\n \r\n \r\n Top\r\n \r\n \r\n \r\n Dugongs are seagrass community specialists and the range of the dugong is broadly coincident with the distribution of seagrasses in the tropical and sub-tropical waters in their Australian range. Seagrasses are anchored in the sediment by their roots and rhizomes. The below-ground biomass (roots and rhizomes) is typically greater than the above-ground biomass (leaves) in the seagrass species eaten by dugongs (de Iongh et al. 1995, 2007; Lanyon and Marsh 1995; Aragones and Marsh 2000; Masini et al. 2001) and evidence of dugong feeding has been detected in areas with little or no above-ground seagrass.\nSeagrass habitats in tropical and sub-tropical Australia are characterised by low nutrient concentrations and high disturbance, and are spatially and temporally dynamic (ephemeral (short-lived); Carruthers et al. 2002). There are around 20 species of seagrasses in tropical and sub-tropical Australia, and they occur in four major habitat types: tidal reaches of rivers, coastal, reef and deepwater (Carruthers et al. 2002). Estuarine and coastal seagrass habitats occur in the intertidal and sub tidal waters of sheltered coastlines and soft-bottomed waters (including sand and mud substrates). Where substrate allow, seagrass habitats can reach into mangrove forest. Seagrasses also grow in sandy lagoon areas between reefs and on reef tops and may be intertidal or subtidal depending on the depth range. The maximum depth at which seagrasses occur along the coast is variable (controlled by turbidity and light availability), but they can occur down to depths of 50–60 m. However, the majority of seagrasses are found in shallow inshore and intertidal zone areas to water depths of around 25 m.\nDugong feeding aggregations tend to occur in large seagrass meadows within wide, shallow protected bays (e.g. Hervey and Moreton Bays); wide, shallow mangrove channels (e.g. Hinchinbrook Channel); and in the lee of large inshore islands (Marsh et al. 2011a). Dugongs also feed in offshore seagrass habitats in areas where the continental shelf is wide, shallow and protected. In the Torres Strait, which supports the largest seagrass bed in Australia (Carter et al. 2014), between Australia and Papua New Guinea, significant numbers of dugongs are seen more than 10 km from land (Grech et al. 2011). Dugongs also use estuarine creeks and streams and have been tracked travelling within creeks upstream for several kilometres (Marsh and Rathbun 1990).\nNot all seagrass meadows are accessible to dugongs. Dugong feeding trails have been observed at depths of up to 33 m off northeast Queensland (Lee Long et al. 1997), however some seagrass meadows occur at depths beyond the dugong's known diving range (<~35 m) (Coles et al. 2009) and may be permanently inaccessible. Other seagrass meadows are inaccessible on a seasonal or daily basis. At the high latitude limits of the dugong's range (such as Shark Bay in Western Australia), some seagrass meadows are avoided in winter, presumably as a form of behavioural thermoregulation (see Marsh et al. 2011a). Tides restrict dugong foraging on intertidal seagrass meadows on a daily basis (Anderson and Birtles 1978; Nietschmann and Nietschmann 1981; Sheppard et al. 2009). In areas where the tidal range is large, such as tropical Australia, the area of intertidal seagrass meadows to which dugongs have limited access is vast. In turbid areas where most seagrass is intertidal, temporary or permanent destruction of intertidal seagrass may mean that dugong cannot feed on enough seagrass in the

time available for feeding to maintain their body weight.\nThere is some evidence that dugongs use specialised habitats for various activities. Dugongs may avoid predators (e.g. sharks) by resting on the edges of sandbanks in Moreton Bay (Hodgson 2004) and deeper waters in Shark Bay (Wirsing et al. 2007). There is also evidence that dugongs avoid predators by utilising shallow waters when calving (Marsh et al. 2011a), such as tidal sandbanks (Marsh et al. 1984) and estuaries. Mating herds of dugong have been observed in Moreton Bay, shark Bay and the northern Great Barrier Reef region (Preen 1989; Holley 2006; Marsh et al. 2011a). Observations at South Cove, Shark Bay suggest a lek mating system (gathering of males for mating display) may occur, but the conditions are poorly understood (Anderson 1997, 2002; Holley 2006; Marsh et al. 2011a).\n\r\n \r\n \r\n \r\n \r\n Life Cycle\r\n \r\n \r\n Top\r\n \r\n \r\n \r\n Dugongs are long-lived and slow breeding. The oldest wild dugong whose age has been estimated was a female from Western Australia estimated to be more than 70 years old (Marsh 1995). Neither mature males nor mature females are continuously in breeding condition. Dugongs are diffusely seasonal breeders and the seasonality of breeding is more marked in the sub-tropics (mostly spring, early summer calving) than in the tropics. Usually a single calf is born after a gestation period of about 14 months and nursed for 18 months or more. Twins are rare.\nLike many other long-lived species, dugongs delay breeding in adverse environmental conditions. Marked fluctuations have been documented in the pregnancy rate, the age at first reproduction in both sexes (7 -17 years in females), the body size at which sexual maturity is reached (see Marsh and Kwan 2008) and the incidence of reproductively active males (Marsh 1995, Burgess et al. 2012). These fluctuations apparently track major changes in the status of the dugong's food supply, which is subject to episodic (a series of separate events) diebacks that are often associated with extreme climatic events, including exceptionally high rainfall and cyclones (Johannes and MacFarlane 1991; Preen and Marsh 1995; Poiner and Peterkin 1996; Marsh and Kwan 2008; Marsh et al. 2011a; Sobtzick et al. 2012). This life history limits the reproductive potential of dugongs and high survival of immature animals, especially adults, is required for population growth or stability (Marsh et al. 2011a).\n\r\n \r\n \r\n \r\n \r\n Feeding\r\n \r\n \r\n Top\r\n \r\n \r\n \r\n Dugongs employ two different feeding modes: excavating (feeding on both the aboveground and belowground parts of plants by disturbing the sediment, which leaves distinctive serpentine tracks in the sediment) and cropping (feeding on the above ground parts only which leaves much less evidence). Dugongs mostly use excavating when feeding on seagrasses with accessible rhizomes; cropping when feeding on other plants. Although several researchers have concluded that dugongs preferentially feed on pioneer genera such as Halophila and Halodule, Marsh and colleagues' (2011a) meta-analysis indicates that within their relatively specialised habitats of intertidal and subtidal tropical and subtropical seagrass meadows, dugongs are capable of exploiting a relatively wide diet including most species of seagrass, macro-invertebrates (Anderson 1989; Preen 1995) and algae (Marsh et al. 1982). Sheppard and colleagues (2010) also found a weak association between dugongs and seagrass species, and a preference of dugongs for high-energy (nitrogen rich) foods.\n\r\n \r\n \r\n \r\n \r\n Movement Patterns\r\n \r\n \r\n Top\r\n \r\n \r\n \r\n Dugongs fitted with radio and satellite/GPS transmitters demonstrate that their home ranges can overlap and that most individuals maintain a close association with inshore seagrass beds (Sheppard et al. 2006; Gredzens et al. 2014). Scales of movement are individualistic and heterogeneous. Some tracked dugongs have moved < 15 km (micro-scale), others 15–100 km (mesoscale), others 100–560 km (macroscale; Sheppard et al. 2006). Males, females, and females with calves all make large-scale movements; tracked dugongs that failed to move > 15 km also encompass these age and sex categories. The travel of the tracked dugongs that moved > 15 km was rapid and directed.\nA pedigree analysis of 1002 dugongs across four locations in southern Queensland (Moreton Bay, the Great Sandy Straits, Hervey Bay and Shoalwater Bay) detected recent movement of the parent or offspring; approximately 30% of assigned parents had at least one offspring in a different location (Cope et al. 2015). Cope and colleagues (2015) also found that male dugongs move between populations more frequently than females at the four locations.\nSheppard and colleagues (2006) proposed that dugongs have evolved to cope with unpredictable and patchy seagrass abundance (e.g. Preen and Marsh 1995; Marsh and Kwan 2008; McKenzie et al. 2012) by making direct moves between sites of significant seagrass habitat (Gales et al. 2004; Sheppard et al. 2006). Use of these areas may be learned by calves from their mothers (Marsh et al. 2011a).\nAt the high latitude limits to their range, such as Moreton Bay (Preen 1992) and Hervey Bay in southeast Queensland (Sheppard et al. 2006) and Shark Bay in Western Australia (Holley et al. 2006), dugongs exhibit seasonal movements, a behavioural thermoregulatory response to winter water temperatures (Marsh et al. 2011a). Such movements have similarities to those of the Florida manatee (Deutsch et al. 2003).\n\r\n \r\n \r\n \r\n \r\n Survey Guidelines\r\n \r\n \r\n Top\r\n \r\n \r\n \r\n Determining the presence/absence of dugongs is difficult because they mostly live in turbid water, do not have a dorsal fin and tend to surface discreetly, often with only their

nostrils breaking the surface. Thus false-negatives (assuming dugongs are not present when they are there) are likely.\nAerial surveys\nThe dugong aerial survey methodology has been designed to inform regional planning and management at vast spatial scales (tens of thousands of square kilometres). The absence of dugongs from an area should not be inferred from aerial surveys that have not been specifically designed for dugongs. Expert assistance is required to define survey area and survey intensity. Survey design and methodology needs to be customised to address different objectives at finer special scales (tens or hundreds of square kilometres) using advice from experts in dugong surveys and statistics and peer review. Such methodology will almost certainly need refining for a particular location after a pilot study.\nDugong aerial surveys need to be conducted using high-winged aircraft, helicopters or drones flying at heights of < 900' (274 m) and ground speeds of < 100 knots (185 km per hr) and with trained observers. Despite the experimental results of Marsh and Sinclair (1989a), Hodgson (2013, pers comm.) has some unpublished evidence that lower survey heights e.g. 500' (152 m) provide more accurate dugong counts than survey heights of 900' (274 m).\nDugongs can be difficult to identify from the air and flying/sea conditions need to be near perfect. Baseline surveys should also be flown at different seasons and tides and over several years to identify inter- and intra-annual variations in occurrence. Aerial surveys should not be used to estimate the absolute abundance of dugongs and have very limited capacity to detect changes in distribution or abundance unless such changes are very large. Even if changes are detected, they may be due to temporary immigration. Dugong relative abundance and distribution are very sensitive to changes in their seagrass habitat, which tend to have multiple causes.\nMost of the information on dugong distribution and relative abundance in Australia has been inferred from dedicated aerial surveys combined with sophisticated statistical models. Detailed information on dugong aerial survey techniques is presented in Marsh and Sinclair (1989a, 1989b), Pollock and colleagues (2006), and Marsh and colleagues (2002, 2011a). These papers outline methods for correcting for elements of detectability: (a) the probability of animals being close enough to the surface to be available for detection by the observers (availability bias) and (b) the probability of an animal being seen and counted by an observer given that it is available for detection (perception bias). Using location and dive data from nine dugongs in eastern Australia fitted with satellite telemetry units and time-depth recorders (TDRs), Hagihara and colleagues (2014) found that availability for detection differed with water depth. Information on water depth is currently being used to refine availability estimates and subsequent abundance estimates from dugong aerial surveys in northeastern Australia (Sobtzick et al. 2015b).\nHodgson and colleagues (2013) explored the use of unmanned aerial vehicles (UAVs) to facilitate more accurate, human-risk free, and cheaper aerial surveys in Shark Bay, Western Australia. They found that dugong detection was not affected by UAV altitude, and UAV systems are not as limited by sea state conditions as sightings from manned surveys.\nCapture-mark-release and telemetry techniques\nCapture-mark-release techniques for dugongs are much more labour-intensive than aerial surveys. They require at least two sampling occasions and a relatively high proportion of identifiable individuals, rendering the approach logistically infeasible for most subpopulations of more than approximately 1000 dugongs. The assumptions are rigorous but if they can be met, capture-mark-release has many advantages for small subpopulations occupying defined areas where the risk of double-counting during aerial surveys is considerable. Beck and Clark (2012) summarise methods for identifying individual dugongs including: (1) marks and tags applied at capture such as Passive Integrated Transponder (PIT) tags or titanium turtle tags; acoustic and GPS/satellite telemetry; and (2) genetic analysis of tissues. Capture-mark-release and telemetry have significant initial establishment costs for vessels and equipment along with training of personnel. The target dugongs generally have to be captured using a rodeo technique (Lanyon et al. 2006) with associated human health and safety and environmental requirements. Such approaches can provide baseline information to assess impacts but generally need to be carried out by experts over several years. A recent study found relatively good correspondence between dugong presence and movement data collected by satellite and acoustic telemetry (Zeh et al. 2015), demonstrating that acoustic tracking may be a cost-effective tool for monitoring dugongs at locations with established acoustic arrays.\n\r\n \r\n \r\n \r\n \r\n Threats\r\n \r\n \r\n Top\r\n \r\n \r\n \r\n The Action Plan for Australian Mammals 2012 (Woinarski et al. 2014) identified the following threats to dugongs in Australian waters.\nThreat factor\r\nConsequence rating\r\nExtent over which threat may operate\r\nEvidence base\r\nHabitat degradation including coastal development, port expansion and aquaculture\r\nmoderate-severe\r\nmoderate\r\nseagrass loss leads to reduced food resources and condition, delayed reproduction or starvation, or temporary immigration from affected regions (Marsh et al. 2002, 2011a; Haynes et al. 2005)\r\nPollution\r\nmoderate-severe\r\nminor-moderate\r\nsome contamination with heavy metals and other pollutants (Marsh et al. 2011a)\r\nEntanglement and incidental bycatch in fisheries gear\r\nmoderate\r\nminor-moderate\r\nincidental net entanglement and deaths are a major cause of

regional population decline, evident in the severe decline along the urban coast of Queensland (Marsh et al. 2005)\r\nEntanglement in shark netting\r\nmoderate\r\nminor\r\nincidental net entanglement and deaths are a major cause of regional population decline, evident in the severe decline along the urban coast of Queensland (Marsh et al. 2005)\r\nIndigenous hunting\r\nminor- moderate\r\nminor–moderate (most hunting is within 30 km of communities)\r\npopulation modelling indicated Indigenous hunting was not sustainable in Cape York and Torres Strait (Marsh et al. 2004; Heinsohn et al. 2004); however, this evaluation was based on flawed estimates of absolute abundance. The time series of aerial surveys has not detected a decline, probably because of the high proportion of high-density dugong habitat that is not accessible to hunters (Grayson 2011; Marsh et al. 2011b).\r\nVessel strike\r\nmoderate\r\nminor (but potentially increasing to moderate)\r\nincreased vessel movements and vessel strike can cause disturbance, stress, or disrupt behaviour (Marsh et al. 2002; Haynes et al. 2005)\r\nAnthropogenic noise and acoustic disturbance\r\nmoderate\r\nminor (but potentially increasing to moderate)\r\nincreasing anthropogenic noise can cause disturbance, stress, or disrupt behaviour (Marsh et al. 2002; Haynes et al. 2005)\r\nClimate variability and change\r\nminor to moderate\r\nminor to moderate\r\naltered coastal environmental conditions and projected increases in severe cyclones and flood events could affect both Dugongs and their essential seagrass habitats (Marsh et al. 2011a)\r\n\r\n \r\n \r\n \r\n Threat Abatement and Recovery\r\n \r\n \r\n Top\r\n \r\n \r\n \r\n Conservation objectives for dugongs in Australian waters identified by The Action Plan for Australian Mammals 2012 (Woinarski et al. 2014) are:\nManage threats to ensure recovery in regions where decline has been reported, and maintain or increase abundance in other regions.\r\nManage human activities to ensure continued use of important habitats.\r\nThe Action Plan for Australian Mammals 2012 (Woinarski et al. 2014) also identified the following information needs:\nTheme\r\nSpecific actions\r\nPriority\r\nSurvey to better define distribution\r\ncontinue, co-ordinate and extend aerial surveys throughout the Australian range and adjacent regions to better define the distribution, abundance, movements and habitat use\r\nmedium-high\r\nAssess impacts of threats on species \r\nuse spatial risk assessment to assess potential for increasing rates of net entanglements and vessel strike injury to affect population recovery and maintenance\r\nhigh\r\nuse spatial risk assessment to assess impacts of increasing anthropogenic noise, vessel movements, port expansion, coastal development and pollution on the health status of dugongs and use of important habitats\r\nmedium-high\r\nassess potential for climate change and coastal development and associated runoff to affect seagrass beds and food resources\r\nmedium\r\nEstablish or enhance monitoring program\r\nextend long-term monitoring across northern Australia, to better quantify abundance, population trends, movements and population structure\r\nhigh\r\nAssess relative effectiveness of threat mitigation options \r\nassess the effectiveness of Dugong Protection Areas and zoning in the GBRMP for reducing human impacts, and assess the effectiveness of sustainable Dugong hunting management plan\r\nmedium-high\r\nundertake social and behavioural research to determine how to improve compliance with vessel speed limits and go-slow areas for Dugongs\r\nmedium\r\nAssess habitat requirements \r\nexpand research to better define feeding and breeding areas, movement corridors and other habitat requirements\r\nlow-medium\r\nmap seagrass distribution and biomass (Saalfeld and Marsh 2004)\r\nlow-medium\r\nAssess diet, life history\r\nimprove understanding of food selection and seasonality and the roles of Dugongs in seagrass ecosystems, and improve understanding of potential changes in life history parameters resulting from increased anthropogenic impacts on Dugongs and seagrasses\r\nlow-medium\r\nUndertake research to develop new or enhance existing management mechanisms \r\nimprove understanding of population genetics to better define population structure and management units (Blair et al. 2014)\r\nmedium-high\r\nenhance remote survey techniques and analyses and employ satellite tracking to monitor movements, abundance and habitat use\r\nmedium\r\n\r\n \r\n \r\n \r\n Mitigation Approach\r\n \r\n \r\n Top\r\n \r\n \r\n \r\n Mitigation approaches for dugongs in Australian waters identified by The Action Plan for Australian Mammals 2012 (Woinarski et al. 2014) are:\nTheme\r\nSpecific actions\r\nPriority\r\nActive mitigation of threats \r\nensure high levels of protection in important habitats\r\nhigh\r\nreduce incidental catch in nets from shark exclusion devices and fisheries\r\nhigh\r\nmanage Indigenous hunt to ensure it is sustainable\r\nhigh\r\nimprove national coordinated planning and management of coastal development, port expansion, and vessel movements to reduce risks to Dugongs and their seagrass habitats\r\nhigh\r\nCommunity engagement\r\nenhance education programs to inform fishers and other users of marine environments of best practice codes of conduct for avoiding dugong injury or death, minimising seagrass loss, and ensuring future hunting is sustainable and that the cultural motivations for traditional hunting are understood by the wider community\r\nmedium-high\r\n\r\n \r\n \r\n \r\n Marine Bioregional Plans\r\n \r\n \r\n Top\r\n \r\n \r\n \r\n Marine bioregional plans have been developed for four of Australia's marine

regions - South-west, North-west, North and Temperate East. Marine Bioregional Plans will help improve the way decisions are made under the EPBC Act, particularly in relation to the protection of marine biodiversity and the sustainable use of our oceans and their resources by our marine-based industries. Marine Bioregional Plans improve our understanding of Australia's oceans by presenting a consolidated picture of the biophysical characteristics and diversity of marine life. They describe the marine environment and conservation values of each marine region, set out broad biodiversity objectives, identify regional priorities and outline strategies and actions to address these priorities. Click here for more information about marine bioregional plans.\nThe Dugong has been identified as a conservation value in the North (DSEWPaC 2012x) and North-west (DSEWPaC 2012y) marine regions. See Schedule 2 of the North-west Marine Bioregional Plan (DSEWPaC 2012y) for regional advice. Maps of Biologically Important Areas have been developed for dugong in the North-west (DSEWPaC 2012y) Marine Region and may provide additional relevant information. Go to the conservation values atlas to view the locations of these Biologically Important Areas. The \"species group report card - dugongs\" for the North (DSEWPaC 2012x) and North-west (DSEWPaC 2012y) marine regions provide additional information.\n\r\n \r\n \r\n\r\n\r\n\r\n \r\n \r\n Species Profile References\r\n \r\n \r\n Top\r\n \r\n \r\n \r\n \r\n Allen, S., H. Marsh & A. Hodgson (2004). Occurrence and Conservation of the Dugong (Sirenia: Dugongidae) in New South Wales. Proceedings of the Linnean Society of New South Wales. 125:211-216.\r\n \r\n Anderson, P.K. (1989). Deliberate foraging on macro-invertebrates by Dugongs. National Geographic Research. 5:4-6.\r\n \r\n Anderson, P.K. (1997). Shark Bay dugongs in summer. I: Lek mating. Behaviour. 134(5-6):433-462.\r\n \r\n Anderson, P.K. (2002). 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