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The Indo-Pacific Humpback Dolphin, *Sousa chinensis* (Osbeck, 1765), in Australian Waters: A Summary of Current Knowledge

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Abstract

Indo-Pacific humpback dolphins (*Sousa chinensis*) occur in the coastal northern waters of Australia from approximately the Queensland – New South Wales border (31°27´S, 152°55´E) to Ningaloo Reef (22°17´S, 113°48´E) in Western Australia. Due to their coastal, estuarine distribution, Indo-Pacific humpback dolphins are particularly vulnerable to several human activities in and adjacent to coastal areas. At present, it is not possible to assess the population status of humpback dolphins in Australian waters because information on their biology and ecology is limited. The sparse data available for selected areas indicate that humpback dolphins occur in discrete, geographically localized populations and are susceptible to anthropogenic threats (e.g., incidental captures in gill nets). The conservation of humpback dolphins in Australia's northern coastline will depend on the maintenance of high-quality habitat in areas that are already under some protection, the identification of critical habitats, the inclusion of these habitats in the rezoning initiatives of protected areas, and the reduction of conservation threats. Precautionary measures should be adopted while further work on abundance estimates, population structure, and levels of human-caused mortality are carried out on a wider scale in Australian waters.

Key Words: Indo-Pacific humpback dolphin, *Sousa chinensis*, Australia, distribution, threats, conservation, management, habitat degradation, incidental take

Introduction

Given their close proximity to human concentrations, many coastal cetaceans are especially vulnerable to human activities in and adjacent to the coastal zone. The conservation of these species often requires the mitigation and regulation of a variety of threats, including incidental catches in gill nets, shark nets set for bather protection, habitat degradation, and pollution (Perrin, 1999; Perrin et al., 1996).

Indo-Pacific humpback dolphins (*Sousa chinensis*) occur in the coastal waters of the Indo-pacific region from the eastern shores of South Africa to the northern coast of Australia. Throughout their range, the ecology and status of Indo-Pacific humpback dolphins remains poorly known, with the exception of populations off South Africa and Hong Kong where the animals have been relatively well studied (Jefferson & Karczmarski, 2001). The Indo-Pacific region is under increasing pressure from expanding human populations, especially in coastal zones, and the protection of high-quality habitat for Indo-Pacific humpback dolphins appears uncertain in most countries throughout their range (Perrin et al., 1996).

In Australian waters, humpback dolphins occur mostly in the coastal northern regions, from approximately the Queensland – New South Wales border (31°27´S, 152°55´E) in the east to Exmouth Gulf (21°56´S, 114°07´E) in the west (Corkeron, Morissette, Porter, & Marsh, 1997) (Figure 1). Despite this wide distribution, information on the ecology and population status of this species in Australian waters is very limited. *The Action Plan for Australian Cetaceans* (written in 1994) listed Indo-Pacific humpback dolphins as "insufficiently known," a category that may include "endangered" or "vulnerable" species by virtue of their inshore distribution and close proximity to potentially detrimental human activities (Bannister et al., 1996).

This paper reviews the current knowledge on Indo-Pacific humpback dolphins in Australian waters and the relevance of this information to their conservation. Much research is needed in Australia before the status of humpback dolphins can be assessed. At present, information is limited and restricted to small areas, but suggests that populations are small and localized, and are under pressure by human activities in coastal areas.

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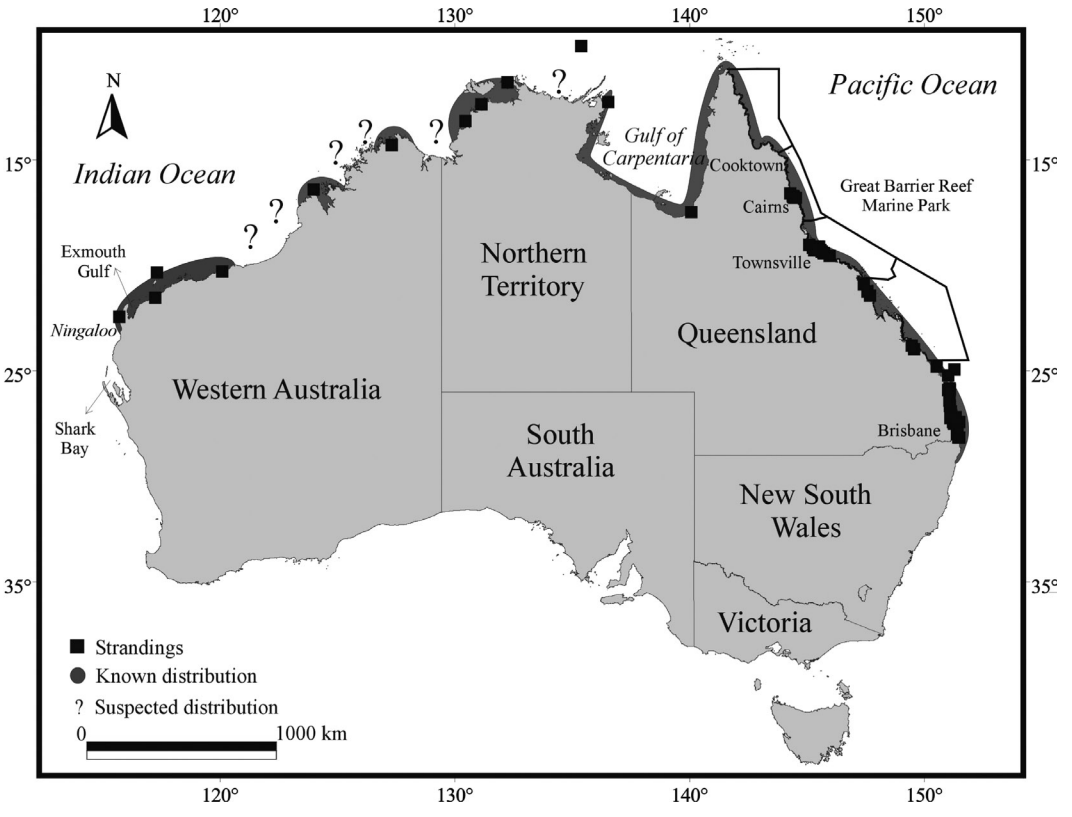

Figure 1. Distribution of Indo-Pacific humpback dolphins in Australian waters. The known distribution is based on stranding records and published literature (Corkeron et al., 1997; Jefferson & Karczmarski, 2001; Preen et al., 1995; Ross et al., 1994).

Review of Current Knowledge on *Sousa chinensis* in Australian Waters

General Characteristics

Indo-Pacific humpback dolphins are characterised by a robust and medium-sized body, up to 2.8 m in length (Ross et al., 1994). In Australian waters, known sizes for humpback dolphins range between 100 and 270 cm (n=44), with males (n=19) and females (n=13) reaching lengths up to 262 cm and 260 cm, respectively (Appendix 1). The shape and size of the dorsal fin are typical of the animals in the eastern portion of their range. The dorsal fin is short, slightly recurved and triangular in shape, and the dorsal "hump," typical of animals in the western portion of their range, is not present on Australian animals (Jefferson & Karczmarski, 2001; Ross et al., 1994). Coloration is uniformly grey, with flanks shading to off-white and spotting towards the ventral surface. Changes in colouration appear to be age related. Younger animals are dark grey, and the dorsal fin, rostrum, and melon whiten with age (Ross et al., 1994).

Distribution and Stock Structure

Stranding and specimen records of Indo-Pacific humpback dolphins held by museums and wildlife services in Australia (Figure 1, Appendix) support the spatial distribution reported by Corkeron et al. (1997). Sightings which extend this range have been reported in Ningaloo Reef and Shark Bay (Preen, 1995) (Figure 1). Sightings in the Ningaloo Reef region appear to be common (G. Ross, Environmental Protection Agency, pers. comm., 2002) whereas in Shark Bay, the site of a long-term study of inshore dolphins, sightings are rare (P. Berggren, University of Stockholm, pers. comm., 2002). There are few records between the Gulf of Carpentaria in the north and Shark Bay on the west coast. This absence probably reflects the remoteness and lack of research effort in most of this region, rather than a real hiatus in the distribution.

Information on the population structure of humpback dolphins in Australian waters is sparse. Preliminary results support a model of discrete local populations (Hale et al., 1998). This

corresponds with the movement data of individual dolphins in Hong Kong and the Pearl River Estuary (Hung & Jefferson, 2004; Jefferson, 2000). Molecular studies are needed to elucidate population structure in Australian populations.

Habitat
Along the east coast of Queensland, the western section of Moreton Bay and the lower reaches of the Brisbane River have been identified as key habitats for this species (Hale et al., 1998), with animals occurring in waters less than 10 m deep and up to 6 km offshore (Corkeron, 1990). Aerial survey sightings throughout the Great Barrier Reef region support this habitat preference, with most animals occurring close to the coast and in shallow waters. Sightings up to 55.6 km from the coast have been recorded in the northern Great Barrier Reef region, however, probably due to the physiography of the coastlines and continental shelves in this area (Corkeron et al., 1997).

Abundance
The only available abundance estimate of humpback dolphins in Australian waters is for Moreton Bay (27°17´S, 153°15´E) (with an area of approximately 1,315 km^2) in southeast Queensland. These photo-identification mark-recapture estimates, for two overlapping time periods, were 163 (1984-1986, 95% confidence intervals = 108-251) and 119 individuals (1985-1987, 95% confidence intervals = 81-166). Based on the substantial decline of raw sighting counts of humpback dolphins during aerial surveys of the Great Barrier Reef Region between the late 1980s and mid-1990s, populations are thought to be probably declining in Australian waters (Corkeron et al., 1997).

Feeding Habits
In Moreton Bay, humpback dolphins feed in association with shrimp trawlers (Corkeron, 1990). Stomach samples from two animals caught in shark nets in the Townsville area contained fish remains and one also had crustacean remains (Heinsohn, 1979; Heinsohn et al., 1980); however, none of the food items was identified to species.

Life History
There are no cross-sectional studies on the life history of humpback dolphins in Australian waters, mainly due to the lack of fresh carcasses; however, up to 20 dentinal growth layer groups were counted in the teeth of seven dolphins from northeastern Australia (Heinsohn, 1979) (Appendix). "Amity," a female humpback dolphin wild caught in 1968, and still held in captivity at Sea World Surfers Paradise, Queensland, is at least 38 years of age (W. Blanshard, Sea World, pers. comm., 2002).

Captivity
At least eight humpback dolphins have been held in oceanaria in Queensland (Sea World) and New South Wales (Port Macquarie and Tweed Heads) (Ross et al., 1994). No births have occurred. Capture of free ranging dolphins for purposes of public displays is no longer permitted under Australian law.

Threats to Populations

Habitat Degradation and Loss
Due to their coastal and estuarine distribution, Indo-Pacific humpback dolphins are particularly vulnerable to human activities in and adjacent to coastal areas. Most of Australia's northern coastline is relatively unpopulated by people; however, the concentration and rapid population growth along the urban coast of Queensland, extending from Cooktown to Brisbane, has increased pressure on coastal resources. The potential impact of the urban area along the Queensland coast is of concern to the future of humpback dolphins in Australian waters. The maintenance of high-quality habitat will be a major challenge for the conservation of humpback dolphins found along the coast of Queensland.

Overfishing
Depletion of local food resources is likely to negatively affect coastal populations of marine mammals over the next century (DeMaster et al., 2001). Most of the Australian fisheries catch is taken close to the coast in waters less than 50 m deep (Resource Assessment Commission, 1993), and commercial fisheries are at or near full exploitation (Kearney et al., 1996). In addition, bottom trawling, widely recognized as a major threat to the structure and functioning of coastal ecosystems (Blaber et al., 2000; Turner et al., 1999), is the main fishing method used to catch prawns in Australia, and it represents one of the major extractive activities permitted within parts of the large, multiple-use marine parks in the humpback dolphins' range in Australia (Gribble & Robertson, 1998; Pitcher et al., 2000). Trawling activities can also influence the behavior, social structure, and habitat use of coastal dolphins, leading to the existence of separate communities with different ecological needs, and posing challenges for management (Chilvers & Corkeron, 2001).

Directed Takes
There is no evidence of direct killing of humpback dolphins in Australian waters. Australian law

prohibits direct killing of any cetacean species in Australian waters. Illegal fishing operations are known to occur within the Australian Fishing Zone, and there is anecdotal evidence of foreign fishing vessels with dolphin meat on board. Whether these kills are the result of a directed fishery or incidental take is not known.

Incidental Takes

Human-related mortality of humpback dolphins in Australian waters is thought to be largely attributable to inshore gill nets set across creeks, rivers, and shallow estuaries for barramundi (*Lates calcarifer*) (Bloch, 1970) and threadfin salmon (*Polynemus sheridani*) (Macleay, 1884) and *Eleutheronema tetradactylum* (Shaw, 1804) (Hale, 1997); and to shark nets set for bather protection (Paterson, 1990); however, there are no estimates of the magnitude of these indirect takes or of their trends over time.

Fisheries observers in gill net vessels operating in northern Australian waters between 1981-1985 reported one humpback dolphin among the cetacean species incidentally taken (Harwood & Hembree, 1987). Between 1967 and 1992 at least 544 cetaceans were caught in shark nets set for bather protection along the Queensland coast (Paterson, 1990). A recent analysis of the effects of this program on nontarget species (Gribble et al., 1998) estimated that between 1962 and 1995, an average of 19.2 dolphins of all species were caught per year, decreasing to 12.5 animals per year from 1992-1995. The species composition for most dolphin catches prior to 1992 is unknown. Eleven of 18 confirmed humpback dolphins collected from shark nets along the Queensland coast between 1968-2001 were caught in nets off Cairns and Townsville, northern Queensland (Haines & Limpus, 2002; Heinsohn, 1979). Although captures of humpback dolphins at a state level appear to be small, most captures occurred in localized areas and could be expected to have a detrimental effect on local humpback dolphin populations.

Net attendance rules and gear modifications have been introduced in the inshore gill net fishery to reduce the incidental take of nontarget species (e.g., turtles, dugongs, whales, and dolphins), but enforcement is lacking in remote areas (Hale, 1997). Additionally, the relevant authority is currently working on a rezoning program of the Great Barrier Reef Marine Park (east Queensland) that is expected to increase the "no take" areas by 30% of the entire Great Barrier Reef Region (Great Barrier Reef Marine Park Authority, 2003). In addition, trawling effort within the Great Barrier Reef Marine Park has been substantially reduced through the East Coast Trawl Management Plan (Huber, 2003).

The Queensland Shark Control Program implemented strategies to reduce the impact of the program on non-target species, including the use of acoustic alarms, mixed use of nets and drumlines, overall reduction in the number of nets, and establishment of mammal rescue squads (Department of Primary Industries, 2001). There is no evidence that any of these measures have provided any benefit to the conservation of humpback dolphins.

Pollution

The transport of agricultural and urban-sourced pollutants into coastal waters of the Queensland coast has been identified as a major threat to the coastal water quality in the region (Haynes & Michalek-Wagner, 2000). High concentrations of heavy metals and persistent organic compounds containing halogens have damaging effects on marine mammals (Tanabe, 2002; Tanabe et al., 1994). A range of organohalogen pollutants (natural and anthropogenic) were detected in the blubber of four bottlenose dolphins (*Tursiops* spp.), one common dolphin (*Delphinus* spp.), and seven dugongs (*Dugong dugon*) from north-east Queensland (Vetter et al., 2001), but no data are available for humpback dolphins.

Vessel Traffic

Acoustic studies on humpback dolphins in Moreton Bay, southeast Queensland, showed that the dolphins' acoustic communication and group cohesion are affected by boat traffic and noise (Van Parijs & Corkeron, 2001). In Algoa Bay, South Africa, humpback dolphins exhibited behavioral changes associated with vessels following them (Karczmarski et al., 1997), and inshore powerboat traffic has been identified as a serious disturbance in this area (Karczmarski et al., 1998). Post mortem investigation on stranded humpback dolphins from Hong Kong suggests that death may have been caused by boat strikes (Parsons & Jefferson, 2000). In Queensland, the number of recreational vessels (motor and sail) registered has increased from 102,853 in 1990 to more than 150,500 in 2000, and the numbers are increasing by at least 10% per year (EPA, 1999, 2000).

Wildlife Tourism

Wildlife tourism may provide conservation benefits (e.g., environmental education), but it also can have negative effects on free-ranging animals (Constantine, 2001; Lusseau, 2003). Tourism based on free-ranging dolphins, including boat-based tours, shore-based observation, swim interactions, and hand-feeding, is one of the most popular icons for marine tourism along Australia's coastline (Birtles et al., 2001).

In Australia, observations and interactions with humpback dolphins probably occur only in Queensland. Four boat-based operators promote dedicated dolphin-watching trips, including humpback dolphins; two are in Moreton Bay Marine Park and another two are in Hervey Bay Marine Park, southeast Queensland (Birtles et al., 2001). Swimming with and hand-feeding of humpback dolphins occurs at Tin Can Bay, southeast Queensland, where the activity developed from a relatively unknown local practice to a growing tourist attraction receiving up to 300 visitors per day. The activity was officially approved by the State Minister of the Environment in 1999, when policy changes limited the amount of fish fed to the dolphins, reduced the total number of contact hours, increased education and interpretation materials, and ensured a volunteer or an interpretation officer was always present during times of interaction (Mayes, 1999). Unfortunately, the monitoring of whether these guidelines are obeyed remains poor.

Although the level of wildlife tourism involving humpback dolphins in Australian waters is low, it is expected to increase. Precautionary measures are needed to ensure that the continued development expected in this industry will not adversely affect humpback populations in Australian waters. In addition, at the 52nd meeting of the International Whaling Commission in Adelaide, the Scientific Sub-Committee on Whale Watching recommended that hand-feeding programs of wild cetaceans be prohibited (IWC, 2001).

Conservation Status

At present, the population status of humpback dolphins in Australian waters cannot be assessed due to the lack of biological data. The limited information available suggests that populations are small, localized, and may be declining (Corkeron et al., 1997; Hale et al., 1998).

Extremely large (thousands of km^2) multiple-use marine parks in Western Australia, the Northern Territory, and Queensland cover a substantial portion of the known and presumed habitat of humpback dolphins in Australian waters. These parks include the Shark Bay and Ningaloo Reef Marine Park (Western Australia); Cobourg Marine Park (Northern Territory); and the Great Barrier Reef, Hervey Bay, and Moreton Bay Marine Parks (Queensland). Commercial uses and extractive industries have a significant role in these parks, and only a small proportion of these areas have been designated as no-take zones (areas that allow access but prohibit all extractive activities) and preservation zones (areas that prohibit all forms of extractive activities). The conservation success of no-take zones within large multiple-use marine protected areas is likely to be low for highly mobile marine mammals (Preen, 1998), unless they coincide with areas which consistently support high numbers of animals (Marsh, 2000). The understanding of the distribution and relative abundance of coastal dolphins needs to improve before effective conservation initiatives can be designed to ensure the persistence of viable populations of humpback dolphins in Australian waters.

Precautionary measures should be adopted while further work on abundance estimates, population structure, and levels of human-caused mortality is carried out on a wider scale in Australian waters. In this context, we consider it important that the agencies responsible for environmental management take a more strategic, proactive, comprehensive, and coordinated approach to marine mammal research and management than they have attempted to date (Preen, 1998). A realistic research plan with defined mechanisms for securing the future of long-term research and monitoring is urgently needed if Australia is to meet its national and international obligations with regard to the conservation of humpback dolphins.

Australia is one of the few developed nations throughout the Indo-Pacific, and it has a relatively extensive and unpopulated tropical coast. Thus, Australia has the opportunity and responsibility to develop research and conservation initiatives that will contribute to the conservation and long-term survival of Indo-Pacific humpback dolphins.

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Appendix. List of Indo-Pacific humpback dolphin strandings and museum specimen records in Australia; n/a = not available; ? = unknown.

Specimen no.	Date[1]	Location	State[2]	Latitude S	Longitude E	Sex	Total length (cm)	Estimated age (yrs)[3]	Institution[4]	Reference[5]
M12691	Jan 1962	Tweed Heads Dolphinarium	NSW	?	?	?	?	?	AM	A
n/a	Aug 1948	Yirrkala	NT	12° 15´	136° 54´	?	?	?	?	B
NTM U.660	28 Nov 1983	Arafura Sea	NT	09° 36´	135° 37´	M	161	?	MAGNT	C
28137	23 March 1984	?	NT	?	?	M	?	?	WAM	D
NTM U.254	23 Nov 1985	Casuarina Beach	NT	12° 21´	130° 52´	M	208	?	MAGNT	E
NTM U.528	28 Oct 1988	Channel Point	NT	13° 10´	130° 07´	?	?	?	MAGNT	E
NTM U.5150	3 March 1996	Knocker Bay	NT	11° 20´	132° 07´	?	200	?	MAGNT	E
NTM U.5149	28 Oct 2000	Lee Point Beach	NT	12° 21´	130° 53´	F	210	?	MAGNT	E
JM5355	?	?	QLD	?	?	?	?	?	QM	F,G
JM6434	?	?	QLD	?	?	?	?	?	QM	G, H, I
J7443	31 Oct 1949	Moreton Bay	QLD	27° 26´	153° 14´	?	?	?	QM	G, H, I
JM4701	09 Oct 1969	Picnic Bay	QLD	19° 11´	146° 50´	M	238	20+	QM	G, H, I
JM4703	04 March 1970	Horseshoe Bay	QLD	19° 07´	146° 51´	M	177	3	QM	H
JM4710	04 Feb 1971	Horseshoe Bay	QLD	19° 07´	146° 51´	M	143	1	QM	F,G
n/a	25 May 1971	Kissing Point	QLD	19° 14´	146° 48´	M	151.0	1	JCU	G, H, I
J21718	14 Oct 1971	North Stradbroke Island	QLD	27° 35´	153° 27´	?	?	?	QM	G, H, I
JM4717	24 Oct 1971	Horseshoe Bay	QLD	19° 07´	146° 51´	M	195	5	QM	H
JM4728	16 Aug 1975	Florence Bay	QLD	19° 07´	146° 53´	?	?	?	QM	G, H, I
n/a	Jan 1976	Cape Cleveland	QLD	19° 21´	147° 01´	?	?	?	JCU	F, G
JM4731	19 Jan 1976	Horseshoe Bay	QLD	19° 07´	146° 51´	F	?	7	QM	F, G
JM1337	15 April 1976	Gold Coast	QLD	28° 00´	153° 26´	?	?	?	QM	G, H, I
JM2149	24 Feb 1977	Gold Coast	QLD	28° 00´	153° 26´	?	?	?	QM	H
JM4737	05 July 1978	Rowes Bay	QLD	19° 13´	146° 47´	M	229	12	QM	F, G
n/a	08 Oct 1979	Balgal Beach	QLD	19° 02´	146° 25´	M	211.0	?	JCU	G, H
JM4377	19 April 1983	Moreton Island	QLD	27° 12´	153° 22´	?	?	?	QM	G
JM4738	30 July 1984	Rowes Bay	QLD	19° 13´	146° 47´	?	?	?	QM	G
W534	05 Aug 1984	Bribie Island	QLD	27° 06´	153° 10´	M	260	?	QPWS	G
W536	30 Aug 1984	Rowes Bay	QLD	19° 16´	146° 49´	?	236	?	QPWS	G, H
W543	23 June 1985	Saunders Beach	QLD	19° 17´	146° 39´	M	227	?	QPWS	G
JM5333	27 Sept 1985	Adder Rock, Pt Lookout, N. Strady	QLD	27° 26´	153° 32´	?	?	?	QM	G
W552	02 Sept 1986	Rowes Bay Beach	QLD	19° 14´	146° 47´	M	230	?	QPWS	G

Appendix (cont.)

Specimen no.	Date[1]	Location	State[2]	Latitude S	Longitude E	Sex	Total length (cm)	Estimated age (yrs)[3]	Institution[4]	Reference[5]
W466	22 Sept 1986	Balgal Beach	QLD	19° 02´	146° 25´	?	247	?	QPWS	G
W576	01 Oct 1988	The Spit	QLD	28° 00´	153° 26´	F	260	?	QPWS	G, H
W577	03 Oct 1988	Saunders Beach	QLD	19° 11´	146° 40´	M	175	?	QPWS	G, H
JM7678	22 Jan 1990	Rowes Bay	QLD	19° 13´	146° 47´	?	?	?	QM	G
JM10416	01 March 1994	Ayr	QLD	19° 34´	147° 24´	M	100	?	QM	G
W64	16 Oct 1995	Yorkeys Knob	QLD	16° 48´	145° 43´	?	?	?	QPWS	G
W49	06 Feb 1996	Ball Beach	QLD	20° 54´	149° 01´	M	?	?	QPWS	G
W122	29 June 1996	Ellis Beach	QLD	16° 43´	145° 39´	?	?	?	QPWS	G
W23	06 Aug 1996	Redcliffe	QLD	27° 14´	153° 07´	F	182	?	QPWS	G
W124	11 Aug 1996	Ellis Beach	QLD	16° 43´	145° 39´	?	?	?	QPWS	G
W125	14 Sept 1996	Ellis Beach	QLD	16° 43´	145° 39´	?	?	?	QPWS	G
Q20248	28 Sept 1996	Off Cleveland	QLD	27° 30´	153° 17´	F	226	?	QPWS	G
W41	03 Oct 1996	Mon Repos	QLD	24° 48´	152° 28´	M	260	?	QPWS	G
W405	19 Feb 1997	Coolangatta	QLD	28° 10´	153° 32´	?	?	?	QPWS	G
W817	10 June 1997	Bushland Beach	QLD	19° 10´	146° 35´	F	220	?	QPWS	G
W906	09 July 1997	Norman River, Karumba	QLD	17° 29´	140° 50´	M	262	?	QPWS	G
W865	02 Aug 1997	Orchid Beach	QLD	24° 57´	153° 18´	F	?	?	QPWS	G
W863	21 Aug 1997	Freshwater Point	QLD	21° 26´	149° 18´	?	227	?	QPWS	G
W913	03 Sept 1997	Belinga	QLD	28° 09´	153° 30´	?	150	?	QPWS	G
W 76	10 Dec 1997	Ellis Beach	QLD	16° 43´	145° 40´	?	260	?	QPWS	G
W896	17 Dec 1997	Yorkeys Knob	QLD	16° 48´	145° 48´	F	?	?	QPWS	G
W912	23 Dec 1997	Ocean Beach	QLD	26° 55´	153° 09´	?	206	?	QPWS	G
W1013	28 Jan 1998	Palm Cove	QLD	16° 45´	145° 40´	M	161	?	QPWS	G
W965	24 June 1998	Moon Point	QLD	25° 14´	153° 01´	?	232	?	QPWS	G
W966	28 July 1998	Noosa	QLD	26° 23´	153° 05´	M	?	?	QPWS	G
W975	06 Aug 1998	Rainbow Beach	QLD	25° 54´	153° 06´	?	?	?	QPWS	G
W1108	13 Aug 1998	Maroochydore	QLD	26° 40´	153° 06´	M	?	?	QPWS	G
W992	16 Jan 1999	Oaks Beach	QLD	16° 35´	145° 31´	M	?	?	QPWS	G
W1044	26 May 1999	Rainbow Beach	QLD	25° 54´	153° 05´	?	?	?	QPWS	G
W1111	03 Sept 1999	Bilinga	QLD	27° 55´	153° 26´	M	150	?	QPWS	G
W1106	07 Oct 1999	Rowes Bay	QLD	19° 14´	146° 47´	?	210	?	QPWS	G
W1136	01 Feb 2000	Pallarenda	QLD	19° 12´	146° 47´	F	200	?	QPWS	G
W1150	27 Feb 2000	Haughton River	QLD	19° 25´	147° 05´	F	245	?	QPWS	G

Appendix (cont.)

Specimen no.	Date[1]	Location	State[2]	Latitude S	Longitude E	Sex	Total length (cm)	Estimated age (yrs)[3]	Institution[4]	Reference[5]
W1161	01 March 2000	Townsville	QLD	19° 25´	147° 07´	F	245	?	QPWS	G
W1312	17 May 2000	Rainbow Beach	QLD	25° 50´	153° 04´	?	?	?	QPWS	G
W1187	17 June 2000	Wild Cattle Ck	QLD	23° 58´	151° 24´	?	210	?	QPWS	G
W1198	07 July 2000	Johnstone Beach	QLD	21° 14´	149° 11´	?	?	?	QPWS	G
W1215	12 Aug 2000	Bohle River	QLD	19° 12´	146° 42´	F	235	?	QPWS	G
W1249	26 Sept 2000	Sunrise Beach	QLD	26° 25´	153° 05´	F	240	?	QPWS	G
W1251	28 Sept 2000	Crocodile Ck	QLD	19° 17´	146° 55´	F	247	?	QPWS	G
W1252	01 Oct 2000	Crocodile Ck	QLD	19° 16´	146° 56´	?	270	?	QPWS	G
W1303	02 May 2001	Sunshine Coast	QLD	?	?	?	180	?	QPWS	G
W1328	18 July 2001	The Strand	QLD	19° 15´	146° 49´	F	232	?	QPWS	G
W1341	18 July 2001	Harbor Quoin Island	QLD	23° 49´	151° 17´	M	179	?	QPWS	G
W1349	29 July 2001	Tin Can Bay	QLD	25° 54´	153° 00´	M	?	?	QPWS	H
W1354	05 Sept 2001	Yorkeys Knob	QLD	16° 46´	145° 41´	F	150	?	QPWS	H
1176	?	Port Headland	WA	20° 18´	118° 35´	?	?	?	WAM	D
5452	20 Sept 1962	Onslow	WA	21° 32´	115° 24´	?	?	?	WAM	D
54187	28 Jan 1966	Kalumburu	WA	14° 18´	126° 38´	?	?	?	WAM	D
7683	10 Feb 1968	Monte Bello Islands	WA	20° 20´	115° 30´	?	?	?	WAM	D
7899	23 Aug 1968	Carbaddaman Passage	WA	22° 26´	113° 42´	?	?	?	WAM	D
30948	July 1988	Cape Leveque	WA	16° 24´	122° 55´	?	?	?	WAM	D

[1] The date given refers to the known date of the stranding, the date the carcass was found and reported, or the date the specimen was registered in a particular database.

[2] NSW = New South Wales, NT = Northern Territory, QLD = Queensland, WA = Western Australia

[3] Heinsohn (1979)

[4] WAM = Western Australian Museum, QPWS = Queensland Parks and Wildlife Service, QM = Queensland Museum, MAGNT = Museum and Art Galleries of the Northern Territory, JCU = James Cook University, and AM= Australian Museum. Experienced personnel within these institutions were responsible for species identification and measurements. Data from QPWS corresponds to the strandings database and are not available as specimens in museums.

[5] A = Sandy Ingleby (AM, pers. comm., 2002), B = Johnson (1964), C = Gavin Dally (MAGNT, pers. comm., 2002), D = Norah Cooper (WAM, pers. comm., 2003), E = Chatto & Warneke (2000), F = Paterson (1986), G = Jenny Haynes (QPWS, pers. comm., 2002), H = Heinsohn (1979), I = Paterson (1994)