A BIOLOGICAL REVIEW OF AUSTRALIAN MARINE TURTLES.

6. LEATHERBACK TURTLE, *Dermochelys coriacea* (Vandelli)




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Cover photographs: Clockwise from top left: Nesting female *Dermochelys coriacea*, Wreck Rock beach; *Dermochelys coriacea* hatchling, Mon Repos; Adult female *Dermochelys coriacea* boat-strike fatality, Bribie Island, 1 July 2003; Wreck Rock Beach, the principal *Dermochelys coriacea* nesting beach in Queensland, January 1985.

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

PREFACE

This review of the locally endemic leatherback turtle provides the first comprehensive collation of biological data for the species. While peer reviewed scientific publications are the most significant source of information for the species, there is a large body of additional information available from many other sources within Australia. In particular, I have drawn together data contained in many unpublished reports on file in various government and non-government agencies. In addition, relevant information has been obtained from newspaper reports and from books and journals describing the early exploration and natural history of Australia. The review provides a comprehensive summary of information available up to August 2004.

To provide a more comprehensive summary of available information, previously unpublished data drawn from the Queensland Environmental Protection Agency (EPA) Turtle Conservation Project database have been summarised and included. These data are a collation of the results of private research undertaken by myself since 1968 and turtle research undertaken by EPA staff and trained volunteers within foraging and nesting populations in Queensland and adjacent areas within Australia and neighbouring countries.

My understanding of sea turtle biology has been greatly enhanced through collaborative studies with Dr John Parmenter, Dr Craig Moritz, Dr David Owens and Dr Joan Whittier and their respective post-graduate students.

Many folks have assisted in the preparation of this review both directly and indirectly. I am particularly indebted to the assistance and support that I received from Queensland Parks and Wildlife Service staff, in particular Dr Jeff Miller and Duncan Limpus and others who worked in our field studies: Barry Lyon, David Walters, Valonna Baker, Annette Fleay, Phillip Read, Emma Gyuris, Darryl Reimer, Mark Deacon, Ian Bell, Cathy Gatley and John Meech. Keith Morris, Dr Bob Prince and Kelly Pendoley provided guidance regarding turtles in Western Australia. Dr Mick Guinea, Scott Whiting, Ray Chatto and Dr Rod Kennett assisted with information regarding turtles in the Northern Territory.

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This assistance is gratefully acknowledged.

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A BIOLOGICAL REVIEW OF AUSTRALIAN MARINE TURTLES

LEATHERBACK TURTLE, *Dermochelys coriacea* (Vandelli)

1. THE SPECIES

1.1 TAXONOMY

Leatherback turtle, *Dermochelys coriacea*.

CLASS:	REPTILIA
ORDER:	TESTUDINES
FAMILY:	DERMOCHELYIDAE
SPECIES:	*Dermochelys coriacea* (Vandelli 1761)

There is one extant species for the genus and there are no valid subspecies currently recognised (Pritchard and Trebbau, 1984).

1a. Nesting adult **1b**. Hatchling

Figure 1. *Dermochelys coriacea* from eastern Queensland rookeries.

1.2 GLOBAL DISTRIBUTION

The monospecific genus *Dermochelys* has a worldwide distribution in tropical and temperate oceans (Behler *et al*. 1996). Initial studies indicate that there are genetically discrete breeding populations on a global scale (Dutton *et al*. 1999, 2002). Until it is demonstrated otherwise, it is assumed that the widely separated regional breeding aggregations should be managed as if each was a separate stock.

1.3 IDENTIFICATION

The carapace of *D. coriacea* is without large keratinised scutes and has five distinct longitudinal ridges, not including the carapace margin; there are no claws on the flippers (Cogger, 1992; Limpus, 1992) (Figure 1). The ribs are separate, not being fused with pleural bones to form the bony carapace typical of other marine turtles (Cogger, 1992). *D. coriacea* eggs are billiard-ball sized (average egg diameter = 5.33 cm) and the clutches contain numerous yolkless eggs (Limpus and McLachlan, 1994).

When ashore, the nesting female moves with a breaststroke gait, pushing with all four flippers together and leaving distinctive tracks > 2 metres wide on the beach (Limpus and McLachlan, 1994).

The morphology and anatomy of *D. coriacea* has been described by Wyneken (2001).

2. BIOLOGY OF THE LEATHERBACK TURTLE, *Dermochelys coriacea* (Vandelli), IN AUSTRALIA

Where possible, data are derived from studies of *D. coriacea* in Australia. Where relevant data is not available from these stocks, data are derived from studies on *D. coriacea* stocks elsewhere (Behler *et al*. 1996) or extrapolated from appropriate studies with other turtle species.

2.1 GENETIC CHARACTERISTICS and STOCK IDENTIFICATION

Genetic assessment of the *D. coriacea* breeding stocks on a global scale are demonstrating that the widely separated clusters of nesting aggregations represent independent stocks (management units) (Dutton *et al*. 1999, 2002). For example, the nesting populations of Peninsular Malaysia and Solomon Islands are genetically different and in turn, each is different to the *D. coriacea* nesting population of Pacific Mexico and Costa Rica.

The Australian breeding population(s) has not been included within the regional population genetics analyses. Therefore, the extent to which the small nesting population in Australia is an outlying subpopulation to the larger population(s) in Papua New Guinea, Solomon Islands and West Papua (Limpus, 1997) cannot be assessed at this time.

Until proven otherwise, the conservative approach would be to assume that the regionally isolated eastern Australian and northwest Arnhem Land nesting populations are separate, though small, breeding stocks.

2.2 AUSTRALIAN BREEDING UNITS

2.2.1 ROOKERIES and POPULATION SIZE

No major *D. coriacea* breeding concentrations have been recorded in Australia at any time (Limpus and McLachlan, 1994). Low density nesting has been recorded at a limited number of sites since the discovery of nesting in Australia during the 1970s (Figure 2a). There are two focal areas for *D. coriacea* nesting in Australia:

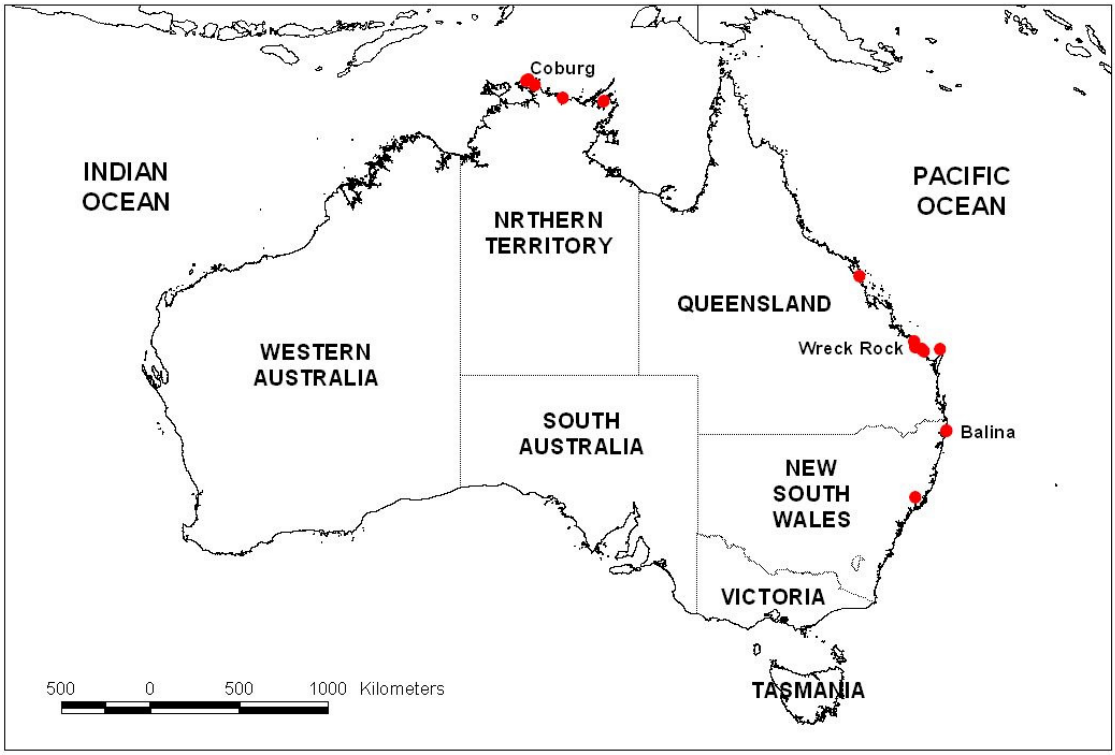
- Wreck Rock Beaches and Rules Beach, southern Queensland.
- Coburg Peninsula and Arnhem Land, Northern Territory.

Queensland

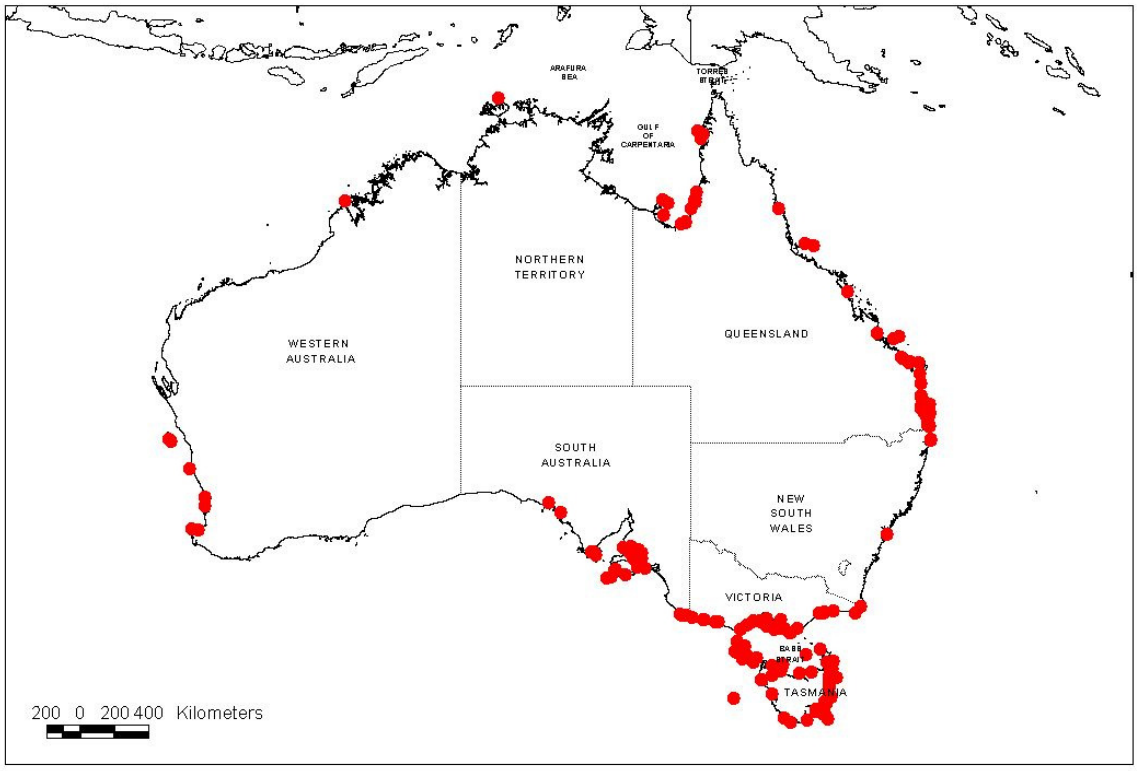
Sporadic nesting by 0–3 females per year were recorded on the southern Queensland coast between northern Hervey Bay (Bundaberg) and Roundhill Head (28 nesting attempts recorded from the area since 1968) in the late 1970's and early 1980's (Limpus and McLachlan, 1979, 1994; Limpus *et al*. 1984). A single nesting has been recorded from Mackay in central Queensland.

The most frequently used nesting beaches for this species in Queensland, Wreck Rock (Figure 3) and Rules Beach, are not protected habitats.

There has been a progressive decline in breeding frequency for *D. coriacea* in eastern Australia from low-density, annual nesting during 1973–1983 to the current situation where nesting is very rare. The last recorded nesting on the Hervey Bay to Roundhill Head beaches was in February 1996 (EPA Queensland Turtle Conservation Project).

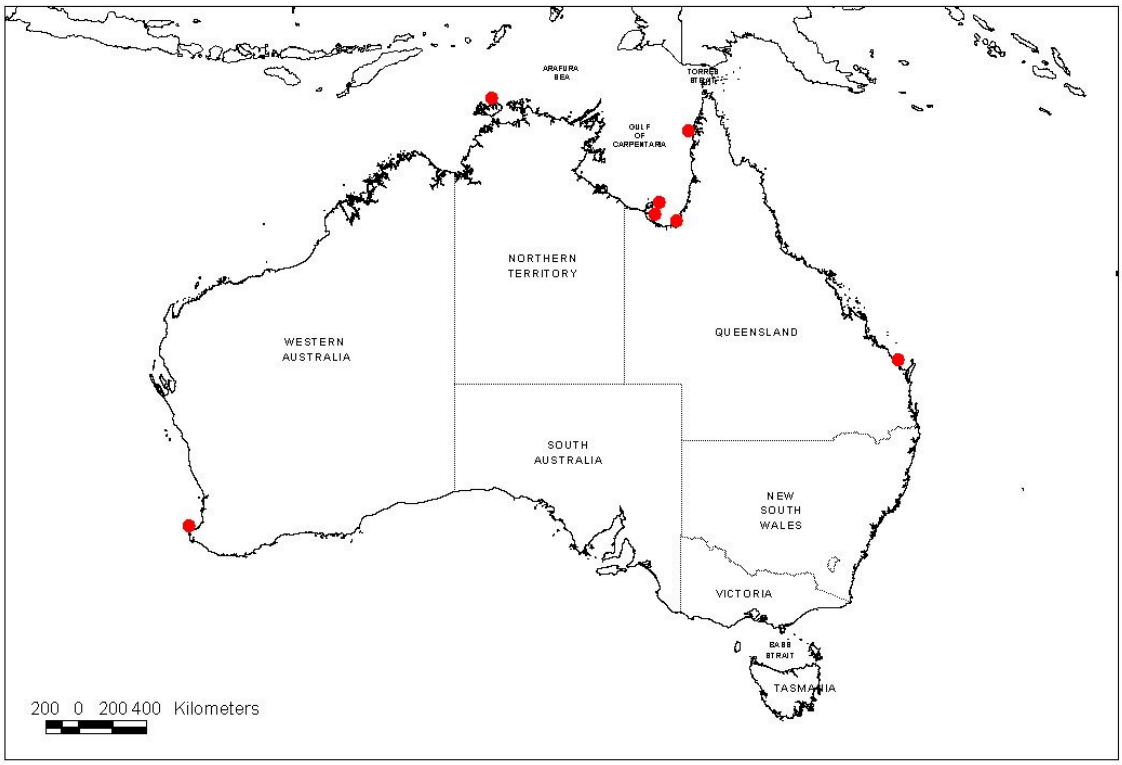


2a. Distribution of confirmed *Dermochelys coriacea* nesting records in Australia. Dots denote recorded nesting sites.

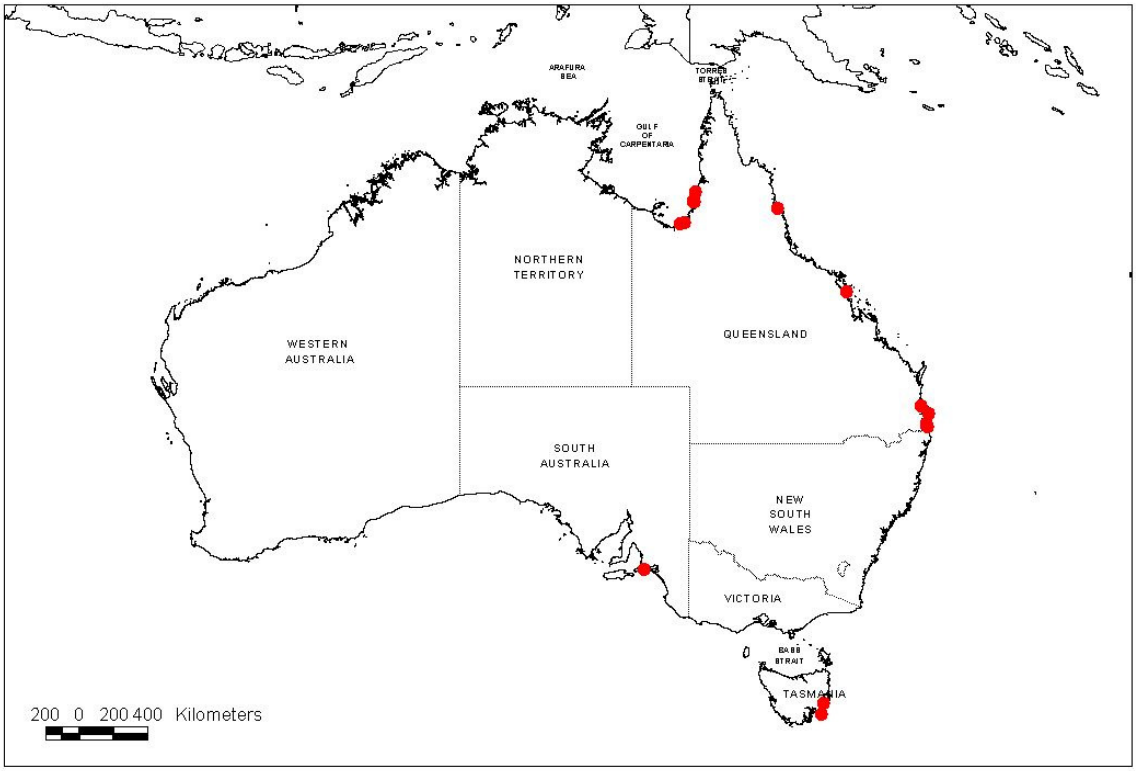


2b. Distribution of non-nesting *Dermochelys coriacea* records in Australia.

Figure 2. Distribution of *Dermochelys coriacea* in Australia.

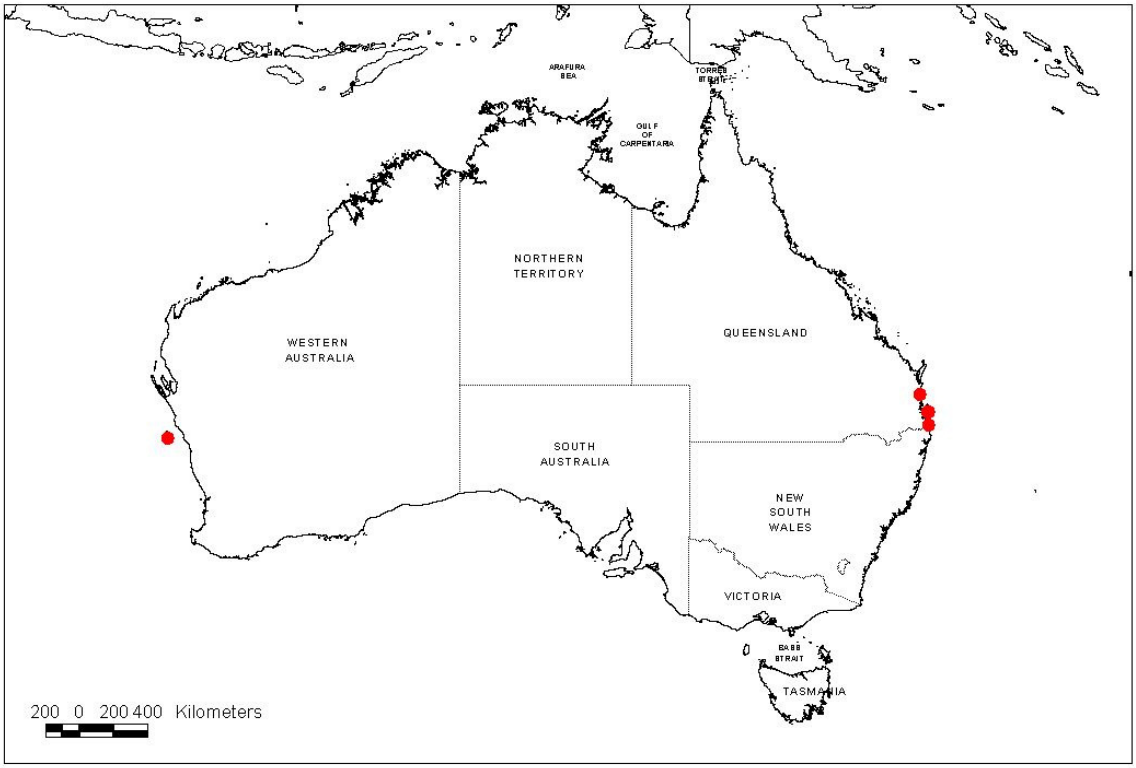


2c. Distribution of captures of *Dermochelys coriacea* in trawl fisheries.

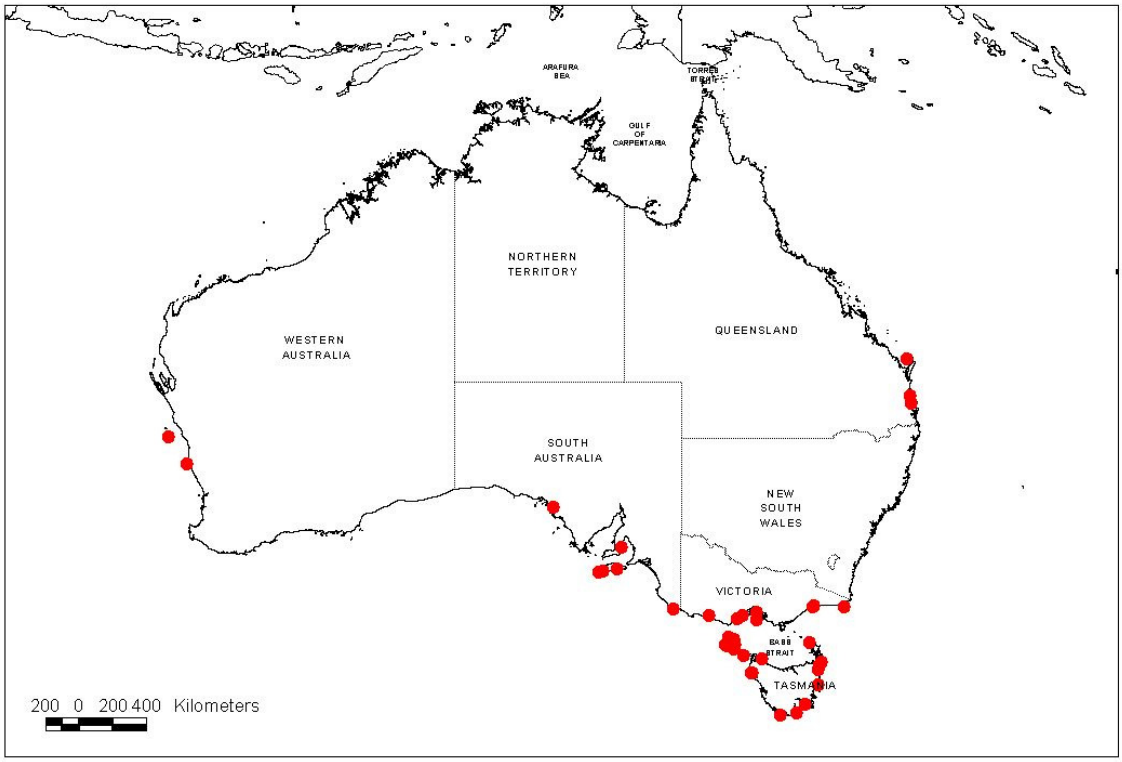


2d. Distribution of captures of *Dermochelys coriacea* in gillnet fisheries, including shark control programs.

Figure 2. Continued



2e. Distribution of hookings of *Dermochelys coriacea* in line fisheries including shark control programs.



2f. Distribution of entanglements of *Dermochelys coriacea* in float-lines within crayfish and crab fisheries.

Figure 2. Continued.

New South Wales
In the 1992/1993 breeding season, three, or possibly four, *D. coriacea* clutches were laid on beaches near Ballina, presumably by the same female (Tavey, 1993). In December 1995, 1 clutch was laid at Bootie Bootie National Park, south of Forster (L. Tavey, pers. comm., January 1996)

Northern Territory
Five nesting attempts have been recorded from the Arnhem Land coast from Coburg Peninsula to Maningrida, including Croker Island (Limpus and McLachlan, 1994; Limpus *et al*. 1984; Guinea, 1994).

Western Australia
There have been at least two unconfirmed reports of nesting attempts in Western Australia (R. Prince, pers. comm., August 2004).

Figure 3. Wreck Rock Beach, the principal *Dermochelys coriacea* nesting beach in Queensland, January 1985.

2.2.2 FIDELITY to NESTING SITES

Based on the limited recaptures of *D. coriacea* in Australia (Limpus and McLachlan, 1979; Limpus *et al*. 1984) and more intensive studies in the Caribbean (Eckert *et al*. 1989) and the eastern Pacific (Behler *et al*. 1996), individual *D. coriacea* can be expected to display a high level of fidelity to particular nesting beaches, although perhaps not as precise as is shown by other species of marine turtles.

2.2.3 MIGRATION

There have been no long-term recaptures from the eleven *D. coriacea* tagged on Australian nesting beaches (Limpus and McLachlan, 1994). There has been one tag recovery from northern Western Australia of a *D. coriacea* that had been tagged while nesting in Java, Indonesia (R. Prince, pers. comm.).

The population of *D. coriacea* that forages in Australian waters greatly exceeds the number of turtles that would be needed to account for the small Australian nesting population. It is presumed that most of these turtles are migrating to Australian waters from the larger nesting populations in neighbouring countries (Indonesia, Papua New Guinea, Solomon Islands) (Limpus, 1997) or from further afield in the Americas or India.

2.2.4 BREEDING SEASON

Mating has not been recorded for this species in Australian waters. Nesting in southeastern Queensland commences in mid December, reaches a peak in January and ends in about mid February (Limpus *et al*. 1984). Incubation is slightly slower than with other marine turtle species and hatchlings emerge from nests approximately 8–9 weeks after oviposition (Hirth, 1980).

2.2.5 BREEDING ADULTS

This is the largest marine turtle with, in the extreme, adults approaching a tonne in weight. Adult *D. coriacea* are black with pale spots and have a very pointed posterior carapace with five distinct ridges (Figure 1, Limpus and McLachlan, 1979). Breeding males are similar in appearance to the females in carapace size and colour but have a longer tail (Limpus, 1993). The Australian nesting females (Table 1) are above average size when compared to overseas populations (Hirth, 1980).

Table 1. Size of nesting female *Dermochelys coriacea* in eastern Australia.

	Measurement				Reference
	Mean	**SD**	**range**	**n**	
Curved carapace length (cm)					
Female					
Queensland	162	6.8	150.5–174.5	11	Limpus and McLachlan, 1994

2.2.6 BREEDING CYCLES

D. coriacea in Queensland, as is typical for the species globally, has the shortest renesting interval of all marine turtle species (Table 2). There is no measure of remigration interval for the Australian population.

Table 2. Breeding cycles for *Dermochelys coriacea* in eastern Australia.

	Measurement				Reference
	mean	**SD**	**range**	**n**	
Renesting interval (days)					
Female					
Queensland	9.17	0.75	9–11	6	Limpus and McLachlan, 1994
New South Wales	9.5	–	–	1	Tavey, 1993
Remigration interval (yr)	No records for Australia				

2.2.7 EGGS

The eggs are cleidoic, white and spherical and, like other marine turtle eggs, require 25 °C – 33°C, well ventilated, low salinity, high humidity nest substrate not subjected to flooding for successful incubation (Miller, 1985). There is no parental care of the eggs or hatchlings. Embryos can be killed by rotation of the eggs during early incubation, as occurs with cheloniid turtle eggs (Chan *et al*. 1985; Limpus *et al*. 1979). Measurements of eggs and nests are summarised in Table 3.

2.2.8 HATCHLINGS

Dermochelys coriacea hatchlings are black (dark grey when dry) dorsally and ventrally and have five distinct ridges on the carapace, not including the carapace margins (Limpus and McLachlan, 1979). Each ridge is highlighted by a row of white scutes. The carapace is covered with small scutes that are lost as the turtle grows. Measurements of hatchlings are summarised in Table 4.

The hatchling life history phase lasts several days, during which the hatchling depends on nutrients from the internalised yolk sac. As hatchlings they probably orient to similar cues as the cheloniid hatchlings (Lohmann, 1992; Lohmann and Lohmann, 1992, 1993). They orient to low elevation light horizons when moving from the nest to the sea but they can be disoriented by bright lights. However, they experience minimal disorientation with the yellow wavelengths of low-pressure sodium vapour lights (Witherington and Bjorndal, 1991) and with intermittent flashing lights (Mrosovsky, 1978). They orient to the earth's magnetic field as they leave the nest (Lohmann, 1991; Lohmann and Lohmann, 1993, 1994; Kloc, 1996). Imprinting may also occur to the smell of the sand or the water the hatchling first contacts (Grassman *et al*. 1984). By orienting to swim perpendicular to wave fronts, the hatchlings are directed to swim out to the open ocean (Lohmann and Lohmann, 1996). This age class does not feed or sleep between leaving the nest and entering to deep offshore waters but lives off the internalised yolk sac.

Table 3. Measurements of *Dermochelys coriacea* eggs and nests from eastern Australia. *ten eggs measured per clutch.

		Measurement				Reference
		mean	SD	range	n	
Clutches per season/female						
	Queensland & NSW			up to 4		Limpus and McLachlan,1994; Tavey, 1993
Eggs per clutch						
	Queensland	86.1	15.7	64–121	16	Limpus and McLachlan, 1994
	New South Wales	97.7	–	94–104	3	Tavey, 1993; Tavey, pers. comm.
Yolkless eggs per clutch						
	Queensland	44.6	15.6	16–79	15	Limpus and McLachlan, 1994
	New South Wales	17.7	–	6–33	3	Tavey, 1993; Tavey, pers. comm.
Egg diameter (cm)						
	Queensland	5.33	0.11	5.11–5.63	130*	Limpus and McLachlan, 1994
	New South Wales	5.09	0.05	5.03–5.18	5	Tavey, 1993
Egg weight (g)						
	Queensland	82.2	4.15	74.0–90.8	80*	Limpus and McLachlan, 1994
Nest depth (cm)						
Top	Queensland	65.3	8.24	52–81	12	Limpus and McLachlan, 1994
	New South Wales	65.0	–	60–70	2	Tavey, 1993
Bottom	Queensland	88.2	7.57	77–103	13	Limpus and McLachlan, 1994
	New South Wales	93.5	–	92–95	2	Tavey, 1993
Incubation Period (d)						
	Bundaberg (Qld)	60.5	–	60–61	2	Limpus *et al*. 1984
	Ballina (NSW)	93	–	–	1	Tavey, 1993

Table 4. Measurements of *Dermochelys coriacea* hatchlings from Australia.

		Measurement				Reference
		mean	SD	range	n	
Straight carapace length (cm)						
	Queensland	5.88	0.29	5.14–6.52	39	Limpus and McLachlan, 1994
	New South Wales	6.10	–	5.73–6.53	39	Tavey, 1993
Hatchling weight (g)						
	Queensland	46.9	4.66	38.3–54.2	39	Limpus and McLachlan, 1994
	New South Wales	39.9	–	35.0–44.0	36	Tavey, 1993

2.2.9 EGG and HATCHLING SURVIVORSHIP

Total clutch failure from natural causes was 43% at southeast Queensland beaches (n = 7 clutches, Limpus *et al*. 1984).

No total clutch failure has been recorded due to feral predators. Fox predation of other species of turtle eggs and hatchlings has been common on the Bundaberg to Roundhill Head beaches in recent decades (Limpus, 1985) and potentially could impact on *D. coriacea* clutches.

No eggs have been recorded as destroyed by nesting turtles.

Incubation success for *D. coriacea* clutches is summarised in Table 5.

Survivorship of hatchlings on the beach during the crossing from nest to sea (including impact of crab and bird predation) has not been recorded but it is expected to be very high.

Survivorship of hatchlings in inshore waters while crossing from beach to deep water has not been recorded.

Table 5. Incubation success from natural *D. coriacea* clutches including those that produced no hatchlings. * The Bootie Bootie clutch failed to complete embryonic development because of the low nest temperature (< 25 °C) during the summer months.

		Measurement				Reference
		mean	SD	range	n	
Incubation success						
Queensland		15.3%	17.6	0–39	7	Limpus, *et al,* 1984
NSW	Ballina	60.5%	–	43–78	2	Tavey, 1993
	Bootie Bootie	0%*			1	Tavey, pers. comm.

2.2.10 SEX RATIO

The sex of hatchlings is a function of the temperature of the nest during incubation (Mrosovsky, 1984; Mrosovsky *et al*. 1984).

Pivotal temperature has not been recorded for the species in Australia. In western Atlantic populations, the pivotal temperature is about 29.5 °C (Wibbels, 2003).

Sex ratio has not been measured for any component of the Australian population.

2.2.11 AGE and GROWTH

Preliminary growth/age data for eastern Pacific *D. coriacea* suggest that this species is faster growing than the cheloniid turtles in Australian waters, possibly reaching maturity at about 13–14 years (Zug and Parham, 1996). No growth measurements have been recorded for wild *D. coriacea* in Australia.

2.2.12 POST-HATCHLINGS

The post hatchling phase is defined as beginning when the small turtle commences feeding and ceases dependency on its internalised yolk sac for nutrients. There are no data on the distribution and diet of post-hatchling *D. coriacea* in the Australian region (Limpus *et al*. 1994). There may be little need for distinction between “post hatchlings” and larger sized *D. coriacea* given their almost totally pelagic life history (Bolten, 2003).

2.2.13 ADULT and IMMATURE TURTLES

This is a turtle of open water habitats from many areas of Australia (Figure 2b).

Feeding habitat

Dermochelys coriacea is generally regarded as an oceanic species that does not have a neritic juvenile and adult phase – a Type 3 life history pattern (Bolten, 2003). It is a widely distributed inhabitant of oceanic waters surrounding Australia (Robins *et al*. 2002) but its fine scale distribution in this region is poorly documented.

In addition, the species regularly forages over Australian continental shelf waters. However, there have been no quantified surveys of its abundance and distribution in these coastal waters. In the extreme, *D. coriacea* has been regularly recorded foraging in inshore waters, including ~3 m deep intertidal waters, in the southeastern Gulf of Carpentaria from July to September (Unpublished data, EPA Queensland Turtle Research Project). These foraging *D. coriacea* are 1000km from the nearest oceanic water east of Torres Strait and as such indicate that the species may be more flexible in its life history strategy than is implied by categorising it as having a Type 3 life history pattern (Bolten, 2003). The species is most commonly reported from coastal waters in central eastern Australia (from the Sunshine Coast in southern Queensland to central New South Wales); southeast Australia (from Tasmania, Victoria and eastern South Australia) and in southwestern Western Australia (Limpus and McLachlan, 1979; Bone 1998. Figure 2b). It is regularly seen in Tasmania and Victoria in the summer months, especially in western and eastern Bass Strait (Green, 1971; Bone, 1998). In Bass Strait, *D. coriacea* appears to concentrate in areas where southward flowing warm currents converge with steep bathymetric contours, presumably where food is more readily available (Bone, 1998).

Dermochelys coriacea was a commonly caught turtle in the shark nets and set-lines off southern Queensland beaches in the early 1970s through to the early 1980s (Queensland Shark Control Program contractor data reported by Limpus and McLachlan, 1979). The captures of *D. coriacea* on the drum-lines of the Point Lookout shark control contract (Figure 4) can be used as an index of the abundance of the species in southern Queensland coastal waters. These turtles are captured on the drum-lines by being hooked as they swim by the hooks. None were hooked in the mouth and they rarely die as a result of these captures. In the early to mid 1980s, *D. coriacea* were regularly captured as they swam through these waters. The species is now rarely captured on these drum-lines. Indeed, since 1992, *D. coriacea* has been rarely captured within any contract area with the southern Queensland Shark Control Program (B. Lane, pers. comm., 2004). These data suggest that the number of *D. coriacea* entering southern Queensland coastal waters have declined in the past two decades.

A comprehensive database on *D. coriacea* mortality and fisheries bycatch in Western Australian waters is in preparation (R. Prince, pers. comm., October, 2002).

Diet

D. coriacea is carnivorous. In Australian waters it feeds extensively on colonial tunicates such as *Pyrosoma spp.* (Prince, 2004), jellyfish such as *Catostylus spp*. and other soft-bodied invertebrates (Bone, 1998; Cogger, 1992; Limpus, 1984; Limpus and McLachlan, 1979). It will feed at all levels of the water column from benthos to surface (Limpus, 1984).

Population structure and dynamics

Adult and immature turtles occur together in the feeding areas of Australian coastal waters. The immature turtles include rare individuals as small as CCL = 47 cm in the Great Barrier Reef waters (Robins and Mayer, 1998) and 30.5 cm in southwest Western Australia (Prince, 2004). The population structure in feeding areas has not been described for any part of the population in Australian waters.

Survivorship
Adult female survivorship while on the nesting beach = 1.0 (n = 13) (Unpublished data, EPA Queensland Turtle Conservation Project).

Adult female survivorship between breeding seasons and survivorship of immature turtles has not been recorded.

Age structure
Population age structure has not been recorded for Australia, although the size range of individuals reported from Australian waters includes both immature and adult sized turtles.

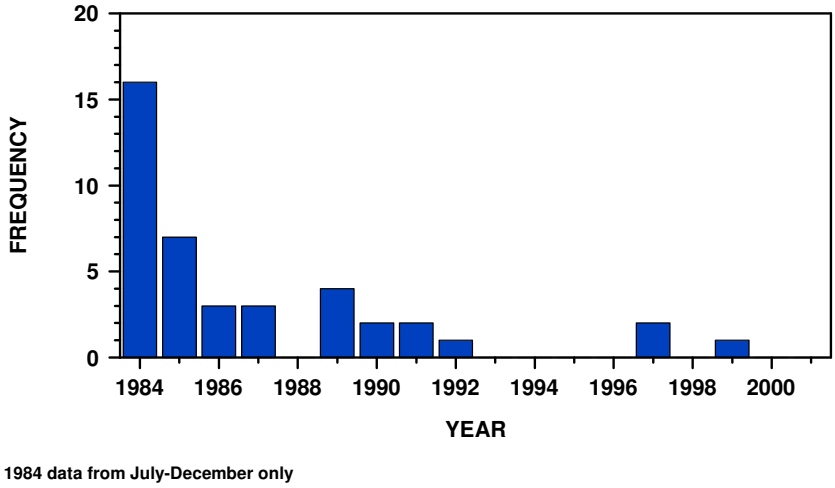


Figure 4. Declining annual capture of Dermochelys coriacea on Queensland Shark Control drum-lines at Point Lookout as an index of abundance of the species in southern Queensland waters. Data set supplied by Queensland Shark Control Program and commences with the employment of the current contractor in 1984. The fishing effort has been approximately constant with 24 drum-lines deployed in approximately the same locations in each year. The turtles were tangled, not hooked, and almost all were released alive.

3. ANTHROPOGENIC IMPACTS and MORTALITY

It is not possible to precisely quantify the magnitude of mortality from anthropogenic sources for *D. coriacea* within Australian waters. Additional mortality from longline and gillnet fisheries outside the Australian continental shelf can also be expected when turtles from this same population(s) migrate through oceanic waters.

There has been no commercial harvest of this species or its eggs in Australia and currently, commercial harvest is not permitted under any State or Federal legislation in Australia.

3.1 INDIGENOUS HARVEST FOR FOOD

Indigenous peoples with a recognised Native Title right can legitimately hunt marine turtles in Australia for communal, non-commercial purposes.

Few *D. coriacea* are eaten by indigenous Australians (Figure 5b). In Queensland, the reports received suggest that less than one *D. coriacea* per decade has been captured and killed by indigenous peoples (Unpublished data, EPA Queensland Turtle Conservation Project). In most instances the turtle was discarded because it was considered unpleasant to eat.

The take of eggs and/or hatchlings for human consumption has been probably nil in the last decade.

3.2 FISHERIES BYCATCH

Dermochelys coriacea have been rarely captured in prawn trawls in eastern Queensland and Gulf of Carpentaria, Northern Territory and Western Australia (Figure 2c, 5a).

- Trained observers aboard prawn trawlers prior to 1990 recorded no *D. coriacea* among 90 turtles trawled in the Gulf of Carpentaria; 45 turtles trawled between Cape York and Princess Charlotte Bay; and 30 turtles trawled in the Townsville area (Unpublished data, EPA Queensland Turtle Conservation Project).
- No *D. coriacea* were recorded among turtles captured during the 1989–1990 CSIRO survey of turtle captures in the Northern Prawn Fishery (Poiner and Harris, 1994).
- No *D. coriacea* were recorded among 151 marine turtles reported caught in the Torres Strait Prawn Trawl Fishery during 1991 to 1996 (Robins and Mayer, 1998).
- Only one *D. coriacea* was recorded among 1527 marine turtles reported caught in the Queensland East Coast Trawl Fishery during 1991 to 1996 (Robins and Mayer, 1998).

There were 15 *D. coriacea* recorded trawled among 1493 turtles reported in 1996 log-book data from the Northern Prawn Fishery (NPF) (Wallner and Sashse, 1998). However, species identification was not validated within this study. Given the rarity of *D. coriacea* recorded in catches for which the species identification is well validated, these 1996 NPF records should be treated with scepticism.

There are no records of *D. coriacea* drowning as a result of being trawled in Queensland (Unpublished data, EPA Queensland Turtle Conservation Project). However, the single reported Western Australian trawl capture resulted in drowning (Anon, 1982).

The capture of *D. coriacea* in gillnet fisheries in Australian waters has been wide spread (Figure 2c) but the catch rate(s) and numbers killed as bycatch within these fisheries has not been quantified.

- *D. coriacea* have drowned in past Taiwanese gillnet fisheries off the Arnhem Land coast (Hembree, 1985–1986): An onboard observer on a Taiwanese gillnet boat (*Chyun Fure No.7*) off the Arnhem Land coast in 1985–1986 recorded one *D. coriacea* out of 16 turtles captured (56% mortality for pooled species. Records spanned a 4month period with 81 sets

of a 14–15 cm mesh monofilament net, with a surface headline of 10.5 km and a drop of 15 metres,).

- *D. coriacea* were captured regularly during the early 1990s and an undetermined, but probably low, number drowned in the barramundi gill–net fishery of the southeastern Gulf of Carpentaria (Unpublished data, EPA Queensland Turtle Conservation Project).
- They have been reported as bycatch in Western Australian herring nets (Anon, 1985).
- A retired Tasmanian tuna fisher reported catching "an estimated 800 leatherback turtles in drifting gillnets over a 50 year period up to 1986" (Bone, 1998). This report indicates the need for further investigation of the impact of past and present gillnet fisheries.

The species is caught only rarely on hook and line fisheries (Figure 2c) (Limpus, 1984).
Only two *D. coriacea* were killed in the late 1980s – early 1990s in the Queensland and New South Wales Shark Control Programs (SCP) (Kidston *et al*. 1992; Krogh and Reid, 1996). This equates to an annual mortality rate of about one *D. coriacea* every three years. In the eight years from 1996, two of the three *D. coriacea* caught in Queensland SCP nets have drowned (giving 0.25 mortalities/year) (EPA Marine Wildlife Stranding and Mortality Database). In addition, *D. coriacea* is occasionally hooked on drum-line hooks used in the Queensland SCP (Figure 2e) or tangled in the traces to the hooks. All six *D. coriacea* caught on Queensland SCP drum-lines during 1996–2004 were released alive and none had ingested the hook.

In eastern Queensland during the 14 years, 1990 to 2003, two *D. coriacea* drowned when tangled in buoy-lines to crab pots giving 0.14 mortalities/year (EPA Marine Wildlife Stranding and Mortality Database. Figure 5c).

D. coriacea deaths from entanglement in buoy line to rock lobster pots may be the most significant cause of death from human related activities for the species in Australian continental shelf waters (Figure 2f).

- *Dermochelys coriacea* deaths from entanglement in buoy line to rock lobster pots are common in Western Australia but this mortality has not been quantified (Anon, 1982, 1985, 1987; Limpus and McLachlan, 1979).
- Most records of the species in Tasmanian waters are the result of entanglement in buoy-lines to crayfish pots (Bone, 1998). This same study estimated that over 75% of these turtles are released alive. However, the annual bycatch mortality from this fishery has not been quantified.
- There is a similarly unrecorded mortality rate for the *D. coriacea* captured in the buoy-lines to crayfish pots in Victoria and eastern South Australia (Bone, 1998).

Approximately 60% of the several hundred turtles captured annually in the Australian east coast and west coast tuna and billfish longline fisheries are believed to be *D. coriacea* (Robins *et al*. 2002). The mortality rate with *D. coriacea* caught in these Australian longline fisheries is unknown but probably low (Robins *et al*. 2002). Within the entire Pacific Ocean, it was estimated that 20,000–40,000 *D. coriacea* were captured as bycatch in longline fisheries in 2000 (Lewison *et al*. 2004). The same study concluded that there was insufficient data to permit a reliable estimate for the comparable annual bycatch in the Indian Ocean.

In international waters, *D. coriacea* are caught on longlines. Their survival following being hooked in the upper digestive tract and pulled to the surface from considerable depths by the fishermen is undetermined (Wetherall *et al*. 1993). The impact of oceanic longline fisheries on this species needs further clarification. Driftnet/gillnet fisheries within some national waters such as in Solomon Islands, Papua New Guinea, Indonesia and Philippines, may also be significantly affecting the survival of *D. coriacea* populations that forage and breed within Australia.

5a. Adult-sized *D. coriacea*, trawled in Northern Prawn Fishery, 2000.

5b. Indigenous butchering of an adult-sized *D. coriacea* in the Weipa area, 1956.

5c. **Z3681**: Adult-sized *D. coriacea* entangled in multiple crab-pot float-lines, Hervey Bay, 1992.

5d. **Z4205**: Cluster of ingested plastic bait-bags causing gut blockage in adult male *D. coriacea*, Bribie Island, 4 June 2000.

5e. **Q234**: Adult female *D. coriacea* boat-strike fatality, Bribie Island, 1 July 2003.

Figure 5. Examples of human impacts on *Dermochelys coriacea* in Australia. Tag numbers refer to records within the EPA Marine Wildlife Stranding and Mortality Database.

3.3 BOAT STRIKES

Occasional deaths of *D. coriacea* from boat strikes have been recorded in eastern Australia and in southwestern Western Australia. The mortality from this cause appears to be minor with one death reported in the 14 years, 1990 to 2003, in Queensland giving 0.07 mortalities/year (EPA Marine Wildlife Stranding and Mortality Database. Figure 5e)

3.4 MARINE DEBRIS

While synthetic debris may be commonly ingested by *D. coriacea*, there has only been one record of a death for the species in Queensland from ingestion of plastics or other debris during the 14 year period, 1990 to 2003 giving 0.07 mortalities/year (EPA Marine Wildlife Stranding and Mortality Database. Figure 5d). This turtle washed ashore on Bribie Island in June 2000 with a gut blocked with plastic debris including three bait bags (Haines and Limpus, 2001).

In Western Australia, necropsy has not identified any death of *D. coriacea* from ingestion of synthetic material (R. Prince, pers. comm. August 2004).

No *D. coriacea* have been identified among the many turtles recorded entangled in ghost nets in the Arafura Sea – Gulf of Carpentaria region.

3.5 DISEASES and INJURIES

There are no records of disease related mortality of *D. coriacea* in Australia.

High levels of arsenic compounds were recorded in a *D. coriacea* from the Western Australian coast (Edmonds *et al*. 1994). No explanation with respect to the arsenic's origin or impact on a turtle's health was offered in the study.

Cookie-cutter shark bites that penetrate the skin into the blubber layer are regularly observed on *D. coriacea* in eastern Australia (EPA Marine Wildlife Stranding and Mortality Database).

3.6 HARVESTS IN NEIGHBOURING COUNTRIES

Within the Australasian region there have been three major *D. coriacea* nesting aggregations (thousands of nesting females annually) recorded since European colonisation.

Malaysia

Terengganu, Peninsular Malaysia: approximately 2000 nesting females per year in late 1950s; nesting population has declined by 98% in recent decades (Figure 6) in response to long term excessive egg harvest (Limpus,1997) and bycatch mortality in fisheries (Behler *et al*. 1996).

Indonesia

Northwestern West Papua: Population size is imprecisely defined but probably exceeds 1000 nesting females per year. It appears to be a declining population as a result of egg harvesting by coastal villagers and nest predation by pigs (Starbird and Suarez, 1994). The smaller nesting populations of Java and Sumatra appear to be subject to near total egg harvest (Schulz, 1984, 1989).

- A traditional fishery that targets *D. coriacea* feeding on jellyfish in deep water off the Kai and Aru Islands of Eastern Indonesia takes some 100s of turtles annually (Saurez and Starbird, 1996; Suarez 2000).

Papua New Guinea-Solomon Islands

A third significant but dispersed breeding population occurs along the Northern Papua New Guinea coast and extends into the Solomon Islands. Widespread, low-density nesting has

occurred along the north coast of PNG with a nesting population of hundreds of nesting females annually. Intense traditional and commercial harvesting of the eggs are common practice. Villagers have claimed that there were fewer nesting females in the early 1980s than in the past (Quinn *et al*. 1985). In some areas adults are taken for food and/or oil when available but the occurrence of *D. coriacea* in the markets appears to be rare (Hirth and Rohovit, 1992).

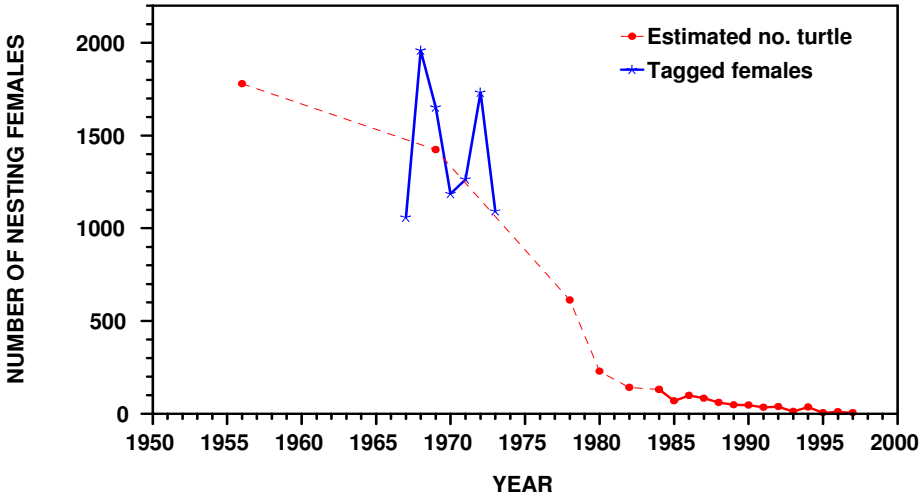


Figure 6. *Dermochelys coriacea* population decline in Malaysia. Data supplied by K. Ibraham, Malaysian Fisheries Department. See Limpus 1997 for more details.

4. POPULATION STATUS

The survival prospects for this species in the Australian region are bleak. If the majority of *D. coriacea* in Australian waters originate from rookeries in neighbouring countries, then the numbers of turtles in our waters must be declining, given the population declines within the Pacific Ocean basin and southeast Asia (Limpus, 1997; Behler *et al*. 1996. Figure 4).

There is limited census data by which we can judge the stability or otherwise of the species within Australian waters. The eastern Australian nesting population appears to be declining towards extinction (Section 2.2.1). If the *D. coriacea* that breed in Australia are a separate stock, then, given the low nesting numbers and poor incubation success, this species has a low chance of survival. Even the occasional death of individual turtles within Australian waters would contribute significantly to the population's demise.

The Queensland Shark Control Program data are consistent with a declining population in the southwestern Pacific region (Section 2.2.13).

5. CONSERVATION STATUS WITHIN AUSTRALIA

Conservation management of *D. coriacea* within Australia had its beginnings in 1968 with the 18 July 1968 Order in Council under the Queensland Fisheries Act that declared an all year round closed season for the harvest of all species of marine turtles and their eggs for all of Queensland.

D. coriacea is recognised currently as a threatened species throughout Australia (Table 6). It warrants consideration for listing as an endangered species across all jurisdictions.

The Australian Government has jurisdiction over waters three nautical miles offshore to the end of Exclusive Economic Zone (EEZ). In these waters marine turtles are protected under the EPBC Act. The respective Australian States and Territories have jurisdiction over intertidal waters and coastal waters out to three nautical miles offshore from their State lands. The respective State legislations are applicable to the management of marine turtles in these State and Territories waters. Under the Commonwealth Environment Protection and Biodiversity (EPBC) Act actions in all Australian waters that have, will have or are likely to have a significant impact on marine turtles are subject to a rigorous referral, assessment, and approval process.

Table 6. Summary of the legally defined conservation status of *Dermochelys coriacea* for Australia.
* Effective from 8 January 2009 this status was uplisted from Vulnerable to Endangered.

	Status	**Legal basis**
International obligations		
Convention for the Conservation of Migratory Species of Wild Animals (CMS)	Appendix I & II	Australia is a signatory state.
Convention for International Trade in Endangered Species (CITES)	Appendix 1	Australia is a signatory state.
Legislation		
Australia including Australian Territories	Vulnerable* Migratory species Marine species	*Commonwealth Environment Protection and Biodiversity Conservation Act 1999*
Tasmania	Vulnerable	*Threatened Species Protection Act 1995*
Victoria	Critically endangered	*Advisory list of Threatened Vertebrate Fauna in Victoria 2003*
New South Wales	Vulnerable	*Threatened Species Conservation Act 1995*
Queensland	Endangered	*Nature Conservation Act 1992*
Northern Territory	Vulnerable	*Territory Parks and Wildlife Conservation Act 2000*
Western Australia	Rare or likely to become extinct	*Wildlife Conservation Act 1950*
South Australia	Vulnerable	*National Parks and Wildlife Act 1972*

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