THE LEATHERBACK TURTLE (*DERMOCHELYS CORIACEA*) IN WESTERN AUSTRALIAN WATERS: HISTORY TO DECEMBER 2001 AND THE CONNECTIONS WITH FISHERIES.

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The leatherback turtle, *Dermochelys coriacea*, has long been included on the Western Australian 'threatened species' listings (Western Australia 1978), largely due to the growing 1960-70s knowledge of problems for the South East Asian region breeding populations. Prince (1993, 1994) further noted the species to be an apparently scarce, but regular, non-nesting feeding migrant visitor to Western Australian waters. The leatherback turtle has no presently known nesting presence here. Occasional false crawls only of leatherback turtles made during the austral summer nesting season have been recorded in recent times (Prince; Robinson, unpubl. notes) from Western Australian locations being monitored at the time of nesting use by other sea turtle species (see Prince 1993, 1998.

Elsewhere in Australia, limited nesting by the leatherback turtle has been reported from Queensland and the Northern Territory (Limpus and McLachlan 1979, 1994; Limpus *et al.* 1984), and the northern New South Wales coasts (Tarvey 1993). Leatherback turtles are, however, more frequently observed at sea practically right round the Australian coast. Reports from inadvertent captures in the course of commercial or other fishing (Bone 1998; this paper), or in association with recreational or other boating activities are perhaps the most common. Carcases in varying state of breakdown are also discovered and reported from beach strandings.

In this paper I report on the occurrence and circumstances of record of the leatherback turtle information now available for the Western Australian region prior to year 2002, and further discuss conservation status and matters of better management.

Methods

Previous papers including references to Western Australian leatherback turtles were reviewed and the primary source data and any associated reporting rechecked. Other historic records with acceptable documentation were sought via appropriate networking. Further focal reporting, and a carcase salvage program, including necropsy sampling where possible, was also promoted and implemented from the mid-1980s on within the prevailing constrained project resource limits. Carcases that could conveniently be retrieved from reported drowning events or salvaged from beach discoveries were sought for further examination and sampling as practicable. Sight records were verified by securing photographs where available, and/or by direct querying of the reporters in a manner designed to discover what exactly had been observed.

Results

Consolidated case data now available include: two early 20th century photographic records of leatherback turtle encounters in Western Australian (WA) waters; the WA records from the period February 1966 through February 1974 previously made available for reporting by Limpus and McLachlan (1979; Table 4); some further cases for this period not then accessible; and, additional information for the period from 1974 through to the last on record from an October 2001 discovery. No cases are known for the period November-December 2001. Further records for the remainder of the austral summer of 2001/02, and beyond, will be reviewed and dealt with at a later date.

Apart from the early 20C records, and the February 1966 case (above), we have a main dataset spanning *c.* 31 years from 1970 on to December 2001 with reasonable continuity of records. Where sequential multiple localised reports obtained from different sources over relatively short periods could be considered references to the presence of very few turtles, if not one turtle only, I have treated data in that way; eg, Swan River estuary records for the period February-May 1991. Data for the turtle carcases actually handled are first reviewed below. The *c.* 104 cases as indicated for the 1970-2001 dataset are further aggregated to examine: the patterns of distribution of reports; the historic temporal pattern of reporting; the within year timing of occurrences; the sources of, and the nature of the reporting and the encounters being reported, and the consequences for the turtles involved where a range of outcomes, from no effect to possible death, may be the result.

Body Size

Body weight versus over the curve carapace length data for Western Australian region leatherback turtles with reliable data on body weight and carapace dimensions available are presented and compared with data from some other stocks in Figure 1 (Renumbered from??).

Sex and Maturity Data

Sex and maturity status of individual turtles salvaged was generally determined from necropsy examination, but male sex was diagnosed for some other turtles where their

photographs clearly showed extruded hemipenes. The sex ratio indicated from the cases available was 6M: 6F. Gonad and reproductive tract appearance at necropsy for the male and female individuals examined suggest that immature animals (body weights ≤300kg) only have been sampled.

Distribution of Cases

Data to hand span the main part of the Western Australian coast, from the south coast temperate locations to the east of Esperance, westward and northward around to the tropical waters of the West Kimberley coast at the head of King Sound (Figure 2). A bias to predominantly south western WA coastal observations with a further strong bias in case numbers available from within a *c.* 50km radius around the Perth metropolitan region coast is also apparent (Figure 2, inset). (Original numbering OK =**?2?**). FONTS for TOWNS and LAT/LONG ticks to be increased.

Temporal Pattern of Reporting, Including Within Year Timing of Occurrence

The year by year pattern of reporting by financial year (July through June; 1970 through 2001) is shown in Figure 3 (Renumbered from**?7?**). This presentation is consistent with the apparent austral mid-winter period seasonal minimum for the cases on record shown by the month by month reporting frequencies for the whole data set irrespective of year (Figure 4) (Renumbered from**?3?**). DELETE?

Reporters and the Encounters Reported

Reporters of the 104 case encounters recorded 1970 through 2001 comprise a wide group of people. Mainly, noting the variable quality of case records, these include recreational (n=8) and professional (n=33) fisherfolk, other professional mariners (n=5) and recreational sailors/boat operators (n=12), fisheries and conservation management agency (n=15), and marine research (n=9) staff, divers (n=5), and beachcombers (n=11). The events on record include: sightings of free swimming turtles at sea (n=26); entrapment in - rock lobster (n=38) or crab pot float/buoy lines (n=1); other fishing gear - nets (n=5), or hook lines (n=4), and trawls (n=4); boat strikes (n=5); cases where the proximate event preceding carcase discovery could not be ascertained (n=20); and stranding with death due to natural causes (n=1).

Consequences for Turtles by Event as Reported

The 26 reports of live turtles at sea (above; 25% of all), the 20 indeterminate event cases (19.2% of all) generally related to stranded carcases not recovered, and the 1 natural causes stranding which also died, are noted. Case data for the other turtles on record can better indicate some of the real risk factors needing to be taken to account in further management considerations. The largest focal case group comprises turtles found tangled in float/buoy lines of bottom fished rock lobster (n=38) or crab pot (n=1) gear. Of the 39 (37.5% of all) cases reported, 20 (51.3% of group) turtles were drowned at discovery, and 17 (43.6% of group) were released alive. Condition of the other 2 turtles was not fully documented. The 13 other fishing gear (12.5% of all) cases included: 1 drowned and 4 released alive for the nets; 1 drowned and 3 released alive for the hook lines; and 1 released alive plus 3 not fully documented for the trawls. Propellor wound patterns on the 5 boat strike victims indicated fatal collisions with both outboard powered medium size (5-6m) recreational craft and larger (≥15m) possibly commercial vessels.

Discussion

The body size data in Figure 1 show that the leatherback turtles frequenting Western Australian waters as sampled are very similar, body weight for carapace length, to turtles from other populations. Slight differences in method of carapace measurement, and reproductive status of some of the turtles included are noted. Limited necropsy information for the Western Australian turtles further suggests that sexual maturity is generally not achieved if body weight is below 300kg. Apparent equality of sexes is indicated from the turtle carcases sampled. The record of the single small (3.3kg) juvenile in September 1983 is unusual.

Coming generally from well within the 200m isobath right around the Western Australian coast (Figure 2), the case reports received taken together with the annual reporting patterning over the past 30 years or so from 1970 on (Figure 3), further suggest that the leatherback turtle remains a poorly documented and probably not particularly abundant member of this State's inshore coastal vertebrate fauna. Data are too few to ascertain any possible real trends in abundance.

Apart from the geographic distribution of cases, other strong case reporting bias is also evident. Approximately 65% of the cumulative records (Figure 2 inset; source data) are derived from within a *c.* 50km radius around the Perth metropolitan region coast. All 5 boat strike cases on record are from the restricted Fremantle and Cockburn Sound ports sector within this area (≤20km radius) too. These particular biases most certainly reflect combination of: the major residential source and locus of marine activities of the parties most likely to make reports, and their probability of making a functional connection to an interested authority when disposed to making a report; and a more localised boat traffic risk factor. These matters are further discussed below.

Figure 4 data does suggest that leatherback turtles may be present offshore around southwestern and southern Western Australia practically year round, with a possible seasonal influx into the inshore waters. A variable range of different case interactions is also suggested. The current 'Nil' reporting record for July (the austral mid-winter month in southern WA), and a further scarcity of

records for August, and on into September is noted. This patterning has not yet been studied in detail.

The aggregated mainly southwestern and southern Western Australian pattern of case records for all months except July may however be largely a winter sampling artefact for the coastal zone southward from Shark Bay. The overlapping rock lobster fisheries, which certainly present a major entanglement risk factor when being worked (see below), have also maintained seasonal closures from June 30 each year from the 1977/78 season on. Our main case data minimum could merely reflect reduced regional activity of the smaller coastal zone fishing vessels and recreational watercraft being worked by many of the usual incident reporters at other times.

Overall, sightings of live turtles at sea account for *c.* 25% of all our case reports, with another 50% of reports being derived from fisheries activities. The remainder of cases (*c.* 25% of total) includes *c.* 5% of all cases involving boat strike leading to fatal injury of live turtles, but, predominantly, these others comprise records of stranded turtle carcases, often with minimal supplementary information being available (*c.* 19% of total).

Practically three quarters of the known fisheries case reports (37.5% of total) have originated from the Western Australian rock lobster fisheries, with the majority of these being provided from the commercial fisheries sector. The seasonal fishery (open November 15 through June 30) operates predominantly within the 50m isobath, deploying *c.* 10 to 11 million 'buoyed line and pot' fishing days effort per season in recent years (Chubb and Barker 2002). The other fishery interaction cases (12.5% of all) do suggest a vulnerability of leatherback turtles to capture by a wider range of fishing gear too.

Sourcing of these fishery interaction records emphasises the importance of recognising the necessary contributions to case knowledge already made by many commercial fisherfolk, and of further including them in any new discussions of possible better risk management issues, and associated studies and remedial actions.

Despite the commendable engagement of some fisherfolk mentioned above, we should not ignore the approximately one in 5 (of all) cases where carcases came to notice after stranding. The majority of these cases, where intact carcases were accessed for necropsy examination after discovery, or sufficient documentation including photographs was obtained, appeared likely to have involved accidental deaths of otherwise healthy turtles.

Excluding the one clear case of death by natural causes among the records (a deformed small juvenile stranded September 1983), there are another 48 cases of dead turtles reported. Twenty of these 48 were stranded carcases or remains. Noting we have only recorded bodies that have subsequently floated and later drifted ashore relatively intact to the point of discovery and reporting, we can certainly conclude that up to 40% of the dead turtles possibly meeting known accidental deaths have not previously been reported direct. This matter requires further attention.

There are several issues to be addressed here. The first of these is to encourage without prejudice to possible reporters of accidental captures, better reporting and recording of future cases as they occur. The second but related requirement is to maintain a continuing adequate proactive official formal regional focus on the documentation and study of such interactions.

A temporal pattern of generally low frequency, but also uneven annual case reporting as indicated by Figure 3 data; eg, the gaps in the record for the 1970-1980 period, and the peak numbers around the late-1980s – early 1990s. This patterning certainly includes variability related to differences in focus and intensity of any efforts intended to promote disclosures of encounters of whatever sort. Exact consequences of this sampling variation cannot be better addressed now. Adequacy of programme support and proper integration of that effort across necessary reporting networks are however the identifiable keys to future improvement.

The matter of improved timely reporting and documentation of the apparent accidental captures presently going unreported requires establishing of confidence and good working relationships with people most likely to be involved in such interactions, but whom might also presently feel threatened by such disclosure. This particularly requires cooperative working with commercial and other fisherfolk and fisheries management authorities. Complementary statutory measures derived from associated sustainable environmental management and fisheries operations licencing legislation that can assist should also be applied where available.

Operational programme improvements as suggested above should reduce, but not eliminate future finding of some stranded carcases. The rock lobster fisheries of southwestern Western Australia might possibly still produce the majority of these. However, other overlapping commercial net and long-line fisheries now operating are possible sources of carcases too. Australian-flagged long-line vessels fishing further offshore for swordfish and tuna in much deeper waters are presently reporting some foul-hooked or entangled leatherback turtles (Carolyn Robins, pers. comm.; my further enquiries and contact with fisherfolk). This matter is now being addressed via the Australian fishery bycatch action planning process and proposed focal studies.

Nevertheless, we might still not be able to determine origins of many future strandings. Turtles carrying remains of fishing gear may be discovered and associated

with a fishery; eg, we have one record of a reef stranded carcase with attached lobster pot lines and floats. In contrast, none of the other well-weathered apparently entire unencumbered carcases previously recorded stranded have seemingly retained any relevant visible signs around necks or flippers that might otherwise indicate an unreported fatal lobster pot line entanglement and discard case. Possible net and monofilament line fatalities from similar capture and discard cases may be much harder to detect from external marks too. More importantly, most of the likely observers/reporters of remote location strandings cases are not skilled in detection of such signs, even when 'fresh' carcases have been found but not recovered. Secondary boatstrike cases resulting from post-mortem collision with a floating carcase will also be confused without any detailed skilled necropsy.

Noting these primary reporting and recording problems and associations, we can look again at the free occurrence reporting and the apparent risk and impact factors being indicated from the other cases.

Professional fisherfolk have provided 'live at sea' leatherback turtle reports, but the majority of these records have come from other groups. The characteristic of 'unusual large marine vertebrate rarity' seems to have encouraged many of the observers to try and share their leatherback turtles observations with the presumably interested authorities. There does not appear to be any focal interest in reporting of free sightings of the more common Chelonid species in similar circumstances. Generally, programmes to solicit such reports have not been promoted.

The western rock lobster fishery in particular has provided the bulk of the better-documented cases. Turtles records being attributed to these fisheries interactions may have been drowned at discovery, found alive and able to be freed from the gear involved, or, rarely, have apparently died while carrying the gear at sea and then stranded. We have records of two such turtles able to be released alive when found swimming with a lobster pot plus ropes and floats attached, and one stranded carcase with ropes and floats attached. Death, by apparent drowning in most cases, has accounted for *c.* 52% of the reported rock lobster fishery cases, and the successful live releases slightly less.

The seasonal rock lobster fisheries of southwestern Western Australia (coastal zone southward from Shark Bay) clearly pose a real risk of entanglement and death for leatherback turtles foraging within that fishery area. However, interpretation of the historic profile of the rock lobster fisheries encounters with leatherback turtles remains uncertain. Our best data are most likely reflecting some balance between the individual fishers assignment of public importance versus perceived occupational threat of making particular encounters widely known, given that fisheries management authorities have only recently become engaged in this debate. The personal inclinations of the fisherfolk actually taking the trouble to have reported such previous events are most significant.

Leatherback turtles also come in contact with other Western Australian-based fisheries where risk of death is involved. These include hook lines, nets, and trawls. Comparatively, the relative frequency of our records of interactions with leatherback turtles sourced from these other types of fisheries versus the rock lobster fisheries reporting very roughly indicates the relative importance of the different fisheries in the Western Australian coastal waters zone. Our data are not comprehensive enough to further explore possible differences between the WA coastal fisheries at this time, or in the past.

Conservation consequences arising from the deaths of some of the leatherback turtles interacting with the various Western Australian regional fisheries cannot presently be readily assessed. Information required from the various fisheries and about the turtle population involved is generally unavailable. What we can say however is that there has been a continuing leakage of at least large juvenile or sub-adult leatherback turtles to fisheries operations in the Western Australian region for some time.

Documentation of the possible fatal interaction cases at sea has been generally restricted to particular areas of the coast and the adjacent shallower inshore waters. Further, a high proportion of the fatal case records is derived from stranded carcases apparently translocated from the point of death to a beach discovery point. Apart from the reporting deficiencies noted above, Epperly *et al.* (1996) have suggested as few as 1 in 7 carcases only might strand after being released at sea. The historic loss of much larger numbers of leatherback turtles than is documented to a variety of Western Australian regional fisheries is suggested.

Biological or sampling factors may explain the apparent absence of mature adult turtles from the more recent case records. Spontaneous comment from some experienced rock lobster fishermen (30 – 50 years in fishery) met in the recent past when I have been retrieving carcases for necropsy has suggested some knowledge of entanglement of adult size turtles. However, we have no confirmed recent interactions involving adult leatherback turtles.

Fishermen recalling past encounters with leatherback turtles while fishing have also usually remembered the cases having been few, and far between. Our data may simply reflect the small sampling access overall, with the mature adult turtles also being in the minority at sea, and the very few expert case assessments made. Nevertheless, long term changes in population structure of the leatherback turtles vulnerable to capture cannot be ruled out. Regional scale focal aggregations and possible

seasonal redistributions might also involve particular age classes only. Relevant population information cannot now be accessed, and prior opportunities to follow up on other leads have not arisen.

The leatherback turtle, a truly remarkable large marine vertebrate, has been listed as one of Western Australia's 'endangered' fauna species since 1978, but is still only known largely from the results of often fatal encounters with various forms of human marine pursuits in our coastal zone. That it continues apparently in recent times to be recorded relatively infrequently, and then practically only as large juveniles of either sex, without drawing further attention is also possibly surprising. However, the paucity of records of such leatherback turtles at sea is not unusual in the absence of dedicated studies (Hodge and Wing 2000; Eckert 2002). Our inability to properly assess current status and to test some observations offered by experienced fishermen is largely attributable to this omission.

Noting the now parlous status of the leatherback turtle breeding populations in some other parts of the world (Spotila *et al.* 1996), including peninsula Malaysia in SE Asia (Chan and Liew 1996), there is good reason to correct this lack of substantial knowledge of the leatherback turtle in western Australian region waters. Particular focus on ecologically sustainable management of the apparent major continuing risks posed by some of the Western Australian based commercial fisheries and related marine activities is needed. Better information on occurrence at the regional scale is also required. Specific information on the occurrence of the species in the pelagic zone offshore is also needed to help put the coastal zone observations into context. One of the related matters most easily addressed would be that of defining stock identity using modern genetic techniques. The leatherback turtle is the only regularly occurring species in the western Australian region for which such data are presently unavailable (eg, Broderick *et al.* 1994; Fitzsimmons *et al.* 1996).

Focus on the leatherback turtle populations is the province of the conservation authorities, but the necessity for constructive engagement of fisherfolk, fisheries and fisheries management personnel in particular in partnerships to properly address the environmental and operational management matters being raised is clear. The engagement of members of the wider community in assisting with the work is also important.

Support for a continuing focused effort on leatherback turtles occurrence in Western Australian waters that could also have promoted more effective discovery reporting and follow up on any possible salvage cases has been diminished in recent years. Renewing of this salvage and recording programme with more adequate support being provided and necessary cooperation being included is indicated. It is also important to note from experience that the agencies being identified by casual finders of carcases or observers of other encounters as the most likely points of contact for reporting include state fisheries managers, museum curatorial staff, or nature conservation managers.

A substantial proportion of the historic reports discussed above have been made by professional and recreational fisherfolk who commonly identify fisheries offices/officers as their primary point of official contact. It is therefore particularly important for the future that the nature conservation and fisheries management agencies and staff establish cooperation and maintain close working liaison to maximise information capture, and to increase the possibilities for salvage where carcases might be available for further study, or other specimens collected *in situ*.

More recent changes in Australian national legislation embracing the concept of environmentally sustainable fisheries and linked biodiversity conservation issues are bringing these matters closer together. Inclusion of the pelagic longline fishery operations within our new regional contacts network will provide a better chance of discovering the connections between the documented coastal occurrences and circumstances of encounter of the leatherback turtle there and the expected occurrences at sea. Some further productive collaboration with the fisherfolk in addressing common bycatch management problems and information needs for wildlife conservation can also be accommodated.

Acknowledgments: This work would not have been possible without the contributions of the various providers of reports and other assistance. The special efforts of those fisherfolk on boats, and the associated fishing industry and other personnel at distant locations in helping us secure fresh carcases for further study following accidental drownings are gratefully acknowledged. Likewise the efforts of other seafarers in facilitating retrieval of the occasional boatstrike victims at sea, and the Local Government staff and my fellow State Government workers who have assisted in dealing with stranded carcases onshore. Occasional *ad hoc* access to Murdoch University Veterinary School necropsy facilities when practicable and convenient was facilitated by Shane Raidal and colleagues. The forbearance of my youngest daughter, Nicole, who, from pre-school age and on into her early school years, was occasionally required to accompany me when I attended to some of these cases at the often odd and inconvenient times over weekends and Public Holiday days is also noted. I thank Mark Sheridan and Philip Kindleysides for their professional help in producing Figure 2. This paper is a further report from work of the Western Australian Marine Turtle Project.

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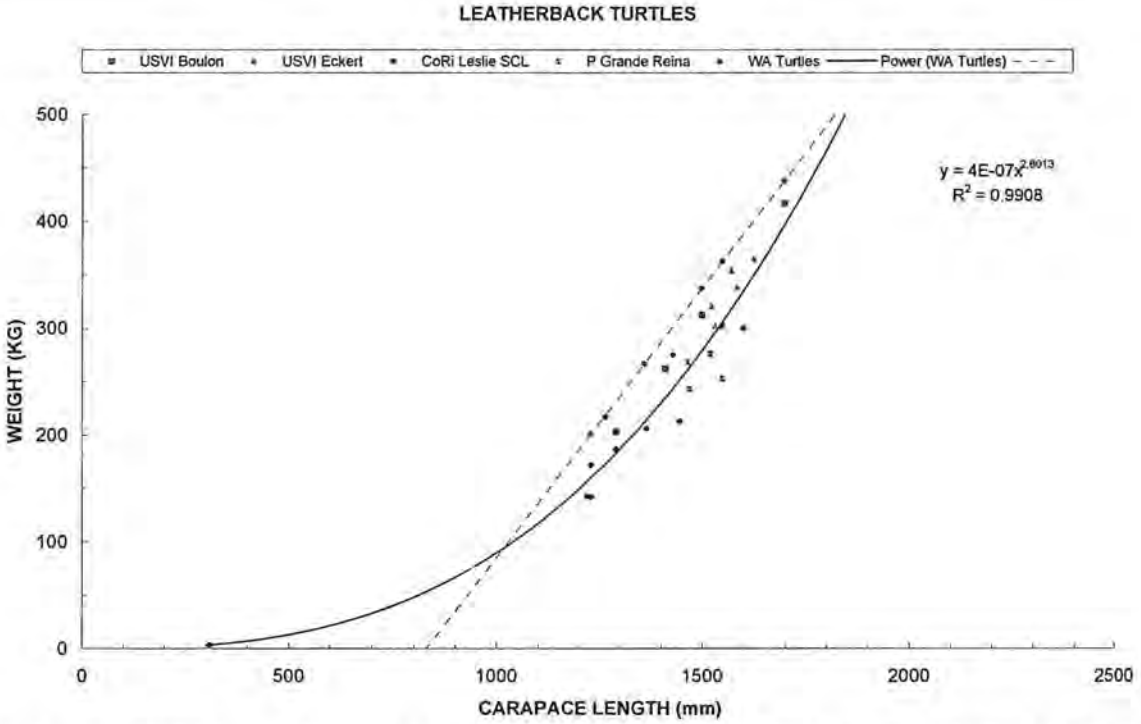

Figure 1. Body Weight versus Carapace Length for Some Western Australian Region Leatherback Turtles Including Comparisons with Turtles from Other Locations [Boulon and Leslie sourced from equations in Chelonian Conservation Biology 2(2), 1996; Eckert from *Can. J. Zool.* **67**:2834-40; Playa Grande Reina via Amanda Southwood, pers. comm.].

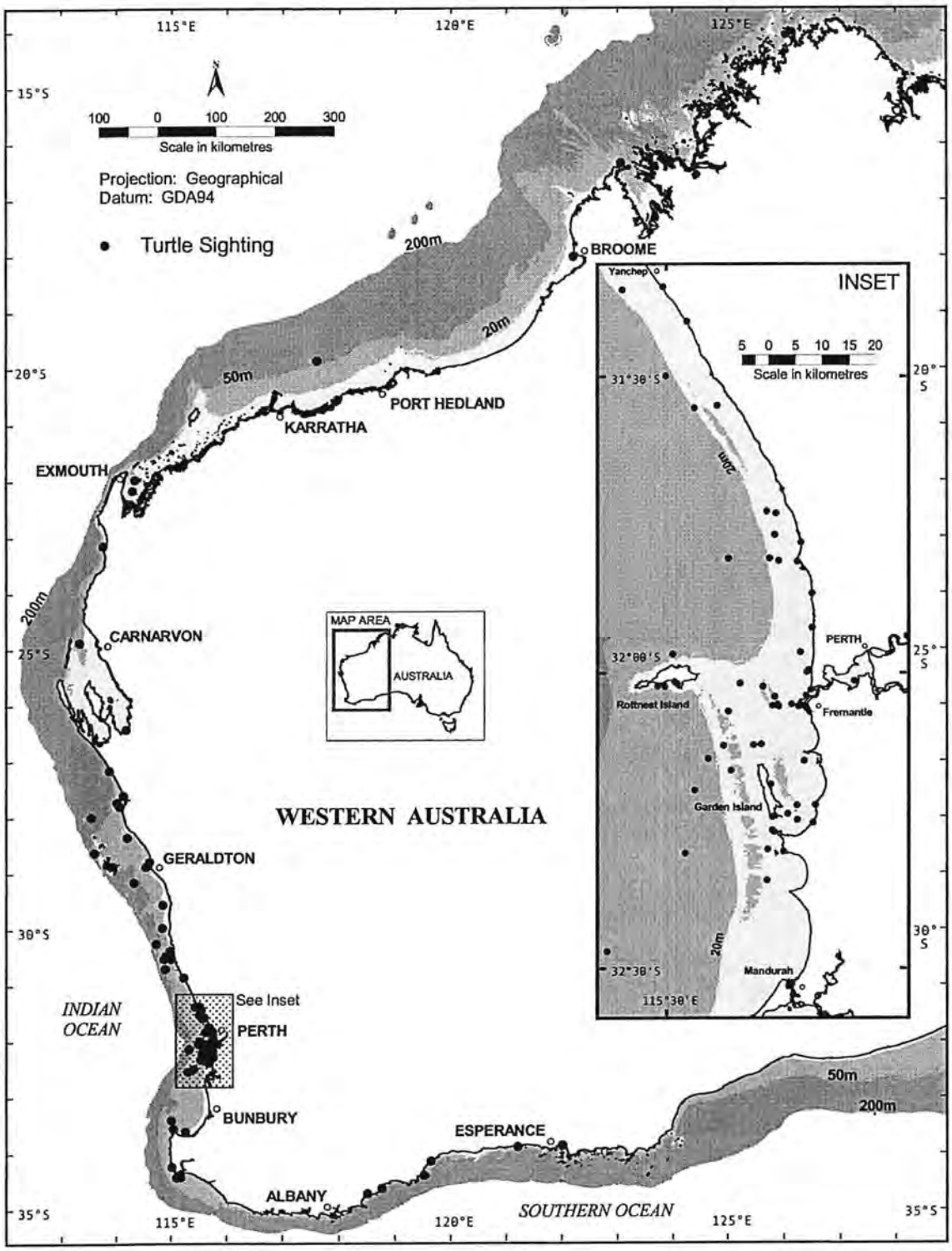

Figure 2. Geographic Distribution of the Leatherback Turtle Occurrences Reported from the Western Australian Coastal Zone to 31 December 2001.

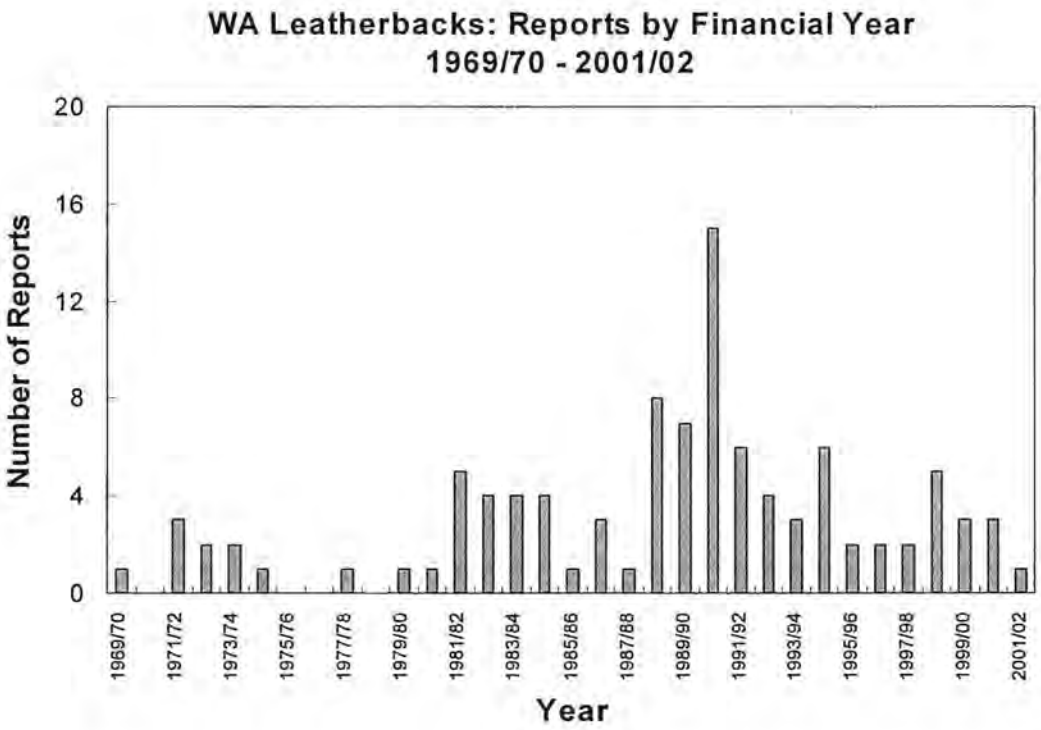

Figure 3. Frequency of Reported Leatherback Turtle Occurrences by Year from the Western Australian Coastal Zone, 1969/70 through 2001/02 (to 31 December 2001).

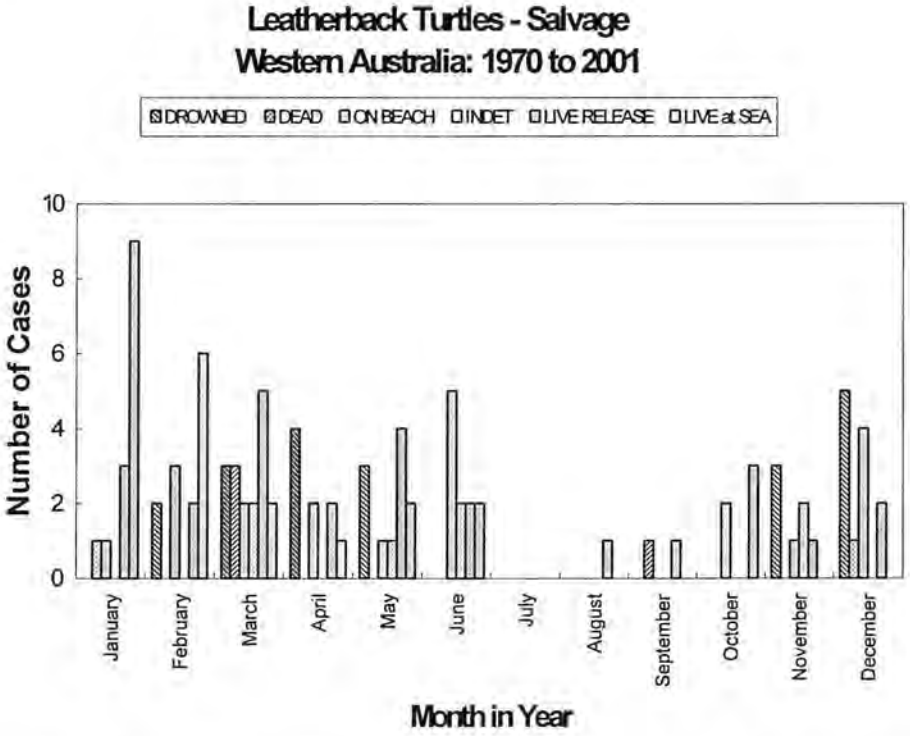

Figure 4. Frequency by Month of Year and Circumstance of All the Leatherback Turtle Cases Recorded from the Western Australian Coastal Zone to 31 December 2001.

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Re Data Table:

{(Brendan: ??? – route of choice to be decided) - Data discussed in this paper are available in Table form from the author. Table content will be updated as necessary to include future new cases and any other historic records yet to be discovered.

Table 1. Records of Occurrence of the Leatherback Turtle from Western Australia – 1926 through 31 December 2001.}