Assessment of saltwater crocodile (*Crocodylus porosus*) attacks in Australia (1971-2013): implications for management

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Abstract

When Saltwater Crocodiles (*Crocodylus porosus*) were protected in Australia (1969-1974) after some 25 years of unregulated hunting, the population had been reduced to less than 5% of its former abundance and comprised mainly young (small) crocodiles. In the Northern Territory (NT), which holds the majority of the Australian population of Saltwater crocodiles, the population is considered to have recovered to pristine levels of abundance, but the average size of crocodile continues to increase. The frequency of crocodile attacks (102 since 1971) is increasing over time. Here, we analyse crocodile attack data and assess future management of Saltwater crocodiles in the NT within the context of reducing human-crocodile conflict, without jeopardizing conservation goals.

Introduction

Saltwater Crocodiles (*Crocodylus porosus*) are distributed within three States/Territories in Australia: Northern Territory (NT), Western Australia (WA) and Queensland (QLD). Human-Crocodile Conflict (HCC) has no doubt been occurring since the arrival of Aboriginal people some 40,000 years ago. However, reliable and comprehensive data on attacks have only been available since the species was protected after some 25 years of unregulated hunting (WA 1969; NT 1971; QLD 1974). The last Australia-wide review of crocodile attacks assessed the available data up to 2004 (Caldicott *et al.* 2004); here we analyse data up to mid-2013, and include some additional information for the period 1855-1971.

Methods

Information on attacks by Saltwater Crocodiles was obtained from various sources, including newspaper reports, journals and other publications (general literature, books, etc.). WMI has maintained a detailed database on attacks since 1971, derived from similar sources, and including victim accounts and Government reports. Attacks on people working with crocodiles in the wild (eg researchers, crocodile farmers, crocodile hunters, wildlife rangers) were excluded from the analysis, and only attacks resulting in injury or death of the victim were considered to be “attacks”.

Results

Pre-1946

Prior to 1946, Saltwater Crocodiles were mainly hunted for sport or as pests, although in the mid-1930s there was some interest in the commercial hunting for skins. The earliest report of a Saltwater Crocodile attack on a human in Australia was around 1855 (Victoria River, NT). At the time of writing, 214 *C. porosus* attacks were identified from the 1855-1945 period. This is considered an underestimate of the real number of attacks, as details are scarce, many historical attacks on indigenous people are known only from oral history, and the review of historical sources is ongoing.

A high proportion (39%) of the attacks involved indigenous people (Table 1). That most (69.2%) attacks occurred in QLD (Table 1) is considered to reflect the larger human population there relative to the sparsely populated Top End of the NT and WA at the time, although lack of reporting may also be implicated. Attacks were biased towards males (86.0% of victims; N= 207), and a most (61.7%) were fatal (Table 1).

1946-1970

Between 1946 and 1971/74, commercial unregulated hunting of Saltwater Crocodiles took place in northern Australia. The peak in hunting occurred in the first 10 years after 1945 (Webb *et al.* 1984), and a lack of Saltwater Crocodile skins in the late 1950s and early 1960s led to hunting of the less valuable Australian Freshwater Crocodile (*C. johnstoni*, protected in 1962 (WA), 1964 (NT) and 1974 (QLD)). By the time of protection the Australian Saltwater Crocodile population had been greatly reduced. In the NT, it had been reduced to <5% of its historical abundance and <1% of its
historical biomass (Fig. 1). This trend is also considered to reflect the situation in WA and QLD, except that the levels of recovery in those States is not the same as the NT, where the population is considered to have reached pre-1946 abundance, but biomass (and mean size of crocodile) continues to increase (Fukuda et al. 2011).

Only 18 attacks were identified in the 1946-70 period (NT 8, QLD 6, WA 4). Details for 5 attacks could not be confirmed or assigned to a year, and so could not be assigned to either the pre-1946 or 1946-71 periods. Nonetheless, the frequency of attacks during 1946-71 (0.7/y) was significantly lower than that prior to 1946 (2.4/y), which reflects the greatly reduced C. porosus populations (Fig. 1), increased wariness of crocodiles towards humans, and improved modes of transport and road infrastructure during the hunting period. Most attacks (72%) involved indigenous people (Table 1) and males (77.3%).

Table 1. Saltwater Crocodile attacks in northern Australia, 1855-June 2013 (information sourced mainly from newspaper reports, as well as journals and other publications). Details for 5 “attacks”, including year, could not be confirmed, and they are not included here (Biddell and Stringer 1988).

<table>
<thead>
<tr>
<th>State/Territory</th>
<th>Fatal</th>
<th>Non-Fatal</th>
<th>Total</th>
<th>% Fatal</th>
<th>Indigenous (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1855-1945 (90 years)</td>
<td>132</td>
<td>82</td>
<td>214</td>
<td>61.7%</td>
<td>84 (39%)</td>
</tr>
<tr>
<td>Western Australia</td>
<td>9</td>
<td>9</td>
<td>18</td>
<td>50.0%</td>
<td>6 (33%)</td>
</tr>
<tr>
<td>Northern Territory</td>
<td>39</td>
<td>19</td>
<td>58</td>
<td>67.2%</td>
<td>32 (55%)</td>
</tr>
<tr>
<td>Queensland</td>
<td>94</td>
<td>54</td>
<td>148</td>
<td>63.5%</td>
<td>46 (31%)</td>
</tr>
<tr>
<td>1946-1970 (25 years)</td>
<td>6</td>
<td>13</td>
<td>19</td>
<td>31.6%</td>
<td>13 (74%)</td>
</tr>
<tr>
<td>Western Australia</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>100.0%</td>
<td>3 (75%)</td>
</tr>
<tr>
<td>Northern Territory</td>
<td>2</td>
<td>7</td>
<td>9</td>
<td>12.5%</td>
<td>7 (78%)</td>
</tr>
<tr>
<td>Queensland</td>
<td>0</td>
<td>6</td>
<td>6</td>
<td>0.0%</td>
<td>4 (67%)</td>
</tr>
<tr>
<td>1971-June 2013 (42.5 years)</td>
<td>29</td>
<td>73</td>
<td>102</td>
<td>28.4%</td>
<td>35 (34%)</td>
</tr>
<tr>
<td>Western Australia</td>
<td>2</td>
<td>11</td>
<td>13</td>
<td>15.4%</td>
<td>2 (15%)</td>
</tr>
<tr>
<td>Northern Territory</td>
<td>18</td>
<td>45</td>
<td>63</td>
<td>28.6%</td>
<td>27 (43%)</td>
</tr>
<tr>
<td>Queensland</td>
<td>9</td>
<td>17</td>
<td>26</td>
<td>34.6%</td>
<td>6 (23%)</td>
</tr>
</tbody>
</table>

Figure 1. Estimated population trends for Saltwater Crocodiles in the NT following unregulated hunting (1946-70) and protection (1971 onwards).

1971-2013
Since protection in the NT (1971), more detailed information has been available on crocodile attacks in Australia. Since 1971 there have been 102 C. porosus attacks, most of which occurred in the NT (62%); QLD accounted for 25% and WA for 13% (Table 1). Ninety-eight attacks involved one person being injured or killed, and four attacks involved two people being killed/injured - a total of 106 victims.

1. **Reason for Attacks**
   For the 102 attacks occurring between 1971 and June 2013, the primary motivation behind the attacks by crocodiles was considered to be:
   a. **Nest defence**: Two attacks involved adult female Saltwater Crocodiles at/near their nest site: one non-fatal attack occurred when a hunter accidentally entered a nesting site, and a fatal was considered to be a case of nest defence.
b. Mistaken Identity/Self Defence: Eight attacks were considered to be a case of self defence or mistaken identity by relatively small crocodiles. Two of these attacks involved crocodiles (1.5-1.8 m TL) that had escaped from farms - the behaviour of these animals may have reflected time in captivity.

c. Food/Territoriality: Most of the remaining 92 attacks are considered to be cases of crocodiles preying on humans for food. However, territoriality cannot be ruled out as the motivation in some cases, particularly where the size of the victim was much greater than the size of the crocodile.

Notwithstanding the lack of details for many attacks prior to 1971 (Table 1), one attack was definitely a case of nest defence, but most appear to have been cases of crocodiles seeking food.

2. Fatality Rate

Around one-third (28.4%) of Saltwater Crocodile attacks in Australia since 1971 have been fatal (Table 1), and at least four of the non-fatal attacks are likely to have resulted in death of the victim had it not been for the assistance of other people at the scene. Despite the relatively small number of attacks between 1946 and 1971, fatality rate (31.6%) was similar to that in post-1971 period. The assessment of pre-1946 records indicated a higher fatality rate (61.7%), which may reflect the degree of reporting of attacks that resulted in minor injuries, but it may also be indicative of the size structure of the C. porosus population at that time, which is considered to have been strongly biased towards large individuals.

The current (post-1970) fatality rate is similar to that reported for C. porosus in Sri Lanka (23.7%; De Silva 2010), but lower than that reported for Malaysian Borneo (43.7-61%; Tisen et al. 2011; Ambu 2011) and India (45.5%; Gopi and Pandav 2009). Similar fatality rates were recorded for C. acutus in Costa Rica (27.5%; Barrantes 2010) and C. palustris in India (22.2-42.1%; Vyas 2010; Whitaker 2008). The relatively high fatality rate (63%) for C. niloticus on mainland Africa (Fergusson 2004) is probably overestimated, as many non-fatal attacks in remote rural areas go unreported. This is also likely to be the case in specific countries where data are available [eg Madagascar 40.7% (Behra 1996); Zambia 67.8% (Wallace 2011)]. In comparison, only 7.6% of unprovoked American Alligator (Alligator mississippiensis) attacks in the USA have been fatal (Conover and Dubow 1997; A. Woodward, pers. comm.), which almost certainly reflects the smaller size and more docile nature of this crocodylian species.

3. Alcohol

Using only 75 cases where adults (>18 y; minimum age for legal alcohol consumption) were attacked since 1971, 21% of attacks are known to have involved the consumption of alcohol by the victim around the time of the attack. This rate is much higher for the 22 fatal attacks (45.5%) and lower for the 53 non-fatal attacks (11.3%). Alcohol is considered to affect the behaviour of victims, in particular risk taking, and increases the probability of attacks.

4. Age and Sex of Victims

The majority of people attacked since 1971 were males (74.5%). Mean age of victims was 33.7 years for males (N= 69, SD= 15.01, range 5 to 75 y), 25.6 years for females (N= 23, SD= 17.09, range 5 to 60 y), and 32.0 years overall (N= 92, SD= 15.86, range 5 to 75 y).

5. Biases toward Indigenous People

A disproportionate number (34.3%; Table 1) of attacks since 1971 involved indigenous people. In the NT, at least 27 of the 63 attacks involved people of Aboriginal descent: 42.9% of all attacks; 50.0% of fatal attacks; and, 40.0% of non-fatal attacks. This bias cannot be explained by demographics alone (around 28-29% of the NT Top End population are indigenous), but it can be explained by traditional lifestyles involving hunting, fishing and gathering, and the disproportionate number of indigenous people who live in remote, traditional homelands: around 60% of Saltwater Crocodile habitat in the NT is on indigenous lands.

6. Residents versus Tourists/Visitors

Since 1971, a high proportion of Saltwater Crocodile attacks in the NT (92.1%; N= 63) and QLD (87.0%; N= 23) have involved “locals” - long-time residents aware of the risks associated with crocodiles. In contrast, in WA locals made up the minority of attacks (36.4%; N= 11). At least two of the attacks on visitors could have been avoided if normal precautions had been taken.

7. Size of Crocodiles Involved in Attacks

The smallest wild Saltwater Crocodile reportedly involved in an attack was estimated to be 0.8 m long, and the largest was 5.1 m (mean= 3.2 m, N= 87, SD= 1.03; Fig. 2). The average total length (TL) of crocodile involved in fatal attacks was 4.2 m (N= 25, SD= 0.82, range 2.1 to 5.1 m), and for non-fatal attacks it was 2.8 m (N= 62, SD= 0.83, range 0.8 to 4.5 m). There is no doubt that the majority of fatal attacks are disproportionately caused by large male crocodiles (>4 m TL) (Fig. 2), that throughout the period of assessment (1971-June 2013) have comprised an increasing proportion of the total population of crocodiles (see Fukuda et al. 2011).
8. Probability of Surviving a Crocodile Attack by Different Sized Crocodiles

The bodyweight of a crocodile increases exponentially with increasing length, hence longer and heavier crocodiles are more able to attack and overpower humans than smaller ones. The probability of a crocodile attack being fatal increases markedly as size increases (Fig. 3). Indeed, all known attacks by crocodiles over 4.5 m in length across Australia have resulted in the death of the victim.

9. Day or Night?

Most attacks by Saltwater Crocodiles have occurred during the day (all attacks 78.0%, fatal 81.4%, non-fatal 70.0%). However, this reflects the timing of activities by victims, rather than any specific preference by crocodiles. We strongly suspect that the rate of attacks would be higher during the night if the same activities were undertaken at the same frequency.

10. Effects of Season on Probability of Attack

Attacks have taken place in every month (Fig. 3), but the majority [92.4% for pre-1971 (N= 119); 85.3% for 1971-2013 (N= 102)] have occurred in the warmer months of the year (August-April), which encompasses the late dry season and wet season. Although this period is correlated with the annual courtship and breeding season (October-April), when crocodiles are thought to be more active generally, there is no real evidence that reproduction is involved. A far more plausible explanation is that the physiological maintenance costs of crocodiles increase exponentially with increasing body temperature. So when the cooler conditions of winter pass by, and water temperatures start to increase, the amount of food required to sustain a crocodile during the warmer months is much, much greater than that in the cooler months. Hence they need to consume much more food to maintain body condition when it is warmer. Recent experiments indicated that of 10 kg of food fed to captive crocodiles in warmer months, 6-7 kg were used for maintenance alone (WMI, unpublished).
11. Effects of Season on Frequency of Attacks

Three broad seasons can be recognised in the Top End of the NT: cool-dry (May-July); hot-dry (August-October); and, hot-wet (November-April) (Webb 1991). The frequency of attacks in Australia was highest in the hot-dry and hot-wet periods of the year (9.7/mth and 9.3/mth respectively), and lowest in the cool-dry (5.0/mth). Access to many areas is constrained during the wet season (hot-wet), when wetlands are greatly expanded. The cool-dry season encompasses the peak period of tourist visitation in northern Australia.

12. Location of Victims at Time of Attack

Not surprising, the majority (86%) of *C. porosus* attacks have occurred whilst people have been in the water (eg swimming, wading, snorkelling, scuba-diving) or on land at the water’s edge (Table 2). That five attacks have occurred on land confirms that large crocodiles will leave the water in search of prey.

<table>
<thead>
<tr>
<th>Location (% of all attacks)</th>
<th>Non-Fatal</th>
<th>Fatal</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water (86.0%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swimming</td>
<td>18</td>
<td>17</td>
<td>35</td>
</tr>
<tr>
<td>In shallow water (eg wading)</td>
<td>20</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>Shallow water (getting into boat)</td>
<td>2</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Shallow water/water’s edge</td>
<td>-</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Snorkelling, scuba-diving</td>
<td>8</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>At water’s edge (on bank)</td>
<td>12</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td><strong>Subtotals</strong></td>
<td>60</td>
<td>28</td>
<td>88</td>
</tr>
<tr>
<td>(82.2%)</td>
<td>(96.6%)</td>
<td>(86.3%)</td>
<td></td>
</tr>
<tr>
<td><strong>Boats/Canoes (9.0%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In canoe</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>In boat</td>
<td>7</td>
<td>-</td>
<td>7</td>
</tr>
<tr>
<td><strong>Subtotals</strong></td>
<td>8</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>(11.0%)</td>
<td>(3.4%)</td>
<td>(8.8%)</td>
<td></td>
</tr>
<tr>
<td><strong>Land (5.0%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asleep in tent near water</td>
<td>2</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Asleep near water</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Asleep on beach</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Near crocodile nest</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td><strong>Subtotals</strong></td>
<td>5</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>(6.9%)</td>
<td>(0%)</td>
<td>(4.9%)</td>
<td></td>
</tr>
<tr>
<td><strong>All</strong></td>
<td>73</td>
<td>29</td>
<td>102</td>
</tr>
</tbody>
</table>
13. Activity of Victims at Time of Attack

Most (90.2%) attacks occurred while people were involved in recreational activities, including fishing and hunting. People working (non-crocodile related; eg commercial divers, researchers) at the time of the attack accounted for 7.8% of attacks, and unknown/miscellaneous attacks (eg escaping from Police) for 2.0%.

14. Canoes

Eight cases of attacks on occupants of canoes prior to 1971 were located, and all involved indigenous people. Since 1971, two attacks have involved people in canoes; a fatal attack in QLD (Normanby River, 2005) considered to have been motivated by feeding, and a non-fatal attack in the NT (East Alligator River, 1985) that may have been territorial/nest defence. These statistics do not reflect attacks that have been directed at canoes by Saltwater Crocodiles, but which have not resulted in injury to the occupants.

It is unclear why crocodiles attack canoes, but the long thin shape may appear like another crocodile, particularly from underwater, and result in behaviour associated with territoriality. Against this, people in canoes are commonly taken by Saltwater Crocodiles in Sarawak and Sabah (Malaysia), and these attacks appear to be crocodiles preying on humans for food.

15. People in Boats

Prior to 1971, 5 attacks directed at people in boats, and which led to injury/death, were identified. A further three cases did not result in injury to the boat occupants.

Since 1971, there have been 7 attacks directed at people on boats. Four of these occurred in the NT; two attacks involved relatively small crocodiles (1.8 and 2.0 m TL) and two attacks involved large (4.0 and 4.5 m TL) crocodiles, and attacks occurred during the day (N= 2) and night (N= 2). In WA, three similar attacks directed at occupants of boats involved 2.0, 2.5 and 3.0 m long crocodiles; all attacks occurred during the day.

Considering the number of boats involved in recreational activities in northern Australian rivers over the last four decades, there have been very few directed attacks on people in boats.

16. Boats

Three cases of crocodiles trying to climb into boats, attracted by dead fish (1930s) or dead crocodiles (1951) in the boats were reported. The reasons for another crocodile climbing onto a ferry (1952) were unclear.

Some cases of Saltwater Crocodiles directing attacks at boats and/or outboard motors merit particular mention:

a. “Sweetheart”, a 5.1 m C. porosus, made numerous attacks on the propellers of outboard motors in the Finniss River in 1978-79 (Stringer and Jakku 1986). Attacks were not directed at boat occupants. The propellers may have sounded like another large crocodile, and elicited a behavioural response from “Sweetheart” (Webb and Manolis 1989).

b. In 1984 a 5.1 m long C. porosus attacked the outboard motor cowlings of a number of boats in the Wildman River, when the boats were tied up at the water's edge, suggesting the crocodile was “attracted” to the warmth of the motors. At night the outboard cowlings may have been mistaken for the warm head of a large mammal at the water's edge (Webb and Manolis 1989).

c. In 2012, 6 attacks on boats by C. porosus occurred in the South Alligator River (5) and Wildman River (1) in Kakadu National Park [Jan, Mar (2), Sep, Oct (2)], all of which occurred at night (G. Lindner, pers. comm.). Occupants were woken by crocodiles attacking the outboard motors (N= 5; 2.0, 3.5, 3.5, 4.0 and 4.0-4.5 m long crocodiles) or the boat hull (N= 1; crocodile size unknown, but large judging by puncture marks in the hull).

With respect to the attacks on boats in 2012, park staff reported a changing trend with respect to fishing activities, with more and more fishermen now fishing at night, and sleeping in their boats overnight. Although not permitted, these activities are difficult to enforce. In all 6 cases, none of the boats had peripheral lighting, which is considered to contribute to safety at night, by illuminating the boat and allowing a better view of the surrounding water (G. Lindner, pers. comm.). Interestingly, a 1934 newspaper article referred to Aboriginals maintaining fires throughout the night to “ward off crocodiles” (Thompson 1934). In areas close to Darwin (eg Adelaide, Mary), fishermen are more likely to undertake day trips, and few fishing boats tend to remain on the river at night.

There is no evidence to suggest that there is a general change in crocodile behaviour towards boats. In areas where tours involve crocodile viewing and feeding (eg Adelaide River), crocodiles respond to the large tour boats, and will generally not approach other boats closely (Lyons 1999).

17. Trends in Attacks over Time

No attacks on people were recorded in the NT in the first 8 years of protection (1971-1978), but the number of attacks has increased significantly between 1979 and 2012 (linear regression; r² = 0.26, p = 0.002). This trend is largely due to a significant increase in the number of non-fatal attacks over time (r = 0.14, p = 0.027); the relationship between numbers of fatal attacks and time was not significant (r² = 0.08, p = 0.11). Given the high variability in these trends, data within 5- and 10-year periods were lumped (eg 1971-75, 1976-80, etc.) to provide more realistic representation of trends (Fig. 5).
On this basis, the average frequency of non-fatal attacks in the NT has increased from 0.0/y in 1971-80 to 1.8/y in 2001-12, for fatal attacks it has increased from 0.2/y in 1971-80 to 0.8/y in 2001-12, and for all attacks it has increased from 0.2/y in 1971-80 to 2.6/y in 2001-12. These data are depicted on Figure 5.

![Figure 5. Frequency of Saltwater Crocodile attacks in 5-year periods (1971-2012). Data for 2011-2015 are restricted to two years (2011 and 2012; two attacks in 2013 are not included).](image)

Discussion

The NT's ability to recover its *C. porosus* population back to the level of historical abundance is largely due to the creation of incentives to ensure that crocodiles have a positive value in the eyes of landowners and the public. Nonetheless, the increasing frequency of attacks by *C. porosus* in recent years has resulted in “calls” from the public to reduce HCC, perhaps through widespread culling.

The analysis of attacks since 1971 confirms that public education remains a critical element of management. That the majority of *C. porosus* attacks in Australia have involved locals indicates that public education programs may need to focus more on this segment of the population. That a high proportion of attacks have involved indigenous people also suggests that particular attention needs to be paid to this sector, perhaps delivered in a more culturally appropriate manner. Although traditional indigenous knowledge is important (eg where it is “safe” to swim), few indigenous people today have lived through periods of high crocodile abundance, as is the case now.

Crocodile farms in the NT rely mainly on the ranching of Saltwater Crocodile eggs, and indigenous landowners derive financial benefits through involvement in this program. In the mid-1990s, the CITES Appendix-II listing of Saltwater Crocodiles in Australia was changed from the purposes “ranching” to an “unqualified” listing. This now allowed other forms of use, such as wild harvest, to be implemented. Wild harvesting in WA was undertaken in the 1990s to provide stock for crocodile farms, and data on the impact of sub-adult/adult harvesting were generated (WMI, pers. comm.). In the NT, a trial wild harvest of adult Saltwater Crocodiles in the late 1990s was not extended into a formal program, and remains an option for future management, particularly for landowners who have limited/no nesting habitat and who are thus unable to participate in the egg ranching program. The Australian Government has previously rejected trophy hunting of Saltwater Crocodiles in the NT, although it is now considering an application from the NT which would allow a trial trophy hunting program, involving a low number of animals, to be undertaken. The proposed harvest of trophy animals is well within sustainable limits (<0.03% of the non-hatchling population), and is consistent with IUCN initiatives on trophy hunting (IUCN 2012).

Tourism is one of the main industries for northern Australia, and the ability to see crocodiles in the wild is a expectation for many visitors. Problem crocodile programs in each State/Territory deal with animals that pose a threat to humans or livestock, and some areas are maintained as crocodile-free as possible (eg Darwin Harbour), and in some cases allow for recreational purposes.

The frequency of attacks was lowest during the 1950s and 1960s, when the wild Saltwater Crocodile populations were greatly reduced due to hunting. With recovery of the populations since protection, the frequency of attacks has increased. The increasing movement of Saltwater Crocodiles into upstream freshwater areas, which are often used for recreation, is now a key management issue being addressed in the NT. The use of barriers to prevent entry of crocodiles into swimming areas, and the application of new methods to capture crocodiles being they reach such areas, are options currently under consideration. The use of Crocodile Exclusion Enclosures (CEEs) as used in Sri Lanka and India (see www.iucncsg.org/pages/Human%252dCrocodile-Conflict.html) also merit consideration.
Literature Cited


