



Northern
Territory
Government

greening the
Territory

A Territory Government initiative



Management Program for the Freshwater Crocodile (*Crocodylus johnstoni*)

in the Northern Territory of Australia, 2010–2015



Management program for the Freshwater Crocodile (*Crocodylus johnstoni*) in the Northern Territory of Australia, 2010–2015

Parks and Wildlife Service of the Northern Territory

Department of Natural Resources, Environment, the Arts and Sport
PO Box 496
Palmerston NT 0831

© Northern Territory of Australia, 2010

ISBN 978–1–921519–51–2

This work is copyright. It may be reproduced for study, research or training purposes subject to an acknowledgment of the sources and no commercial usage or sale. Requests and enquires concerning reproduction and rights should be addressed to the Chief Executive, Department of Natural Resources, Environment, The Arts and Sport, PO Box 496, Palmerston, NT 0831, Australia.

Citation

Delaney R., Neave H., Fukuda. Y. and Saalfeld. W.K. (2010). Management program for the Freshwater Crocodile (*Crocodylus johnstoni*) in the Northern Territory of Australia, 2010–2015. Northern Territory Department of Natural Resources, Environment, the Arts and Sport, Darwin.

Acknowledgments

The authors thank all those involved in spotlight surveys and earlier analyses of the data. John Woinarski, Glenn Edwards, Greg Leach and Tony Bowland commented on drafts of this program.

A management program prepared under the *Territory Parks and Wildlife Conservation Act*.

Executive Summary

The freshwater crocodile *Crocodylus johnstoni* is found only in northern Australia, where it commonly lives in rivers, lagoons and billabongs, largely upstream of tidal influences. Freshwater crocodiles have a high cultural value with residents and visitors alike and there is currently a small commercial harvest and trade of freshwater crocodiles.

The aim of this management program is:

To ensure the long-term conservation of the freshwater crocodile and its habitats in the Northern Territory.

The four principal objectives of the Management Program which must be consistent with the aim are to:

1. Facilitate the sustainable use of freshwater crocodiles;
2. Promote community awareness and public safety;
3. Ensure humane treatment of freshwater crocodiles; and
4. Monitor and report on the impact of the harvest of freshwater crocodiles.

The freshwater crocodile is protected under the *Territory Parks and Wildlife Conservation Act*, the Australian *Environment Protection and Biodiversity Conservation Act* and is listed internationally under Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Existing land use patterns in the Territory are generally consistent with retaining the habitat required by freshwater crocodiles. The current threats to freshwater crocodile populations are poisoning by cane toads and the effects of climate change and displacement by increasing numbers of saltwater crocodiles (*C. porosus*). Climate change may become an increasingly important threat to crocodile habitat through changes in sea levels, hydrology and saltwater intrusion.

Performance indicators, key actions, and timelines for each objective are given in 'lift-out' tables for managers and staff. Priority actions include reviewing and analysing available long-term population data; implementing monitoring programs for the wild population; investigating the genetic versus environmentally-induced status of "pygmy" freshwater crocodiles; and investigating the relationship between freshwater crocodile population dynamics and cane toads.

Details are also given on management practices, including commercial harvest and use, legal compliance, problem crocodile removal, animal welfare issues and community awareness and participation.

Auditing and monitoring freshwater crocodiles, as outlined in the program, will ensure that the species will remain conserved into the future.

Contents

Executive Summary	i
Definitions and Acronyms	iv
1. Introduction	1
1.1 Aim and objectives	1
1.2 Species	1
1.3 Responsible authority	1
1.4 Legislative, national and international obligations	2
1.4.1 Northern Territory	2
1.4.2 Other States and Territories	3
1.4.3 Commonwealth Government	3
1.4.4 International	4
2. Management Context	5
2.1 Socio-economic values	5
2.1.1 Cultural values	5
2.1.2 Harvesting & farming	5
2.1.2 Tourism	5
2.2 Population estimates and trends	5
2.3 Habitat	7
2.3.1 Protected areas	7
2.3.2 Significant wetlands outside reserves	8
2.4 Problem freshwater crocodiles	8
2.5 Indigenous harvest and use	9
2.6 Commercial harvesting and use	9
3. Threats and Impacts	11
3.1 Cane toad poisoning	11
3.2 Other natural predators	11
3.3 Drought and climate change	12
3.4 Habitat loss and modification	12
3.5 Harvesting	12
4. Management Practices and Performance Measures	13
Objective 1 - To facilitate the sustainable use of freshwater crocodiles	13
4.1 Commercial harvest and use	13
4.1.1 Restrictions on harvesting	13
4.1.2 Harvest ceiling	14
4.2 Permits and compliance	15
4.2.1 Permits to take	15
4.2.2 Permits to keep	16
4.2.3 Permits to export and import	17
4.2.4 Permits and returns	17
4.2.5 Compliance	18
4.3 Management-focused research	19
Objective 2 - To promote community awareness and public safety	20
4.4 Removal of problem crocodiles	20
4.5 Community awareness	21
Objective 3 - To ensure humane treatment of freshwater crocodiles	21
4.6 Animal welfare	21
Objective 4 - To monitor and report on the impact of the harvest of freshwater crocodiles	22
4.7 Monitoring	22
4.7.1 Population estimates	22
4.7.2 Analysis of survey data	23
4.7.3 Commercial harvest estimates	23
4.8 Reporting	24

4.8.1 Crocodile farms	24
4.8.2 Auditing and reporting	24
4.8.3 Review of program	25
5. References	26
Appendix 1: Freshwater crocodile background information.....	30
A1.1 Conservation status	30
A1.2 Distribution	30
A1.3 Ecology	31
A1.4 Nesting ecology.....	31
A1.5 Survivorship and population dynamics.....	32
A1.6 Diet.....	32
Appendix 2. Farm management	33
Appendix 3. Annual milestone matrix for 2010-2015 program	36

Definitions and Acronyms

Adults

Animals greater than 1.5 metres (approx. 5 feet) total length are classed as adults. This is a defined size class for the purpose of this Management Program and may not always equate to sexual maturity.

CITES

Convention on International Trade in Endangered Species of Wild Fauna and Flora

Crocodile Products and By-products

Includes all parts from a crocodile except for skins as defined below.

Crocodile Skins

Includes raw or tanned belly skins (cut along the back), hornbacks (cut along the belly) and whole skins.

DEWHA

Australian Government Department of the Environment, Water, Heritage and the Arts

DoR

Northern Territory Government Department of Resources.

Egg Harvest

The physical removal of an egg from its natural location in the wild and transportation to another location.

Eggs

Unless otherwise stipulated includes all eggs regardless of whether it is fertile or infertile, with a live or dead embryo.

Eggs - viable

Eggs that produce a normal hatchling surviving at least one day outside the egg.

EPBC Act

Environment Protection and Biodiversity Conservation Act. Australian Government legislation.

Harvest Ceiling

The Northern Territory's annual maximum allowable number of individuals that can be harvested in each of the defined life stages.

Hatchling

Animals classed as hatchlings are less than one year old and typically less than 0.6 metres (approx. 2 feet) total length.

Juvenile

Animals classed as juveniles are approximately between 0.6 and 1.5 metres (approx 2–5 feet) total length.

Landholder The owner or occupier of specified lands.

NRETAS

Northern Territory Government Department of Natural Resources, Environment, The Arts and Sport.

Ranching

As used in the context of CITES, it is the rearing in a [controlled environment](#) of [specimens](#) taken from the wild.

Total Length

Animal length measured from the tip of the snout to the end of the tail.

TPWC Act

Territory Parks and Wildlife Conservation Act. Northern Territory legislation.

1. Introduction

This Management Program deals with the conservation and sustainable use of the freshwater crocodile and focuses on population dynamics, harvest limits and monitoring the impact of the harvest on population trends. The program does not deal with commercial aspects of the industry such as promotion or marketing, or mechanisms to increase industry growth and Indigenous participation.

The management of freshwater crocodiles in the Northern Territory has been regulated to date by the “Management program for *Crocodylus porosus* and *Crocodylus johnstoni* in the Northern Territory of Australia” (PWCNT 1998). This current program updates, revises and replaces that previous program.

1.1 Aim and objectives

The aim of this management program is:

“To ensure the long-term conservation of the freshwater crocodile and its habitats in the Northern Territory”.

The program incorporates the subsistence and commercial use of freshwater crocodile populations. The program aims to encourage management practices that favour the freshwater crocodile, and protect wetland habitats beyond the boundaries of parks and reserves.

The program has four principal objectives which contribute to achieving this aim. The four objectives are:

1. Facilitate the sustainable use of freshwater crocodiles.
2. Promote community awareness and public safety.
3. Ensure humane treatment of freshwater crocodiles.
4. Monitor and report on the impact of the harvest of freshwater crocodiles.

1.2 Species

The freshwater crocodile (*Crocodylus johnstoni* Krefft 1873) is one of two species of crocodile found in Australia; the other being the larger saltwater crocodile (*C. porosus*). Subspecies or races have not been formally described but there has been some speculation that a ‘pygmy’ form may warrant taxonomic investigation. Further details on the status and ecology of the freshwater crocodile are provided in Appendix 1.

1.3 Responsible authority

The Northern Territory Department of Natural Resources, Environment, The Arts and Sport (NRETAS) is obliged under the *Territory Parks and Wildlife Conservation (TPWC) Act* to manage wildlife in the Northern Territory. The control of all aspects of the harvest from the

wild in the Northern Territory is administered under this legislation. Once animals are contained in a farm, the Department of Resources (DoR) has the administrative role for crocodile farming. These responsibilities are outlined in Appendix 2.

1.4 Legislative, national and international obligations

1.4.1 Northern Territory

Territory Parks and Wildlife Conservation (TPWC) Act

The *TPWC Act* contains provisions for the management and conservation of native animals including freshwater crocodiles. The freshwater crocodile is classified as protected wildlife throughout the Northern Territory under Section 43 of the *TPWC Act*. Section 66(1) of the Act prohibits the taking or interfering with protected wildlife without a permit issued by the Director of the Parks and Wildlife Commission or their delegate. It is also an offence under Section 66(2) of the Act to possess or trade in live or dead crocodiles, crocodile eggs or parts of crocodiles without a permit. The freshwater crocodile is not classified as threatened in the Northern Territory. It has recovered from the low population numbers in the 1960s resulting from unregulated hunting to now being considered a widespread and abundant species.

Permits to possess and/or trade in crocodiles may be issued by the Director of the Parks and Wildlife Commission or a delegate in accordance with Sections 55, 56 and 57 of the *TPWC Act*. The Director may under Section 57 of the Act apply terms, conditions or limitations to the permit to regulate the harvesting and farming of crocodiles.

The taking of wildlife by Aboriginal people for traditional purposes, including food, is provided for under Section 122 of the *TPWC Act*. Aboriginal people are not bound by hunting regulations or seasons when taking animals for food or other traditional purposes.

Animal Welfare Act

The *Animal Welfare Act* ensures that animals are treated humanely; cruelty to animals is prevented and community awareness about the welfare of animals is promoted. Crocodiles held in captivity under permit are classified as stock animals under the *Animal Welfare Act* and persons must not neglect, or commit an act of cruelty that causes an animal unnecessary suffering.

Code of Practice on the Humane Treatment of Wild and Farmed Australian Crocodiles

Animal welfare standards for crocodiles are detailed in this Code. All crocodiles must be managed in accordance with this Code.

<http://www.environment.gov.au/biodiversity/trade-use/publications/crocodile-code-of-practice.html>

Environmental Assessment Act

New developments for the farming, processing and display of crocodiles will need to meet the requirements of this Act.

Meat Industries Act

Farmed crocodiles may be slaughtered in abattoirs licensed for the slaughter of crocodiles. Unlike the saltwater crocodile, the freshwater crocodile has not been declared as a game

animal under the *Meat Industries Act*. This precludes the use of freshwater crocodiles killed in the wild for human consumption.

Food Act

Crocodile meat is sold for human consumption and this Act provides for the safety and suitability of food for human consumption.

Livestock Act

Farmed crocodiles are treated as livestock under this Act which provides for disease surveillance, disease control, identifying and tracing animals and regulating movement of animals and animal products for the purpose of disease control.

Integrated Natural Resource Management Plan for the Northern Territory: sustaining our resources – people, country and enterprises.

This Northern Territory Government endorsed plan (LCNT 2005) provides the broad framework and a series of actions directly contributing to the conservation of freshwater crocodile habitat and for the sustainable use of wildlife such as freshwater crocodiles.

A Strategy for Conservation through the Sustainable Use of Wildlife in the Northern Territory of Australia.

This Northern Territory Government endorsed strategy provides the policy framework for the sustainable use of wildlife such as freshwater crocodiles.

1.4.2 Other States and Territories

The freshwater crocodile is protected in all Australian States and Territories.

Western Australia

Whilst the freshwater crocodile is listed as common in Western Australia, it is listed as “Other Specially Protected Fauna” under the *Wildlife Conservation Act* in recognition of the potential impact that unauthorised taking can have on wild populations (CALM 2009).

Queensland

Crocodiles and all native fauna in Queensland are protected under the *Nature Conservation Act*. There is currently no management program for freshwater crocodiles in Queensland.

1.4.3 Commonwealth Government

Environment Protection and Biodiversity Conservation (EPBC) Act

The *EPBC Act* regulates imports and exports to and from Australia of all Australian native animals or their parts. The freshwater crocodile is a listed marine species under the *EPBC Act*. This protects the species and limits the circumstances under which they may be taken. Part 13A of the *EPBC Act* regulates imports and exports of crocodiles and crocodile products. It also fulfils Australia’s legislative requirements as a party to CITES (see 1.4.4). Section 303CH lists specific conditions that must be met for the commercial export or import of CITES specimens. For CITES Appendix II exports the specimen must be sourced from an appropriate captive breeding or artificial propagation program, an approved wildlife trade operation, or an approved wildlife trade management plan.

This Northern Territory Management Program has been developed to demonstrate that crocodile management in the Northern Territory satisfies the requirements of the *EPBC Act* for an approved wildlife trade management plan.

A State/Territory management program for wild populations is not required if a State/Territory elects to limit use to captive breeding. However, even crocodile farms based solely on captive breeding in Australia have to be approved under the *EPBC Act* before permission to export products is granted.

Aboriginal Land Rights (Northern Territory) Act

This Act establishes the Land Councils. A function of the Land Councils is that they confirm the correct landholders (traditional owners) have given their permission for any commercial wildlife harvest before *TPWC Act* permits can be issued. This Act also provides for Section 19 Land Use Agreements which should be in place for commercial crocodile harvesting. These agreements can provide the conditions of access to land for the purpose of harvesting and there should be consistency between *ALR Act* Land Use Agreements and *TPWC Act* permits.

1.4.4 International

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

All crocodylians (including alligators, caimans and true crocodiles) are listed on the Appendices of CITES to which Australia is signatory. Those species most threatened in the wild by trade are listed on Appendix I and all remaining species are listed on Appendix II. The freshwater crocodile is listed on Appendix II which allows international trade subject to the provisions of CITES. The Appendix II listing places controls on international trade in crocodiles and crocodile products through export permits. A CITES export permit is required for all commercial exports and can only be issued if it has been determined that the export will not be detrimental to the survival of the species and that the specimen was legally obtained.

Convention on Wetlands of International Importance (Ramsar Convention)

Australia is a signatory to the Ramsar Convention. There are plans of management for two of the three Ramsar-listed areas of the Northern Territory (Stages one and two of Kakadu National Park) which protect wetlands and their dependent fauna, including freshwater crocodiles. NRETAS is currently developing a plan of management for the trial NT Ramsar site, Cobourg Peninsula (Garig Gunak Barlu National Park).

2. Management Context

2.1 Socio-economic values

2.1.1 Cultural values

In the Northern Territory, crocodiles are iconic animals that attract considerable publicity and a wide range of community views and opinions regarding their abundance, distribution and cultural and economic importance. Community views towards crocodiles range from them being regarded as totems of spiritual significance among some Aboriginal communities to being automatically seen as dangerous pests (mostly saltwater crocodiles) among some other sectors of the community.

2.1.2 Harvesting & farming

The harvesting of saltwater crocodiles primarily for their skins but also for their flesh and body parts supports a significant industry in the Northern Territory. There is also a small demand for freshwater crocodiles. The skins of freshwater crocodiles are less valued than those of saltwater crocodiles, as they have a larger scale size, and osteoderms (bone deposits) in the scales of freshwater crocodiles increase processing requirements (Peucker 1997).

2.1.3 Tourism

Crocodiles contribute significantly to visitor enjoyment of the Top End and viewing crocodiles is an important expectation or even a “must” for most Top End visitors. In visitor surveys, Tremblay (2003) reported that crocodile viewing dominates the best experiences in wildlife-viewing. While tourists generally prefer to see the larger saltwater crocodile, attractions featuring freshwater crocodiles are also rated highly and are popular.

2.2 Population estimates and trends

There are no recent reliable estimates of the population size of freshwater crocodiles in the Northern Territory. However, it is common and locally abundant and is not listed as threatened under Northern Territory or Commonwealth legislation. Details of the distribution and density of freshwater crocodiles have been gathered in conjunction with the saltwater crocodile monitoring program (Leach *et al.* 2009), although that monitoring program focuses particularly on the downstream reaches of rivers that form the principal habitat of the saltwater crocodile. Additional data have been collected in other parts of their distribution as part of specific projects. A 1993 population estimate for freshwater crocodiles (Webb and Manolis 1993) suggested that there were approximately 40 000 to 60 000 individuals in the Northern Territory. There are no recent estimates.

Densities of freshwater crocodile vary between habitats. The tidal section (approximately 35 km) and the freshwater section (approximately 165 km) of the Daly River, and the freshwater section (approximately 70 km) of the Mary River have been surveyed as part of the monitoring of freshwater crocodile populations in the Northern Territory (Figure 1). The density of freshwater crocodiles reported from these surveys ranges between 3 to 15 freshwater crocodiles per kilometre in the tidal section of the Daly River and 10 to 17 per

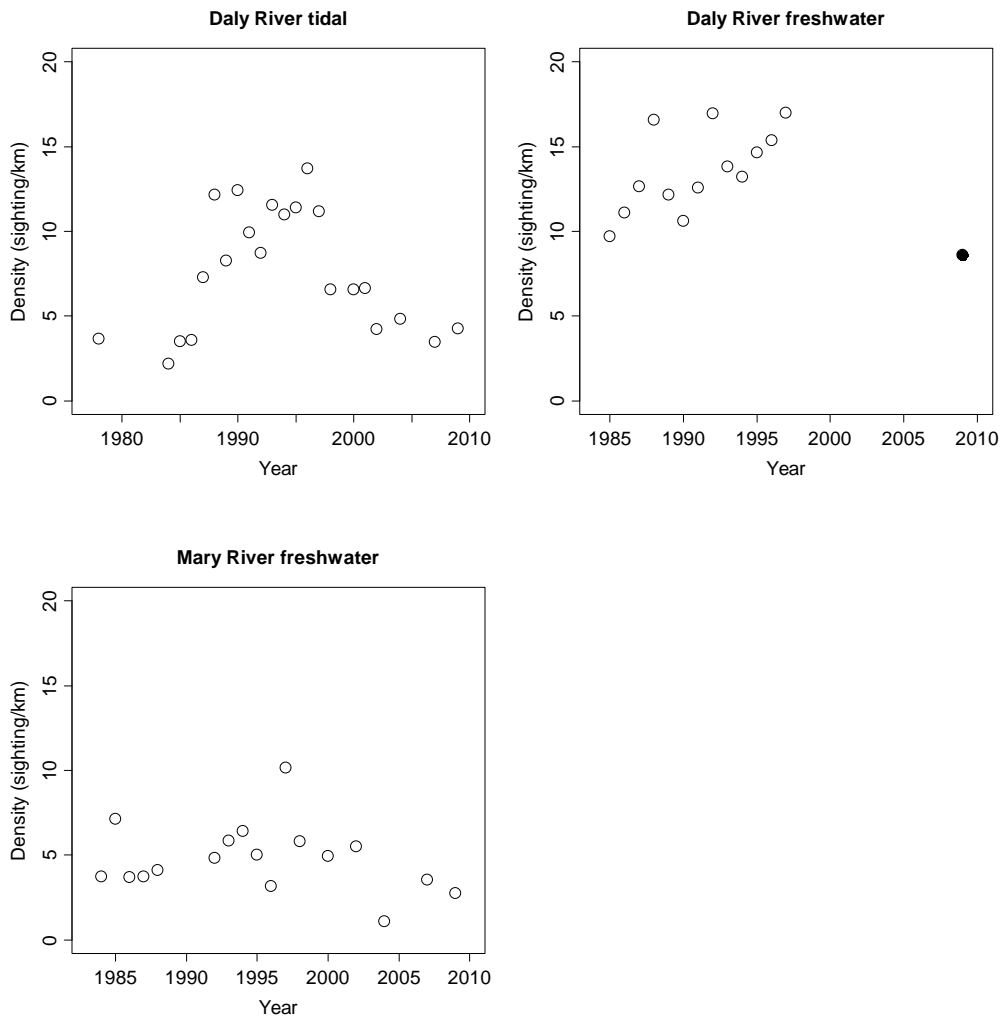
kilometre in the freshwater section; and between 2 to 10 freshwater crocodiles per kilometre in the freshwater section of the Mary River.

The density of freshwater crocodiles in both the tidal and freshwater sections of the Daly River appears to have increased until the late 1990s. Data from the tidal section suggest that numbers of freshwater crocodiles have decreased since the late 1990s, corresponding to an increase in saltwater crocodiles over the same time period in this section of the river. In the Mary River, the population appears to have been relatively stable with a possible decrease in recent years. Further surveys are required before this potential decrease can be confirmed.

The timing of these possible local population decreases roughly coincides with the expansion of saltwater crocodiles into areas formerly used by freshwater crocodiles, and the later advent of cane toads in the area (circa. 2004). Post European settlement in the Northern Territory and particularly during the period of unregulated hunting of both salt- and freshwater crocodiles between 1945 and 1971, populations of both species declined to low levels and in the case of the saltwater crocodile to the point they were considered close to extinction. During this period and post 1971 until the mid to late 1990s it is speculated that freshwater crocodiles have invaded what was traditionally saltwater crocodile dominated habitat. With the recovery of saltwater crocodile populations this trend has been reversed and the recent decline of freshwater crocodiles in saltwater crocodile dominated habitat is not considered to indicate a threatening or unsustainable decline, rather, the re-establishment of equilibrium population balance and habitat utilisation between freshwater and saltwater crocodiles.

Finer details of the population trend in freshwater crocodiles since the arrival of cane toads is under investigation in the McKinlay River in the upper Mary River catchment (Wildlife Management International), and in the Daly and Victoria River catchments (Letnic *et al.* 2008). Letnic *et al.* (2008) report that the impact of cane toads on freshwater crocodile population of the Victoria River is both detectable and detrimental. Freshwater crocodile populations in the Victoria River have declined significantly (some 45%) between 2005 and 2007 and Letnic *et al.* (2008) attribute this decline to the impact of cane toads. The sections of the Victoria River and associated freshwater crocodile populations studied by Letnic *et al.* (2008) are at the lower rainfall limit of the distribution of the freshwater crocodile in the NT and Letnic *et al.* (2008) speculate that the semi-arid habitat of these areas results in greater susceptibility of the freshwater crocodile to cane toad impact than occurs on the “wetter” floodplains to the north, as represented by the Daly and Mary rivers.

Figure 1: Density of freshwater crocodiles (non-hatchlings including eyes-only) sighted in spotlight surveys of the downstream (tidal) and upstream (freshwater) sections of the Daly River and the freshwater sections of the Mary River. The 2009 survey in the freshwater section of the Daly River (filled circle) was shorter than other years by 40 km (126.9 km in 2009 and 165.3 km in the other years) and must be treated with caution.



2.3 Habitat

Freshwater crocodiles inhabit inland wetlands, rivers, creeks and billabongs across the Top End of the Northern Territory. They occur in the upper tidal reaches of some rivers, but are primarily upstream of tidal influences. These upstream rivers, creeks and wetlands contain non-tidal freshwater that may or may not flow during the dry season. Substrate tends toward either sand or, where river channels transect escarpments and plateaus, rocky, and in freshwater wetlands sands, loams and other friable substrate. This reflects the nesting requirements of the freshwater crocodile for friable substrates in which they can dig a 'nest-hole'.

2.3.1 Protected areas

Parks, reserves and sanctuaries in the Northern Territory provide a mosaic of secure areas in which freshwater crocodiles and their riparian and wetland habitats are protected (Table 1).

They also provide areas where the public can view and learn about crocodiles and their conservation. The commercial harvest of freshwater crocodiles is not currently permitted within these protected areas.

Table 1: Protected areas in the NT where the freshwater crocodile is known to be abundant.

Name	Area (km ²)
Kakadu National Park	19 068
Gregory National Park	12 887
Limmen National Park	12 300
Nitmiluk (Katherine Gorge) National Park	2 935
Litchfield National Park	1 459
Mary River National Park	1 217
Keep River National Park	314
Elsey National Park	138
Flora River Nature Park	77
Douglas River / Daly River Esplanade Conservation Area	43
Tjuwaliyn (Douglas) Hot Springs Nature Park	31
Daly River (Mt Nancar) Conservation Area	21

2.3.2 Significant wetlands outside reserves

A major part of the range of freshwater crocodiles in the Northern Territory lies within either Aboriginal lands or pastoral lands. Pastoralists, local communities and/or their legal representatives support the maintenance of freshwater crocodile habitat by controlling activities likely to be detrimental to the long-term conservation of freshwater crocodiles. These protocols and restrictions offer significant protection of freshwater crocodile habitat by assisting with control of fires and invasive species, protecting riparian habitat and controlling access.

2.4 Problem freshwater crocodiles

Crocodile management in the Northern Territory allows problem crocodiles (mostly saltwater crocodiles) to be removed from areas where they may cause harm to people and their property.

Problem crocodiles are defined broadly as those individuals where one or more of the following applies:

- The crocodile has attacked or is about to attack a person or persons;
- The crocodile is behaving aggressively towards a person or persons;
- The location of the crocodile makes it a threat or potential threat to human safety or wellbeing; or
- The activity of the crocodile is affecting the productivity of commercial enterprises.

In the case of freshwater crocodiles, animals may be of concern on occasions where they venture into areas where saltwater crocodiles are considered a problem. It can be difficult for the non-specialist to identify species and the presence of any crocodile in some areas can constitute a problem (Webb *et al.* 1987). Although generally harmless to humans freshwater crocodiles can be of slight concern to the public, particularly if they are provoked or interfered with. Freshwater crocodiles do not generally attack stock or larger prey.

In some areas, such as the Darwin Harbour 'Intensively Managed' Zone and designated swimming areas in National Parks (e.g. Wangi Falls in Litchfield National Park), any saltwater

crocodile found there is removed and in certain circumstances freshwater crocodiles may also be removed (e.g. large aggressive animals).

2.5 Indigenous harvest and use

Crocodile meat and eggs are thought to have been used as a food source by Aboriginal people since their arrival in Australia (McBryde 1979, Flood 1983).

The importance of crocodiles of both species in Aboriginal culture is reflected in a complex system of totems and ceremonies which is still evident in northern Australia (Lanhupuy 1987).

Section 122 of the *TPWC Act* maintains the right for traditional harvest (other than for the purpose of sale) of crocodiles and their eggs for food gathering, ceremonial and religious purposes by Aboriginal people. The extent of traditional harvests of crocodiles is thought to be small but it is difficult to quantify and varies greatly from area to area and year to year. Recent evidence suggests that the contemporary subsistence use of crocodiles in areas where they are relatively abundant is negligible (A Griffiths (NRETAS) and J Altman (ANU), *pers. comm.*). No dedicated monitoring is required for the subsistence use of freshwater crocodiles.

2.6 Commercial harvesting and use

Freshwater crocodiles were commercially hunted in the Northern Territory before they were given protection in 1964. Freshwater crocodiles were only hunted intensively for five years from 1959 to 1964 (Webb *et al.* 1987, Davis 1994). Before this they were largely ignored because their skin quality was inferior to that of saltwater crocodiles. With increased demand and advances in technology, a market for the freshwater crocodile skins was established in 1959 (Webb *et al.* 1987). Although the total number of animals taken is not available, it has been estimated that 60 000 to 80 000 skins were traded (legally and illegally) between 1959 and 1964 (CCNT 1986, Webb *et al.* 1987). The recovery of the freshwater crocodile populations in the Northern Territory since 1964 until at least the late 1990s has largely gone unnoticed by the general public as its preferred habitat is generally away from populated areas (Webb *et al.* 1987) and it does not have the same high predator profile as that of saltwater crocodiles.

Initial management programs for crocodiles (saltwater and freshwater crocodiles) in the Northern Territory included the provision for wild harvest of eggs, hatchlings, sub-adults and adults for rearing in captivity for production purposes. The 1998 management program (PWCNT 1998) also allowed non-hatchlings to enter trade directly after harvesting, without the need to spend time in a farm. The first crocodile farm in the Northern Territory was established in 1980. There are currently six operating crocodile farms in the Northern Territory, which collectively hold 252 freshwater crocodiles as at 31 December 2008 (cf. 86,000 for saltwater crocodiles).

There is a small demand to harvest freshwater crocodiles for their skins, flesh and body parts. While extensive harvests were carried out in the 1980s, very little harvest from the wild has occurred since the mid-1990s. The value of skins from this species is low and the current export market demand for skins or parts is correspondingly low.

The Daly River was one of the main rivers from which freshwater crocodile hatchlings were harvested in the 1980s. A total of 15,655 hatchlings (1983 to 1991), 866 eggs (1983 to 1984) and 27 juveniles/adults were harvested from the Daly River. Figure 1 demonstrates that for

the Daly River this level of harvest of hatchlings from 1983 to 1996 had no adverse detectable effect on populations during that time.

The commercial harvest of freshwater crocodiles in the Northern Territory was mainly of eggs and hatchlings prior to the mid-1990s (PWCNT 1998). Hatchlings were most harvested since 2000 (Table 2). All harvests remained well below the harvest ceilings.

Table 2. Number of freshwater crocodiles of different age classes harvested since 2000.

	Egg	Hatchling	Juvenile	Adult
Annual ceiling	4 000	6 000	1 000	200
2000	30	100	0	0
2001	0	0	0	0
2002	0	80	0	85
2003	0	25	0	12
2004	0	0	0	28
2005	0	150	0	26
2006	0	54	0	30
2007	0	60	0	9
2008	0	0	0	4
Total	30	469	0	194

3. Threats and Impacts

Existing patterns of land use (chiefly pastoral, reserves and Indigenous lands) in the range of the freshwater crocodile are generally consistent with retaining large wetland areas and their dependent crocodile populations. Potential threats or impacts to crocodile populations worldwide are detailed in Groombridge (1987), Jenkins (1987) and Tucker (1998). As with all crocodylian species, most threats (direct and indirect) impacting freshwater crocodiles are anthropogenic in origin. Within the life of this program there are no perceived or likely threats to alter the current conservation status of freshwater crocodiles in the Northern Territory and it is expected that the species will continue to be abundant.

The public expectations of more intensive management of saltwater crocodiles in areas close to human habitation will result in the localised removal of increased numbers of freshwater crocodiles. However, real or perceived changes to public attitudes and any subsequent reduced tolerance of crocodiles will not impact on the broad-scale maintenance of a viable Northern Territory-wide population of freshwater crocodiles.

3.1 Cane toad poisoning

The cane toad *Rhinella marina* (formerly known as *Bufo marinus*) contains high concentrations of a toxin which is poisonous to many Australian vertebrates. Since its introduction to Queensland in 1935, the cane toad has invaded much of northern Australia and its range is still expanding. It is listed as a key threatening process under the *EPBC Act*. The freshwater crocodile has been identified as a species that is potentially at risk of being poisoned by cane toads (van Dam *et al.* 2002). Letnic and Ward (2005) have reported on predatory interactions between freshwater crocodiles and cane toads in the Roper and Daly Rivers of the Northern Territory, confirming previous reports (e.g. Covacevich and Archer 1975; van Dam *et al.* 2002), that cane toads are a prey item for and may be ingested by freshwater crocodiles. Freshwater crocodiles are susceptible to poisoning by cane toads (Letnic and Ward 2005) and there is evidence that cane toads have adversely impacted populations of freshwater crocodiles in the Northern Territory (Letnic *et al.* 2008) at least in the short-term.

While Letnic *et al.* (2008) provide evidence that cane toads have adversely impacted freshwater crocodile populations in the Northern Territory, they do not appear to have had a substantive adverse impact on freshwater crocodile populations in Queensland. Letnic *et al.* (2008) refer to earlier studies in Queensland (Tucker *et al.* 1996 and Tucker *et al.* 1997) which indicate that freshwater crocodiles are abundant and could not demonstrate any adverse population impacts.

Anecdotal evidence suggests that the impact of cane toads will be greatest in low productivity habitats such as the semi-arid zone and sandstone plateau areas where food resources are limited and encounter rates with cane toads are likely to be higher. Conversely crocodiles should be least impacted in the lowland wetlands and rivers which are highly productive and toads are less likely to be encountered compared with other prey.

3.2 Other natural predators

The only significant predator of crocodiles apart from humans is other crocodiles, with larger saltwater crocodiles eating small crocodiles of both species. The current expansion of saltwater crocodiles into former saltwater crocodile habitat occupied by freshwater crocodiles may be causing localised declines or shifts in the structure of freshwater crocodile populations (see Figure 1). These declines or shifts in structure are not considered

threatening, rather the re-establishment of equilibrium population balance and habitat utilisation between freshwater and saltwater crocodile populations.

Monitor lizards (goannas), and to a lesser degree feral pigs, are predators of the eggs of freshwater crocodiles. The current adverse impact of cane toads on goanna populations (Doody *et al.* 2006) may be lowering the predation pressure on, and increasing the survivorship of, crocodile eggs. This is a complex interrelationship which requires detailed study to unravel.

3.3 Climate change

The impact of climate change through changes in sea levels, temperature, rainfall patterns and probable vegetation changes is an unquantified and largely unknown impact on the freshwater crocodile and its habitats. One of the major effects of climate change is an anticipated rise in sea level with conservative estimates (Hennessy *et al.* 2004) anticipating an increase in sea level of 50 centimetres by 2100 and a corresponding loss of wetland habitat. (particularly coastal and near-coastal floodplain wetlands). These calculations do not take into account other anticipated and compounding changes such as further saltwater intrusion or changes in hydrology and in weed and feral animal distributions. Changes in mean nest temperatures may result in shifts in population sex ratios arising from temperature dependent sex-determination during the incubation period for freshwater crocodile eggs. However, changes may also create opportunities for crocodiles to expand their distribution. The impacts of climate change will occur over a time frame much longer than the life of this Management Program. As such they cannot be mitigated within this program but monitoring should be capable of detecting significant population changes through whatever cause.

3.4 Habitat loss and modification

The habitats of freshwater crocodiles are, in general, not threatened by development although current and proposed clearing in the Daly and Katherine regions may have indirect and non-significant long-term impacts. Freshwater crocodiles do not appear to be affected by the invasion of freshwater wetlands by introduced plants such as *Mimosa pigra*. Since the 1970s, the disturbance of floodplain habitats by feral buffalo and cattle has been greatly reduced following eradication campaigns, although the buffalo and pig numbers are again increasing in some areas.

3.5 Harvesting

Over the several decades of regulated harvesting in the Northern Territory, harvest has been managed to deliver the primary objectives of sustainable, viable crocodile populations.

The harvest of freshwater crocodiles and crocodile eggs is widely dispersed and very limited.

There is no evidence or expectation that the commercial harvest is likely to have any impacts on non-target threatened species or ecological communities of conservation significance or that it will cause disturbance or displacement to other native fauna. Similarly there is no evidence that commercial harvest helps introduce or disperse invasive weeds although there is a possibility that boats could be a vector for aquatic weeds such as *Salvinia* or *Eichhornia*.

4. Management Practices and Performance Measures

To achieve the aims and objectives of this management program, NRETAS in conjunction with the Department of Resources (DoR) implements a range of procedures that ensure the conservation of freshwater crocodiles and provides control of their harvest, farming and trade in accord with the *TPWC Act* and the *EPBC Act*.

Performance indicators are provided for each management practice. The milestones and performance measures for the life of the program are summarised in Appendix 3.

Objective 1 - To facilitate the sustainable use of freshwater crocodiles

4.1 Commercial harvest and use

Commercial use will be regulated by issuing individual permits. It is anticipated that commercial demands will be met primarily by farming freshwater crocodiles under permit.

Any commercial operations established will be individually licensed and will be regulated under Section 55 of the *TPWC Act* and such operations are subject to review under the *Environmental Assessment Act*.

4.1.1 Spatial restrictions on harvesting

Harvesting will be prohibited or restricted in some areas or circumstances if necessary to ensure the sustainability and conservation of the species. In particular harvesting will not normally be permitted:

1. In waterways where a watercourse forms the boundary between two or more properties, due to issues surrounding ownership of wildlife on property boundaries
2. In the upstream sections of the catchments where rivers are seasonally restricted to billabongs and waterholes until research clarifies the extent of impact of cane toads on these populations.
3. On populations of the stunted form of the freshwater crocodile (“pygmy” freshwater crocodile) until analysis determines the level of genetic distinctiveness of the stunted form (as found in some upper catchments in the Arnhem plateau and the Pinkerton Range). Further specific management objectives may be determined for such forms should they be demonstrated to be significantly distinct.
4. From sites where crocodiles are particularly significant to local Indigenous people.
5. In catchments that are heavily used by the tourist industry except on a case by case basis. In those cases where low level harvest is permitted it will be strongly regulated to ensure that the tourist and crocodile industries remain complementary.
6. Of particularly large crocodiles (greater than 2.5m) except on a case by case basis. This will be regulated closely to ensure the presence of large iconic animals which are culturally important.

These restrictions are to ensure that harvest has no significant impact on tourism, social or cultural interests and conservation values. Any reported impacts of harvesting by the tourism

industry or indigenous groups will be investigated and management arrangements amended if necessary.

Performance Indicator

Tourism, social and cultural interests do not experience significant detrimental impact as a result of harvesting.

4.1.2 Harvest ceiling

The total number of freshwater crocodiles that can be taken for commercial harvest within the Northern Territory in a calendar year is the annual commercial freshwater crocodile ceiling (Table 3). The Director of the Parks and Wildlife Commission may vary the ceilings, provided that, in the case of an increase, the Australian Government (DEWHA) has provided written approval of the change. Prior to making a decision to revise the ceiling, the Director of the Parks and Wildlife Commission must consider the following:

- current known trends in population size and structure;
- climatic or environmental effects on the population;
- management objectives for specific areas;
- proportion of total habitat subject to harvesting;
- any non-commercial mortality events within populations;
- review of previous harvests;
- review of past and current research results; and
- any other information considered relevant by the Director of the Parks and Wildlife Commission.

Within specific areas of land subject to harvesting, local sustainable harvest levels will be determined after similar considerations.

The natural mortality of eggs and hatchlings is known to be high (e.g. Webb *et al.* (1987) estimate that <5% of eggs survive to become 1 year old hatchlings). With high natural mortality amongst the early age classes of the species, the removal of a small number of hatchlings has limited impact on the overall population. Adult survivorship is considerably higher allowing for a limited harvest to be taken without adversely affecting the stability of populations or its capacity to increase.

The harvest ceilings set out in Table 3 represent substantial reductions in the harvest ceilings from the previously approved freshwater crocodile management program and are considered to be conservative and well within sustainable limits. These reductions from the previous program are primarily in response to the reduced demand for freshwater crocodiles over the past two decades (Section 2.6). Populations harvested at these levels are expected to fluctuate primarily in response to environmental conditions such as rainfall and the availability and quality of breeding habitat.

Table 3: Annual harvest ceilings for freshwater crocodiles from the wild. The size of each category of crocodile is indicated in total length (TL), measured in metres from the tip of the snout to the end of the tail.

Class	Size	Quota 1998, 2005-2010	Quota 2010-2015
Eggs		4 000	300
Hatchlings (0 – 1 year)	<0.6 m	6 000	1 000
Juveniles	0.6–1.5 m	1 000	300
Adults	>1.5 m	200	200

Performance Indicators

All reported and suspected local impacts of the harvest on the population are investigated and appropriate management actions implemented to counter the impact.

Adaptive management actions will be implemented should there be any increase in threats to the freshwater crocodile and their habitat.

A GIS database to assist with monitoring harvest effort and compliance will be developed within the life of this program.

Harvest ceilings will be reviewed after every spotlight survey and adjusted (if necessary) in accordance with the provisions of this Management Program..

4.2 Permits and compliance

Commercial use will be regulated by issuing individual permits under Section 55 of the *TPWC Act*. The NRETAS web site provides details of the types and conditions of permits relating to wildlife (<http://www.nt.gov.au/nreta/wildlife/permits/index.html>). Commercial operations are subject to review under the *Environmental Assessment Act* when established. The commercial processing of farmed crocodile meat from the live animal up to leaving an abattoir is covered under the *Meat Industries Act*. Food products after leaving the abattoir are regulated by the *Food Act*. Packaging is labelled to identify the contents as coming from an approved wildlife trade management program.

4.2.1 Permits to take

The freshwater crocodile is protected in the Northern Territory. The removal of any crocodiles from the wild (animals or eggs; live or dead) requires a Permit to Take from the Northern Territory Government, or on Commonwealth land such as Kakadu National Park, a permit from the Australian Government. Permits to Take must be linked to a Permit to Keep if the specimens are retained. Permit applications must include details on the method, extent and location of the proposed harvest. All permits for harvesting will require the written consent of the landholder. Permits are normally for one year but egg harvesting permits may on request be issued for up to three years. New multiple year egg harvest permits will be issued on the basis of an annual allocation. The allocations for years two and three will be assessed and

adjusted each year as part of a rolling program. The closing date for egg permit applications for each season will be 30 April to ensure all applications have been assessed and issued prior to the nesting season, August to September.

The permit holder must provide the Northern Territory Government with a written report on activities conducted under the permit. This report should include details on the number of animals (including eggs) taken, CITES skin tag numbers if relevant, the size and sex of each crocodile that was taken, and a GPS location and date of the harvest. In the case of egg collections, returns must be lodged by 30 November and the report should provide details of all eggs including the number of live eggs harvested at each collection site with GPS location and the number of viable eggs produced. Annual reports/returns need to be submitted each year for a multi-year permit. Failure to lodge a return or the inclusion of insufficient or incorrect information in the permit return may result in issuing a warning letter, caution notices, an infringement notice, the refusal of future permit applications, revocation of permits and/or prosecution.

The Northern Territory Government may cancel a permit at any time if information becomes available that indicates that conservation management measures may be required to protect a population. Compliance with the Code of Practice (see Section 1.4.1) will be a condition of all permits issued for harvesting crocodiles.

4.2.2 Permits to keep

A Permit to Keep from the Northern Territory Government is required to keep and/or trade the freshwater crocodile and/or its parts. A Permit to Keep in captivity is subject to annual renewal and compliance with the provisions of the *TPWC Act* and the *Animal Welfare Act*. Compliance with the Code of Practice (see Section 1.4.1) will be a condition of all permits issued to keep crocodiles. Crocodiles kept as pets also require a Permit to Keep with a particular set of permit conditions. These conditions can be found at the following link <http://www.nt.gov.au/nreta/wildlife/permits/croc.html>.

Farm records are administered by DoR and the responsibility for farm records rests with DoR. The holder of the Permit to Keep is required to provide monthly farm records to DoR detailing stock gains/losses, transfers, sales, mortality, and skin and meat processing figures. Crocodile farms are also required to submit the details of all animals held on the annual permit return to NRETAS. This information is used to compare farm holdings with wild harvest permit returns and ensure compliance with wild harvest permits. In the case of wild caught animals annual returns are to be provided to NRETAS.

Individuals or companies that trade products derived from freshwater crocodiles taken under this Management Program are required to maintain detailed records. To trade in skins the skin must be marked with a CITES skin tag. For products other than skins, such products must be marked with a product label in accordance with the NRETAS product label guidelines. NRETAS issues product labels for finished products on a cost recovery basis or producers can print the required information on their own labelling and packaging. The minimum requirement for an approved product label is that the label:

- states that this is a crocodile product produced in accordance with an approved management program;

-
- shows the permit number of the Permit to Keep that the product was produced under; and
 - shows the date that the product label was affixed to the product.

These labels identify these products as originating from a legitimate source.

Failure to lodge a return or the inclusion of insufficient or incorrect information in the permit return may result in issuing a warning letter, caution notices, an infringement notice, the refusal of future permit applications, revocation of permits and/or prosecution.

4.2.3 Permits to export and import

A permit issued under the *TPWC Act* is required to export (including re-export) wild caught, commercially farmed and captive-bred freshwater crocodiles, or its parts, from the Northern Territory to other Australian States and Territories. Permits for the export of live animals or parts derived from wild caught animals are obtained from NRETAS. Permits for export of parts derived from ranched or captive-bred animals are obtained from DoR.

The overseas export of shipments of live crocodiles and commercial shipments of crocodilian skins, products or by-products from Australia requires a CITES permit from the Australian Government (DEWHA). DoR provides skin tags on behalf of the Australian Government (DEWHA) for commercial shipments of skins from crocodile farms. All international exports will require an export permit from NRETAS prior to DEWHA issuing a CITES permit.

Under CITES provisions for personal effects, manufactured crocodilian products can leave Australia within a passenger's personal luggage without a CITES permit if they are personally owned, non-commercial, legally acquired, and no more than four items are carried per person. If sourced in the Northern Territory, these items should have a product label attached stating that the crocodilian product is derived from an approved management program (see section 4.2.2).

An import permit issued by the Australian Government (DEWHA) is required for the commercial shipment of crocodilian products or their parts entering the Northern Territory from overseas. A Northern Territory import (including re-import) permit, issued under the *TPWC Act* is required for all shipments of crocodiles or their parts entering the Northern Territory from within Australia. Imports from other Australian jurisdictions should also be accompanied by an export permit from that jurisdiction. Import permits for live animals are issued by NRETAS and are valid for one month. Import permits for crocodile products are issued by DoR.

4.2.4 Permits and returns

Each farm's Permit to Keep requires that the farm submit monthly farm records (see section 4.2.2). Data from the monthly returns from crocodile farms is collated and submitted to DoR, published in annual reports by NRETAS and submitted to the Australian Government (DEWHA) (see Section 4.8.2 for information on reporting requirements). Submitting production data to DoR is a requirement of the Permit to Keep. DoR conduct annual hatchling audits on all farms to validate monthly returns.

Shipment inspections

An AQIS health declaration and certification of any skins and hides is required for international shipment and is supplied by DoR. All international shipments of crocodile products are inspected by a DoR officer. Shipments are inspected to ensure that they comply with the conditions and details on the export permit. Once a shipment is inspected and sealed by a DoR officer it can be exported.

Skins

Each whole skin, whole belly skin and, whole hornback skin and trophy skin entering trade or being exported will be marked with a non-reusable plastic skin tag issued by the Australian Government (DEWHA) in compliance with the provisions of CITES Resolution Conf. 11.12. <http://www.cites.org/eng/res/11/11-12.shtml> . Excised backstraps are packaged into a carton and the skin tag is attached to the carton. The permit issued for backstraps states that the tag is attached to the box and records the total number of backstraps in the carton.

Each farm completes a Specimen Export Record (SER) which should list the number of each skin tag that has been attached to either the whole skin or to each carton of backstraps. The original SER should be sent with the shipment, along with a photocopy of the Multiple Use Consignment Authority. The acquittal notice of the SER should be returned to DEWHA following export. Each skin tag is uniquely numbered and the number serves as an identification number for all subsequent record keeping related to the skin of that particular animal. DoR is responsible for issuing skin tags on a cost-recovery basis. Skin tags are issued annually.

Flesh

Flesh is packed in cartons that are marked to show that the enclosed product is a farmed product. Producers can use pre-labelled cartons which state that the contents are perishable and needs to be kept frozen or kept cold. Alternatively flesh can be sealed in standard cartons using specially marked green tape printed with “contents are perishable and needs to be kept frozen or kept cold”. This labelling requirement applies to both domestic and international shipments. The labelled tape is available from DoR. All international shipments of crocodile flesh or meat need a CITES export permit issued by DEWHA.

By-products

Large parts (e.g. skulls), minor parts and derivatives of animals exported under the program are labelled with a product label in accordance with the NRETAS product label guidelines NRETAS (see section 4.2.2). All by-products exported overseas require a CITES export permit issued by DEWHA.

Manufactured items (excluding tanned whole skins)

Manufactured items are identified with a product label in accordance with the NRETAS product label guidelines (see section 4.2.2). Commercial quantities of manufactured items exported or re-exported from Australia overseas require a CITES permit issued by DEWHA.

4.2.5 Compliance

The Northern Territory government implements the following actions as minimum measures to enforce compliance:

- random checks may be conducted on permit holders to ensure compliance with permit conditions and reporting;
- data collected will be linked and compared to ensure the smooth transition between different NT Departmental auditing systems;
- the Northern Territory Government will work collaboratively with other jurisdictions (i.e. Queensland, Western Australia and Australian Governments) and industry to eliminate the possibility of illegal trade of eggs, animals or products interstate; and
- the Northern Territory Government will investigate any reported potentially illegal incident and take legal action where sufficient evidence is obtained.

The Northern Territory Government has the capacity to develop and introduce permit conditions should any new additional compliance measures be needed.

Performance Indicators

The annual commercial harvest of freshwater crocodiles does not exceed the approved ceiling for each category.

All permits related to freshwater crocodiles issued under the TPWC Act meet the requirements of the management program.

Harvest applications, approvals and returns are assessed and reviewed upon receipt and any discrepancies investigated and resolved.

No harvest permits are issued without correct landholder approval.

All submitted permit returns meet the reporting requirements identified in the management program and included in the permit conditions.

All CITES permits and skin tags issued will be checked against farm returns to ensure compliance.

All crocodile farms will be inspected annually to check farm stock numbers.

Permit conditions will be reviewed annually and amended where necessary.

Compliance with permit conditions is at or near 100% and permit breaches are addressed through warning letters, caution notices, infringement notices or prosecution.

4.3 Management-focused research

Management decisions will be enhanced by some focussed research and analysis at the population level. Firstly, there are several populations of so called “pygmy” freshwater crocodiles that occur in low productivity areas on sandstone plateaus – namely the Arnhem plateau and Pinkerton Range. Within the life of this management program, NRETAS will encourage research to assess the genetic distinctiveness of these two forms. The results of this research will determine the appropriate management strategies to be implemented with respect to these populations in the Northern Territory. Preliminary genetic analysis of a population in the upper Liverpool River on the Arnhem Plateau suggests that the differences do not warrant sub-specific status (Nancy Fitzsimmons University of Canberra, *pers. comm* 2007).

Secondly, updated knowledge of current population dynamics and age/sex structure is strongly needed, particularly with the advent of cane toads across the Territory and the likely future impacts of climate change. This is best initially achieved by a detailed analysis, including population modelling, of existing survey data from all rivers. Comparisons with the long-term detailed capture data from the McKinlay River area (collected by Wildlife Management International) would be valuable. Research into the impact of cane toads on freshwater crocodile populations and population dynamics particularly in the lower rainfall and/or upstream areas of catchments is important and under investigation in the McKinlay River (Wildlife Management International) and in the Daly and Victoria Rivers (M. Letnic, University of Sydney).

Current monitoring surveys will be continued (5.4.7) and should either monitoring or modelling indicate any population decline, further population research will be undertaken. This may involve expansion of monitoring program to include rivers not currently surveyed.

NRETAS will assess and issue permits for research on crocodiles. Crocodiles or any crocodile products taken under a research permit will not be considered as part of this management program unless they are likely to enter into commercial trade. Any live eggs that arise from permitted research activities that enter the commercial farming system will be included within the ceiling and the reporting to the Australian Government (DEWHA). Non-viable eggs collected for permitted research activities will be excluded from the egg ceiling. Additional viable eggs can be obtained for legitimate research provided they do not enter the commercial industry. These eggs would be subject to the normal conditions and processes covered under any research proposals that use wildlife.

Performance Indicators

Available data to describe changes to freshwater crocodile populations and their distribution reviewed and analysed. Outcomes published as appropriate.

Objective 2 - To promote community awareness and public safety.

4.4 Removal of problem crocodiles

The program allows for problem freshwater crocodiles to be relocated, killed and used directly for skin and meat production, or captured and used as stock in crocodile farms.

NRETAS has specialist staff-members who remove problem crocodiles. In remote areas where NRETAS staff-members are unable to attend, crocodiles may be removed following the issue of a Permit to Take by NRETAS. Crocodiles taken in these circumstances will contribute to the ceiling for wild harvested crocodiles. Problem crocodiles removed by NRETAS staff do not contribute to the ceilings for wild harvested crocodiles.

Given that it can be difficult for non-specialists to distinguish between species of crocodile, public awareness campaigns will also be conducted on an as-needs basis to minimise harmful interactions between people and crocodiles, including freshwater crocodiles.

The capture and handling of problem crocodiles must comply with the *Animal Welfare Act* and the Code of Practice.

Performance Indicators

Permits will be issued to remove problem crocodiles as necessary and appropriate.

Program to remove problem crocodiles in designated swimming and 'intensively managed' management areas is maintained.

NRETAS responds to reports of problem crocodiles and implements appropriate management measures.

4.5 Community awareness

The public profile of crocodiles and crocodile management in the Northern Territory is high, particularly for the saltwater crocodile, and has resulted in the development of the CROCWISE education and awareness program. Maintaining effective communication links between NRETAS and the community is considered an important component to the success of this program. Effective communication structures are also essential for adaptive management and incorporation of feedback from industry and community groups into future management policies and practices for crocodiles in the Northern Territory.

NRETAS promotes crocodile awareness among Northern Territory residents and visitors to the Territory by disseminating educational information. NRETAS will also aim to promote relevant legislation, policy and guidelines to the commercial crocodile industry and wider community via promotion of this management program and through the NRETAS permit system.

Performance Indicators

Public awareness, safety and educational message campaigns will be continually conducted through the media and on the NTG website.

This management program, its annual reports and contact information will be published and maintained on the NTG website.

Objective 3 - To ensure humane treatment of freshwater crocodiles.

4.6 Animal welfare

Harvesting and farming of freshwater crocodiles must be in accordance with the provisions of the *Animal Welfare Act* and with the *Code of Practice on the Humane Treatment of Wild and Farmed Australian Crocodiles*.

Compliance with the Code of Practice will be a condition of all permits issued to take and/or keep crocodiles and hence enforcement is achieved through the *TPWC Act*. Compliance with the Code of Practice for harvests will be enforced by NRETAS and in the case of farms by DoR staff. An indication of a decrease in animal welfare standards or a suspected breach of the *Animal Welfare Act* will result in an inspection. Non-compliance with the *Animal Welfare Act* or the Code of Practice may result in an infringement notice, the permit being revoked and/or prosecution under either the *Animal Welfare Act* or the *TPWC Act*.

Performance Indicators

Requirements of the Code of Practice are included as a condition on all permits and that a copy of the Code is distributed to all new permit holders.

All permit applicants must demonstrate that they are competent to comply with animal welfare standards including the Animal Welfare Act and the Code of Practice.

Inspect farms regularly to ensure animal welfare standards are met.

Investigate and take appropriate action on any suspected breaches of the Animal Welfare Act or the Code of Practice.

Objective 4 - To monitor and report on the impact of the harvest of freshwater crocodiles.

4.7 Monitoring

4.7.1 Population monitoring

Spotlight surveys over selected river systems within the Northern Territory provide indices of the size and age structure of crocodile populations and are the standard method of monitoring for both saltwater and freshwater crocodiles (Messel *et al.* 1981; Stirrat *et al.* 2001). The surveys include counts of the 0–2 foot (0–0.6m) size class which is accepted as equating to hatchlings (less than one year old) and so provides a measure of recruitment from the last nesting season.

4.7.2 Population survey timing and locations

The key rivers monitored by this program are the rivers where most crocodile harvesting occurs; that have been surveyed using the spotlight technique in the past; and for which long-term data sets are available. The results of the spotlight monitoring surveys are used to inform harvest quotas.

The spotlight monitoring program for freshwater crocodiles developed for this program focuses on the following rivers in 2010-2015 (Table 4):

- Daly River – the floodplains are currently the site of the only commercial harvest (juveniles and adults) of freshwater crocodiles and there is an increasing interest in harvesting adults from the area. Surveys will include both the downstream estuarine section (99 km), also monitored for saltwater crocodiles (Leach *et al.* 2009) and upstream freshwater sections (126.9 km) of the Daly River.
- Mary River – this river has a particularly high density of large crocodiles of both species, and is also monitored for saltwater crocodiles (131 km total section length) (Leach *et al.* 2009). Additionally, the upper McKinlay River (a tributary of the Mary River) has been monitored for many years by Wildlife Management International.
- Katherine River including Katherine Gorge – the current saltwater crocodile surveys (44 km total section length) will be revised to allow monitoring of the freshwater crocodile populations.

Table 4: Proposed timing of the spotlight surveys for freshwater crocodiles in the monitored rivers..

River	2010	2011	2012	2013	2014	2015
Daly River		✓		✓		✓
Mary River		✓		✓		✓
Katherine River	✓	✓	✓	✓	✓	✓

Note that the Mary River and Katherine River represent “control” populations, as there is no harvest of freshwater crocodiles from these rivers.

Additional rivers may be included if regular harvesting starts to occur or is anticipated in those areas. Under the current harvest regime, the likelihood of populations declining dramatically due to harvesting is very low. Due to the substantial overlap with the established monitoring program for saltwater crocodiles, these surveys will be synchronised and combined wherever possible.

4.7.3 Analysis of survey data

In addition to data collected from these rivers by NRETAS under dedicated monitoring surveys, data from Keep and Gregory National Parks, collected by Parks staff may provide additional information on the status of populations. Data from Kakadu National Park collected by Parks Australia will also be used as a control as no harvest is occurring in this area. Analysis of the various long-term spotlighting datasets held by NRETAS and the long-term capture data from the McKinlay River (as collected and held by Wildlife Management International) may help to interpret whether trends are due to harvesting impacts or unrelated factors (e.g. climate change or cane toads).

Any river showing a population decline that analysis indicates is significantly greater than the population decline that can be attributed to the impact of cane toads, climate change or other causes unrelated to harvesting will be subject to immediate review of harvest levels for that river. Initial response will be the cessation of harvesting in that river until such time as research and monitoring determine the sustainable harvest level for the particular river. Harvest ceilings generally will be reviewed taking into consideration the results of any research and monitoring carried out as a consequence of a population decline that is attributed to the impact of harvesting.

NRETAS will maintain a broad overview of the current extent and quality of freshwater crocodile habitat on all tenures of land.

4.7.4 Commercial harvest estimates

Information on the crocodile harvest (size and sex of non-hatchling crocodiles, numbers of total, live and viable eggs) is obtained through harvest returns submitted by permit holders. Harvest figures will also be considered in combination with numbers removed through other means (e.g. non-commercial destruction), and with environmental conditions that may impact on population size and structure (e.g. poisoning by cane toads). Information on the demographics of the crocodile harvest (e.g. size and sex of non-hatchling crocodiles) is obtained through harvest returns submitted by permit holders.

Performance Indicators

Spotlight surveys will be undertaken on an annual (or biennial) basis as stipulated in Table Four of this management program.

The results of the monitoring program(s) will be analysed and assessed and any resulting management recommendations will be implemented.

Any significant declines in populations will be investigated as appropriate.

Data for monitoring programs will be reported on the NRETAS web site.

4.8 Reporting

4.8.1 Crocodile farms

All crocodile farms are visited by DoR staff on a regular basis for the purposes of inspection and certification of crocodiles and crocodile products for trade and disease investigations. During these visits DoR staff monitor for compliance with animal welfare standards. Designated Northern Territory Government Animal Welfare officers may conduct an animal welfare investigation at any time in response to a complaint. See Sections 4.2 and 4.6 for performance indicators.

4.8.2 Auditing and reporting

The Management Program will be audited internally by the Northern Territory Government (NRETAS and DoR) on an annual calendar year basis. The performance indicators listed in this report will be audited and assessed annually by program management staff. The Northern Territory Government will provide annual reports to the Australian Government (DEWHA). The annual report will include:

- Progress against performance indicators;
- Harvest statistics including:
 - Number of crocodile eggs taken;
 - Number of crocodile hatchlings taken;
 - Number of crocodile juveniles taken;
 - Number of crocodile adults taken;
 - Sex ratio of harvest (adults only); and
 - Average body size of harvested animals for each sex.
- Population monitoring data;
- Number of permits issued for problem crocodile removal and details of the fate of each crocodile covered under those permits;
- Number and location of problem crocodiles removed by NRETAS and the fate of each crocodile;
- Industry production statistics including:
 - Number of crocodiles (hatchlings, juveniles and adults) held and processed;
 - Number of crocodiles produced through captive breeding;

-
- Number of crocodile skins produced and exported;
 - Amount of crocodile meat produced; and
 - Industry compliance statistics including:
 - Number of premises inspected;
 - Number of caution notices issued and reason for issue;
 - Number of alleged offences investigated and outcomes;
 - Any joint surveillance/enforcement activities completed with other agencies; and
 - Any unusual situations that arose (e.g. drought or flood conditions, market influences).

Performance Indicators

The progress of the Management Program against each of the performance indicators will be audited annually (calendar year) and management practices adjusted as necessary.

Annual progress reports will be submitted to the Australian Government (DEWHA) by 31 March and a summary provided on the Departmental website.

4.8.3 Review of program

The 2010–2015 program will be fully reviewed at the end of five years from the date of approval of the program (by 30 June 2015) as required under section 32(2) of the *TPWC Act*. The detail included in this management program in relation to management actions, legislation and administrative arrangements is current as at June 2010.

It is not proposed that the management program will be rewritten should there be changes to management actions, legislation and administrative arrangements during the life of the program unless any such changes are significant and that the Northern Territory Government and Australian Government (DEWHA) agree that a new or amended program is required. The Australian Government (DEWHA) will be advised of any changes to this program.

Performance Indicator

The Management Program is reviewed and updated by 30 June 2015 and the review submitted to DEWHA.

5. References¹

- Burbidge A.A. (1987). The management of crocodiles in Western Australia. In: G.J.W. Webb, S.C. Manolis and P.J. Whitehead (Eds.), *Wildlife Management: Crocodiles and Alligators*. Surrey Beatty & Sons Pty. Ltd. in association with the Conservation Commission of the Northern Territory, Sydney, pp. 125–127.
- CCNT (1986). *Crocodylus johnstoni* in the Northern Territory: biology and history of management. Technical Report No. 32. Conservation Commission of the Northern Territory, Darwin.
- Tucker, A. (1998). *Crocodylus johnstoni*. In: J. P. Ross (Ed.), *Status Survey and Conservation Action Plan*. Second Edition. IUCN/SSC Crocodile Specialist Group. (http://www.iucncsg.org/ph1/modules/Publications/action_plan1998/cjohn.htm)
- DEC (2009). Management Plan for the commercial harvest and farming of crocodiles in Western Australia 1 January 2009 – 31 December 2013. Western Australian Department of Environment and Conservation.
- Cogger H.G. (2000). *Reptiles & Amphibians of Australia*. Sixth Edition, Reed New Holland.
- Compton A. (1981). Courtship and nesting behaviour of the freshwater crocodile, *Crocodylus johnstoni*, under controlled conditions. *Aust. Wildl. Res.* 8: 445–450.
- Cooper-Preston H. and Jenkins, R.W.G. (1993) Natural history of the Crocodylia. In: C.J. Glasby, G.J. Ross and P.L. Beesley (Eds.), *Fauna of Australia, Vol. 2A, Amphibia and Reptilia*. Australian Government Publishing Service, Canberra, pp. 337–343.
- Covacevich J. and Archer, M. (1975). The distribution of the cane toad, *Bufo marinus*, in Australia and its effects on indigenous vertebrates. *Memoirs of the Queensland Museum* 17: 305–310.
- Davis G.W. (1994). Crocodile conservation: the benefits of farming and ranching. In: *Proceedings of the 2nd Regional Meeting of the Crocodile Specialist Group of the Species Survival Commission of the IUCN*. Darwin, Northern Territory Australia, 12–19 March 1993. IUCN - The World Conservation Union, Gland, Switzerland.
- Doody J.S., Green B., Sims R., Rhind D., West P., and Steer D. (2006). Indirect impacts of invasive cane toads (*Bufo marinus*) on nest survival in pig-nosed turtles (*Carettochelys insculpta*). *Wildlife Research* 33:349–354.
- Edwards G.P., Webb G.J.W., Manolis C.S. and Mazanov A. (in prep.). Morphometric analysis of the freshwater crocodile, *Crocodylus johnstoni*.
- Flood J. (1983). *Archaeology of the Dreamtime*. Collins, Sydney.
- Grigg G. and Gans, C. (1993). Morphology and physiology of the Crocodylia. In: C.J. Glasby, G.J.B. Ross and P.L. Beesley (Eds.), *Fauna of Australia, Vol. 2A Amphibia and Reptilia*. Australian Government Publishing Service, Canberra, pp. 326–336.

¹ Note that the references given here also include those in the following appendices.

-
- Groombridge B. (1987). The distribution and status of world crocodilians. In: G.J.W. Webb, S.C. Manolis and P.J. Whitehead (Eds.), *Wildlife Management: Crocodiles and Alligators*. Surrey Beatty & Sons Pty. Ltd. in association with the Conservation Commission of the Northern Territory: Sydney, pp. 9–21.
- Hennessy K., C. Page, J. Bathols, K. McInnes, B. Pittock, R. Suppiah and K. Walsh (2004). *Climate change in the Northern Territory*. CSIRO report for the Northern Territory Department of Infrastructure, Planning and Environment. March 2004.
<http://www.nt.gov.au/nretas/environment/greenhouse/pdf/ntclimatechange.pdf>
- Jenkins R.W.G. (1987). The world conservation strategy and CITES; principles for the management of crocodilians. In: G.J.W. Webb, S.C. Manolis and P.J. Whitehead (Eds.), *Wildlife Management: Crocodiles and Alligators*. Surrey Beatty & Sons Pty. Ltd. in association with the Conservation Commission of the Northern Territory: Sydney, pp. 27–31.
- Lanhupuy W. (1987). Australian aboriginal attitudes to crocodile management. In: G.J.W. Webb, S.C. Manolis and P.J. Whitehead (Eds.), *Wildlife Management: Crocodiles and Alligators*. Surrey Beatty & Sons Pty. Ltd. in association with the Conservation Commission of the Northern Territory: Sydney, pp. 145–147.
- LCNT (2005). *Integrated Natural Resource Management Plan for the Northern Territory: sustaining our resources – people, country and enterprises*. Landcare Council of the Northern Territory.
- Leach G, Delaney R and Fukuda Y. (2009). *Management program for the Saltwater Crocodile in the Northern Territory of Australia, 2009 – 2013*. Northern Territory Department of Natural Resources, Environment, the Arts and Sport, Darwin.
- Letnic M. and Ward, S. (2005). Observations of freshwater crocodiles (*Crocodylus johnstoni*) preying upon cane toads (*Bufo marinus*) in the Northern Territory. *Herpetofauna*, 35(2): 98–100.
- Letnic M., Webb, J.K. and Shine, R. (2008). Invasive cane toads (*Chaunus marinus*) cause mass mortality of freshwater crocodiles (*Crocodylus johnstoni*) in tropical Australia. *Biological Conservation* [doi:10.1016/j.biocon.2008.04.031](https://doi.org/10.1016/j.biocon.2008.04.031).
- McBryde I. (1979). Archaeology. In: D. Barwick, M. Mace and T. Stannage (Eds.), *Handbook for Aboriginal and Islander History*. Aboriginal History, Canberra.
- Messel, H., Vorlicek, G.C., Wells, A.G. and Green, W.J. (1981). *Surveys of tidal river systems in the Northern Territory of Australia and their crocodile populations*. Monograph 1. Pergamon Press: Sydney.
- Molnar R. (1993). Biogeography and phylogeny of the Crocodylia, In: C.J. Glasby, G.J.B. Ross and P.L. Beesley (Eds.), *Fauna of Australia Vol. 2A Amphibia and Reptilia*. Australian Government Publishing Service, Canberra, pp. 344–48.
- Peucker S. (1997). The crocodile industry. In: K. Hyde (Ed.), *The New Rural Industries: A handbook for Farmers and Investors*. Australian Government, Rural Industries Research & Development Corporation (RIRDC), Canberra.
<http://www.rirdc.gov.au/pub/handbook/contents.html>
- PWCNT (1998). *A management program for Crocodylus porosus and Crocodylus johnstoni in the Northern Territory of Australia*. Parks and Wildlife Commission of the Northern Territory. Government Printer of the Northern Territory, Darwin.

-
- Smith A.M.A. and Webb, G.J.W. (1985). *Crocodylus johnstoni* in the McKinlay River area, N.T. VII. A population simulation model. *Aust. Wildl. Res.*, 12: 541–554.
- Stirrat S.C. Lawson, D. Freeland, W.J and Morton, R. (2001). Monitoring *Crocodylus porosus* populations in the Northern Territory of Australia: a retrospective power analysis. *Aust. Wildl. Res.*, 28: 547–554.
- Taplin L.E. (1987). The management of crocodiles in Queensland. In: G.J.W. Webb, S.C. Manolis and P.J. Whitehead (Eds.), *Wildlife Management: Crocodiles and Alligators*. Surrey Beatty & Sons Pty. Ltd. in association with the Conservation Commission of the Northern Territory, Sydney, pp. 129–40.
- Tremblay, P. (2003). Crocodiles and Top End visitors: A meta-review of tourist perceptions, motivations and attitudes towards a controversial local icon. CAUTHE 2003 Conference.
- Tucker, A. (1998). *Crocodylus johnstoni*. In: J.P. Ross (Ed.), *Crocodiles Status Survey and Conservation Action Plan*. Second Edition, IUCN/SSC Crocodile Specialist Group.
- Tucker A.D., McCallum, H.I., Limpus, C.J. and McDonald, K.R. (1993). *Crocodylus johnstoni* in the Lynd River, Queensland: continuation of a long term field study. In: *Proceedings of the 2nd Regional Meeting of the Crocodile Specialist Group of the Species Survival Commission of the IUCN*. Darwin, Northern Territory Australia, 12–19 March 1993. IUCN - The World Conservation Union, Gland, Switzerland.
- Tucker A.D., Limpus C.J., McCallum H.I. and McDonald K.R. (1996), Ontogenetic dietary partitioning by *Crocodylus johnstoni* during the dry season. *Copeia* 1996, pp. 978–988.
- Tucker A.D., Limpus C.J., McCallum H.I. and McDonald K.R. (1997), Movements and home ranges of *Crocodylus johnstoni* in the Lynd River, Queensland, *Wildl. Res.*: 24: 379–396
- van Dam R.A., Walden, D.J. and Begg, G.W. (2002). A preliminary risk assessment of cane toads in Kakadu National Park. Scientist Report 164, Office of the Supervising Scientist, Darwin, Northern Territory.
- Webb G.J.W., Buckworth, R. and Manolis, S.C. (1983a). *Crocodylus johnstoni* in the McKinlay River area, NT. III. Growth, movement and the population age structure. *Aust. Wildl. Res.* 10: 383–401.
- Webb G.J.W., Buckworth, R. and Manolis, S.C. (1983b). *Crocodylus johnstoni* in the McKinlay River area, N.T. IV. A demonstration of homing. *Aust. Wildl. Res.* 10: 403–406.
- Webb G.J.W., Buckworth, R. and Manolis, S.C. (1983c). *Crocodylus johnstoni* in the McKinlay River area, N.T. VI. Nesting biology. *Aust. Wildl. Res.* 10: 607–637.
- Webb G.J.W., Buckworth, R., Manolis, S.C. and Sack, G.C. (1983d). An interim method for estimating the age of *Crocodylus johnstoni* embryos. *Aust. Wildl. Res.* 10: 563–570.
- Webb G.J.W. and Gans C. (1982). Galloping in *Crocodylus johnstoni* – a reflection of terrestrial activity? *Rec. Aust. Mus.* 34:607–618.
- Webb G.J.W. and Manolis, S.C. (1983). *Crocodylus johnstoni* in the McKinlay River area, N.T. V. Abnormalities and injuries. *Aust. Wildl. Res.* 10: 407–420.

-
- Webb G.J.W. and Manolis, S.C. (1989). *Crocodiles of Australia*. Reed Books, Sydney.
- Webb G.J.W. and Manolis, S.C. (1993). Conserving Australia's crocodiles through commercial incentives. In: D. Lunney and D. Ayers (Eds.), *Herpetology in Australia A Diverse Discipline*. Surrey Beatty & Sons, Sydney, pp. 250–256.
- Webb G.J.W., Manolis, S.C. and Buckworth, R. (1982). *Crocodylus johnstoni* in the McKinlay River area, N.T. I. Variation in the diet and a new method of assessing the relative importance of prey. *Aust. J. Zool.*, 30: 877–899.
- Webb G.J.W., Manolis, S.C. and Buckworth, R. (1983e). *Crocodylus johnstoni* in the McKinlay River area, N.T. II. Dry-season habitat selection and an estimate of the total population size. *Aust. Wildl. Res.*, 10: 373–382.
- Webb G.J.W., Manolis, S.C. and Ottley, B. (1994). Crocodile Management and Research in the Northern Territory: 1992–94. Proceedings of the 12th Working Meeting of the Crocodile Specialist Group of the Species Survival Commission of the IUCN. Pattaya, Thailand, 2–6 May 1994. IUCN - The World Conservation Union, Gland, Switzerland.
- Webb G.J.W., Manolis, S.C. and Sack, G.C. (1983f). *Crocodylus johnstoni* and *C. porosus* coexisting in a tidal river. *Aust. Wildl. Res.*, 10: 639–650.
- Webb, G.J.W. and Messel, H. (1977). Crocodile capture techniques. *J. Wildl. Mgt.*, 41: 572–575.
- Webb G.J.W. and Smith A.M.A. (1984). Sex ratio and survivorship in the Australian freshwater crocodile, *Crocodylus johnstoni*. In: M.W.J. Ferguson (Ed.), *The Structure, Development and Evolution of Reptiles*. Academic Press, London, pp. 319–355.
- Webb G.J.W. and Smith, A.M.A. (1987). Life history parameters, population dynamics and the management of crocodilians. In: G.J.W. Webb, S.C. Manolis and P.J. Whitehead (Eds.), *Wildlife Management: Crocodiles and Alligators*. Surrey Beatty & Sons Pty. Ltd. in association with the Conservation Commission of the Northern Territory: Sydney, pp. 199–210.
- Webb G.J.W., Whitehead, P.J. and Manolis, S.C. (1987). Crocodile management in the Northern Territory of Australia. In: G.J.W. Webb, S.C. Manolis and P.J. Whitehead (Eds.), *Wildlife Management: Crocodiles and Alligators*. Surrey Beatty & Sons Pty. Ltd. in association with the Conservation Commission of the Northern Territory, Sydney.

Appendix 1: Freshwater crocodile background information

Crocodylus johnstoni Krefft

A1.1 Conservation status

Northern Territory (*Territory Parks and Wildlife Conservation Act*): Protected species, but not listed as threatened.

Australia (*Environment Protection and Biodiversity Conservation (EPBC) Act*): Marine protected species, but not listed as threatened.

International (Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES)): Appendix II (unqualified). Australia is a party to CITES, and with the *EPBC Act* ensuring that its obligations are discharged.

A1.2 Distribution

The freshwater crocodile is endemic to northern Australia where it is generally confined to permanent freshwater rivers, lagoons and billabongs (Figure 2). In the Northern Territory, freshwater crocodiles inhabit wetlands and river channels largely upstream of the tidal reaches of coastal rivers. In the dry season, freshwater crocodiles tend to congregate in isolated permanent and semi-permanent billabongs along secondary creek lines in both rocky escarpments and floodplains (Webb *et al.* 1987).

Geographic variation in morphology has been shown, however the extent of geographic variation across its entire range is yet to be determined (Webb and Manolis 1993, Edwards *et al. in prep.*). Some populations of freshwater crocodile are strikingly stunted with mature males reaching only 1.2 metres in total length and weighing 7 kilograms (Webb and Manolis 1989).

Figure 2: *The distribution of the freshwater crocodile Crocodylus johnstoni in Australia (Source: Cogger 2000).*



A1.3 Biology

Cogger (2000) provides a general description of Crocodylia. Grigg and Gans (1993), Cooper-Preston and Jenkins (1993) and Molnar (1993) discuss morphology, physiology, natural history, biogeography and phylogeny. Detailed discussion of many topics concerning crocodile biology may be found in Webb *et al.* (1987).

Considerable research has been conducted into the biology and status of the species in northern Australia. Its biology, population dynamics, recovery since protection and management have been the subject of intensive research efforts (Table 5), the details of which are contained in a variety of publications (e.g. Burbidge 1987, CCNT 1986, Compton 1981, Smith and Webb 1985, Taplin 1987, Tucker *et al.* 1993, Webb and Gans 1982, Webb *et al.* 1982, Webb *et al.* 1983a-f; Webb *et al.* 1987, Webb *et al.* 1994, Webb and Manolis 1983, 1989, 1993; and Webb and Smith 1984 and 1987).

The freshwater crocodile is morphologically distinct from other freshwater species found in the Asian region (e.g. *C. porosus*, *C. mindorensis*, *C. novaeguineae*) because of its very narrow snout (Tucker 1998).

Table 5. Basic ecological data for the freshwater crocodile *C. johnstoni* (Source: Webb and Manolis 1993 and citations therein).

Characteristic	Freshwater crocodile <i>C. johnstoni</i>
Biology	
Size and age at sexual maturity (males)	1.7 m; 17 yrs
Size and age at sexual maturity (females)	1.5 m; 12 yrs
Normal length (males)	2.0 m
Normal length (females)	1.8 m
Normal maximum length (males)	3 m
Normal maximum body weight	70–80 kg
Nesting Season; months	Dry Season; Aug.– Sept.
Duration of egg laying	4 weeks
Mean clutch size; (range)	13.2 (1–21)
Mean egg weight; (range)	68.2 g (47–89)
Mean hatchling weight	44.7 g
Nest defence	rare

A1.4 Nesting ecology

Female freshwater crocodiles lay eggs into holes which they dig in exposed sand bars and sandbanks during the dry season. Mating occurs about six weeks prior to nesting and all females nest in a short period of time (Webb *et al.* 1987). There are some slight geographic variations in the timing of nesting. For example, nesting in the McKinlay River area is from August – September, while nesting occurs slightly later in the Victoria and Roper River

regions where females and clutch sizes also appear to be smaller (Webb *et al.* 1987). On average 13 eggs are laid and incubation normally lasts 75–85 days (Webb *et al.* 1983c). Females do not attend or defend their nests during the incubation period. Around October females show renewed interest by excavating their nests in response to the calls of hatchlings. Females often remain with hatchlings which congregate in crèches among fallen trees or semi-emergent vegetation (Webb *et al.* 1987).

As with saltwater crocodiles, the sex of freshwater crocodile hatchlings is determined by the incubation environment of the egg. Data from the McKinlay River and 13 other rivers in the Northern Territory indicates a significant female bias in hatchlings (Webb *et al.* 1987). Further information on reproduction can be found in Compton (1981), Smith and Webb (1985), Webb and Smith (1984), Webb *et al.* (1983b) and Webb *et al.* (1987).

A1.5 Survivorship and population dynamics

The population dynamics of freshwater crocodiles are generally characterised by low egg and hatchling survivorship, but reasonably high survivorship among sub-adults (Webb *et al.* 1987). Eggs fail to hatch for a number of reasons including predation by monitor lizards and pigs, nest inundation, overheating, infertility, trampling by livestock, and excavation of nests by other females. Predation by monitor lizards (*Varanus spp.*) poses the largest threat to incubating eggs. Most losses of hatchlings up to one year old occur in the first six months after hatching. The survivorship between ten years of age and reproductive senescence is unknown, but has been estimated to be greater than 85% per year (Webb *et al.* 1987).

In the absence of human predation or hunting, freshwater crocodile populations fluctuate primarily in response to seasonal conditions such as rainfall and temperature (Webb and Smith 1984; Webb *et al.* 1987). While there is recent evidence of rapid changes in population numbers and age structure in local areas when cane toads arrive (Letnic and Ward 2005); there is still an abundant population of freshwater crocodiles in Queensland where cane toads have been present for much longer than in the Northern Territory.

A1.6 Diet

The diet of freshwater crocodiles is quite varied and includes a wide variety of invertebrates and small vertebrates. The most important prey items are aquatic and terrestrial insects, fish and crustaceans (Webb *et al.* 1982). Freshwater crocodiles appear to feed opportunistically at the water's edge, and more prey is taken during the warmer wet season than during the cooler dry season (Webb *et al.* 1982), when growth is negligible (Webb *et al.* 1983a).

Appendix 2. Farm Management

Farm biosecurity

Farms are advised to follow the Biosecurity plan available from DoR. Any signs of illness, disease outbreak or unusual deaths should be reported as soon as possible to DoR. The crocodile industry will be alerted to any possible disease problems and a disease investigation will be undertaken if needed. In the event of an emergency crocodile disease outbreak, the Biosecurity plan would be mandated under the *Livestock Act* for the period of the emergency animal disease response.

Farm security

Farms are required to have secure fencing, capable of containing crocodiles, as a condition on the permit to keep and trade. Fences and enclosures must be maintained to ensure animals cannot escape. NRETAS will check farm security annually as part of the process for renewing permits.

Farm data and audit Validation

Each month farms will submit stock data to DoR to validate and collate before it is submitted to NRETAS each year. Individual farm performance data will be compared with Northern Territory industry averages and provided to individual farms.

DoR will validate monthly returns using annual physical audits for hatchlings and will also conduct random spot audits for all other class of animal on the farm. Hatchlings will be audited each year by hand counting all animals gained for that current year on the farm when they are transferred to raising/yearling class pens.

Farm visitation

Farms will be visited by DoR under the powers of the *Livestock Act* to ensure animal welfare, farm biosecurity, inspection of shipments, animal audits, disease investigation and any other related matter. Farms will be visited by NRETAS to ensure that farms meet the conditions stated on the Permit to Keep, investigate any wildlife breaches and other related matters.

Animal welfare

Animal welfare on all crocodile farms will continue to comply with the *Animal Welfare Act* and follow the Code of Practice on the Humane Treatment of Wild and Farmed Australian Crocodiles as stated in this Management Program. Animal welfare on farms will be enforced by DoR as animal welfare inspectors under the *Animal Welfare Act*.

Farm workers OH&S

Workers on all crocodile farms that have duties involving handling crocodiles or being in close contact with crocodiles must meet the relevant Northern Territory OH&S legislation.

Farmer responsibilities

The responsibilities of farms are detailed in Table 6.

Table 6: Stakeholder Responsibilities in the freshwater crocodile Management Program 2010–2015

Stakeholder	Responsibilities
Department of Natural Resources, Environment, The Arts and Sport	<ul style="list-style-type: none"> • Assess applications and issue permits as appropriate. • Ensure compliance with permit conditions. • Issue permits for domestic shipments of live crocodiles from farms within ten working days. • Remove and dispose of problem crocodiles from agreed intensively managed areas. • Collate and submit annual report to the Australian Government (DEWHA). • Compare wild egg collection data with farm hatchling data each year. • Review the Management program for the freshwater crocodile (<i>C. johnstoni</i>) in the Northern Territory of Australia. • Monitor wild populations
Department of Resources	<ul style="list-style-type: none"> • Ensure monthly returns from crocodile farms are submitted and collated. • Process applications for permits to import/export crocodile skins and products both overseas and domestic within two business days of application. • Inspect crocodile skins and products for export and process appropriate paperwork. • Annually audit the hatchlings on each farm to validate data in the monthly returns. • Visit farms to ensure animal welfare standards are being met. • Ensure production data from monthly returns is collated, validated and passed on to NRETAS annually. • Ensure each crocodile farm is given confidential feedback every six months on their farm production performance compared with the Northern Territory industry average. • Ensure the supply, payment and issue of skin tags for crocodile skins for trade. • Investigate breaches in trade conditions or illegal trade of crocodilian skins or products. • Implement the Biosecurity plan in the event of an emergency crocodile disease outbreak
Northern Territory Crocodile Farming Industry	<ul style="list-style-type: none"> • Comply with all permit conditions. • Submit production returns to DoR each month. • Ensure animal welfare standards are being met in accordance with the <i>Animal Welfare Act</i> and the Code of Practice. • During an emergency disease outbreak comply with the Biosecurity plan. • Ensure worker safety is not comprised by adhering to appropriate Workplace Health and Safety requirements. • Assist DoR and/or NRETAS to annually audit hatchlings. • Submit applications for permits to import/export crocodile shipments both domestically and overseas to DoR, at least two business days before the date needed. • Ensure applications for inspections on shipment dates are lodged with DoR at least ten working days in advance. • Ensure that a CITES permit has been issued and that CITES permit numbers are available for overseas shipments of crocodile skins and products. • Ensure that permit applications to remove live crocodiles from farms are submitted to NRETAS at least ten working days before the desired transport date. • Ensure an application to renew the commercial permit to keep and trade

Stakeholder	Responsibilities
	<p>for the farm is submitted to NRETAS before the current permit expires.</p> <ul style="list-style-type: none"> • Submit any application(s) to NRETAS to harvest wild eggs by 30 April each year. • Submit completed egg collection returns for the season to NRETAS by 31 January each year.

Appendix 3. Annual Milestone Matrix for 2010– 2015 Program

Milestone matrix for each objective in the Freshwater Crocodile 2010–2015 Management Program.

Milestone	Program Reference	Action Officer	2010	2011	2012	2013	2014	2015
Objective 1. To facilitate the sustainable use of freshwater crocodiles								
Tourism, social and cultural interests do not experience significant detrimental impact as a result of harvesting.	4.1 Restrictions on harvesting	Director, Wildlife Use	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing
All reported and suspected local impacts of the harvest on the population are investigated and appropriate management actions implemented to counter the impact.	4.1 Harvest ceilings	Director, Wildlife Use	Ongoing, review	Ongoing, review	Ongoing, review	Ongoing, review	Ongoing, review	Ongoing, review
Adaptive management actions will be implemented should there be any increase in threats to the freshwater crocodile and their habitat.	4.1 Harvest ceilings	Director, Wildlife Use	Ongoing, review	Ongoing, review	Ongoing, review	Ongoing, review	Ongoing, review	Ongoing, review
A GIS database to assist with monitoring harvest effort and compliance will be developed within the life of this program..	4.1 Harvest ceilings	Director, Wildlife Use			Commence			
Harvest ceilings will be reviewed after every spotlight survey and adjusted (if necessary) in accordance with the provisions of this Management Program..	4.1 Harvest ceilings	Director, Wildlife Use	January–March	January–March	January–March	January–March	January–March	January–March
The annual commercial harvest of freshwater crocodiles does not exceed the approved ceiling for each category.	4.2 Permits and compliance	Director, Wildlife Use	January–March	January–March	January–March	January–March	January–March	January–March
All permits related to freshwater crocodiles issued under the TPWC Act meet the requirements of the management program.	4.2 Permits and compliance	Director, Conservation and Wildlife	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing
Harvest applications, approvals and returns are assessed and reviewed upon receipt and any discrepancies investigated and resolved.	4.2 Permits and compliance	Director, Wildlife Use	Ongoing, review	Ongoing, review	Ongoing, review	Ongoing, review	Ongoing, review	Ongoing, review

Milestone	Program Reference	Action Officer	2010	2011	2012	2013	2014	2015
No harvest permits are issued without correct landholder approval..	4.2 Permits and compliance	Senior Wildlife Ranger, Conservation and Wildlife	Ongoing, review	Ongoing, review	Ongoing, review	Ongoing, review	Ongoing, review	Ongoing, review
All submitted permit returns meet the reporting requirements identified in the management program and included in the permit conditions..	4.2 Permits and compliance	DoR	Ongoing, review	Ongoing, review	Ongoing, review	Ongoing, review	Ongoing, review	Ongoing, review
All CITES permits and skin tags issued will be checked against farm returns to ensure compliance.	4.2 Permits and compliance	DoR	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing
All crocodile farms will be inspected annually to check farm stock numbers.	4.2 Permits and compliance	DoR	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing
Permit conditions will be reviewed annually and amended where necessary.	4.2 Permits and compliance	Directors, Wildlife Use and Conservation and Wildlife	January–March	January–March	January–March	January–March	January–March	January–March
Compliance with permit conditions is at or near 100% and all permit breaches are addressed, either through warning letters, caution notices, infringement notices or prosecution.	4.2 Permits and compliance	Director, Conservation and Wildlife	Annually	Annually	Annually	Annually	Annually	Annually
Available data to describe changes to freshwater crocodile populations and their distribution reviewed and analysed. Outcomes published as appropriate.	4.3 Management-focused research	Director, Wildlife Use	Commence					
Objective 2. To promote community awareness and public safety.								
Permits will be issued to remove problem crocodiles as necessary and appropriate.	4.4 Removal of problem crocodiles	Director, Conservation and Wildlife	Ongoing, as needs	Ongoing, as needs	Ongoing, as needs	Ongoing, as needs	Ongoing, as needs	Ongoing, as needs
Program to remove problem crocodiles in designated swimming and 'intensively managed' management areas is maintained.	4.4 Removal of problem crocodiles	Director, Conservation and Wildlife	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing
NRETAS responds to reports of problem crocodiles and implements appropriate management measures.	4.4 Removal of problem crocodiles	Director, Conservation and Wildlife	Ongoing as needs	Ongoing as needs	Ongoing as needs	Ongoing as needs	Ongoing as needs	Ongoing as needs

Milestone	Program Reference	Action Officer	2010	2011	2012	2013	2014	2015
Public awareness, safety and educational message campaigns will be continually conducted through the media and on the NTG website.	4.5 Community awareness	Director, Marketing and Communications	Ongoing, as needs	Ongoing, as needs	Ongoing, as needs	Ongoing, as needs	Ongoing, as needs	Ongoing, as needs
This management program, its annual reports and contact information will be published and maintained on the NTG website.	4.5 Community awareness	Director, Marketing and Communications	Ongoing, as needs	Ongoing, as needs	Ongoing, as needs	Ongoing, as needs	Ongoing, as needs	Ongoing, as needs
Objective 3. To ensure humane treatment of Freshwater Crocodiles.								
Requirements of the Code of Practice are included as a condition on all permits and that a copy of the Code is distributed to all new permit holders.	4.6 Animal welfare	Director, Conservation and Wildlife	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing
All permit applicants must demonstrate that they are competent to comply with animal welfare standards including the <i>Animal Welfare Act</i> and the Code of Practice.	4.6 Animal welfare	Director, Conservation and Wildlife	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing
Inspect farms regularly to ensure animal welfare standards are met.	4.6 Animal welfare	DoR	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing
Investigate and take appropriate action on any suspected breaches of the <i>Animal Welfare Act</i> or the Code of Practice.	4.6 Animal welfare	Director, Conservation and Wildlife	Ongoing as needs	Ongoing as needs	Ongoing as needs	Ongoing as needs	Ongoing as needs	Ongoing as needs
Objective 4. To monitor and report on the impact of the harvest of freshwater crocodiles.								
Spotlight surveys will be undertaken on an annual (or biennial) basis as stipulated in Table Four of this management program.	4.7 Monitoring	Director, Wildlife Use	Commence	Review	Review	Review	Review	
Any significant declines in populations will be investigated as appropriate.	4.7 Monitoring	Director, Wildlife Use	Ongoing as needs	Ongoing as needs	Ongoing as needs	Ongoing as needs	Ongoing as needs	
The results of the survey program(s) will be analysed and assessed and any resulting management recommendations will be implemented.	4.7 Monitoring	Director, Wildlife Use	October–December	October–December	October–December	October–December	October–December	
Data from monitoring programs will be reported on the NRETAS web site.	4.7 Monitoring	Director, Wildlife Use	December	December	December	December	December	

Milestone	Program Reference	Action Officer	2010	2011	2012	2013	2014	2015
The progress of the Management Program against each of the performance indicators will be audited annually (calendar year) and management practices adjusted as necessary.	4.8 Reporting	Director, Wildlife Use	March	March	March	March	March	
Annual progress reports will be submitted to the Australian Government (DEWHA) by 31 March and a summary provided on the Departmental website.	4.8 Reporting	Director, Wildlife Use	March	March	March	March	March	
The Management program is reviewed and updated by 30 June 2015 and the review submitted to DEWHA.	4.8 Reporting	Director, Wildlife Use				Commence in July		Complete 30 June