

# Management Program for the Saltwater Crocodile (*Crocodylus porosus*) in the Northern Territory of Australia 2024-2034



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1.1	18 April 2024	Mike Welch	Various amendments based on public comment.
1.2	13 February 2025	Robby McLeod	Amendment to Section 3.5.1 - to allow keeping crocodiles as pets.

Acronyms	Full form
Aboriginal traditional harvest	Harvest carried out by Aboriginal people in accordance with section 122 of the <i>Territory Parks and Wildlife Conservation Act 1976</i>
AIATSIS	Australian Institute of Aboriginal and Torres Strait Islander Studies
ALARA	<i>Aboriginal Land Rights (Northern Territory) Act 1976</i>
CITES	Convention on International Trade in Endangered Species
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
NLC	Northern Land Council
DEPWS	Department of Environment, Parks and Water Security
DITT	Department of Industry, Tourism and Trade
NT	Northern Territory
PBC	Prescribed Body Corporate. The AIATSIS managed PBC website provides information and resources for native title groups and corporations.
PIC	Property Identification Code under the <i>Livestock Act 2008</i>
Top End	Northern Territory north of 15°S latitude
TPWC Act	<i>Territory Parks and Wildlife Conservation Act 1976</i>
TLC	Tiwi Land Council
WTMP	Wildlife Trade Management Plan - Northern Territory Crocodile Farming 2021-25. A wildlife trade program under the EPBC Act.

Acronyms	Full form
SCRMF	NT Saltwater Crocodile Risk Management Framework

## Management Program for the Saltwater Crocodile (*Crocodylus porosus*) in the Northern Territory of Australia, 2024-2034

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A management program prepared under the *Territory Parks and Wildlife Conservation Act 1976*. An Act to make provision for and in relation to the establishment of Territory Parks and other Parks and Reserves and the study, protection, conservation and sustainable utilisation of wildlife

Glenn Edwards, Alaric Fisher, Kristen Hay, Neva McCartney, Clare Pearce and Tony Griffiths provided invaluable comments on drafts of this program.

Front cover: Saltwater Crocodile (photographed by Yusuke Fukuda)

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## Executive Summary

The Management Program for the Saltwater Crocodile (*Crocodylus porosus*) in the Northern Territory (NT) is a legal instrument under the *Territory Parks and Wildlife Conservation Act 1976* (TPWC Act). Its purpose is to ensure the “protection, conservation, sustainable use, control and management” of Saltwater Crocodile in accordance with Part 4, Division 2, Subdivision 3 of the TPWC Act. It acknowledges the socio-economic value of the annual harvest of Saltwater Crocodiles to the NT, as well as the significant threat this species poses to human life. In addition to the TPWC Act, management of Saltwater Crocodiles is governed by a complex array of interconnected Territory, National and International laws, regulations and policies. This Management Program provides a unified expression of all requirements to ensure safe, sustainable and legal management and use of the species and a transparent approach to engaging with stakeholders.

The program has five principal objectives:

1. To maintain this iconic keystone predator species at appropriate densities across its range within the Top End of the NT
2. To enhance public safety through the identification and management of problem Saltwater Crocodiles and reduction of crocodile densities in selected areas, within a best practice risk management framework
3. To enable a robust and profitable crocodile industry through a sustainable harvest, that facilitates its economic growth and ensures that landholders receive real benefits from their continuing support for the conservation of the Saltwater Crocodile and its habitats
4. To enhance Aboriginal livelihoods through active participation in the crocodile industry and development of new, culturally appropriate economic opportunities
5. To improve community awareness of the risks posed by Saltwater Crocodiles and appreciation of their natural and cultural values, through appropriately targeted education programs.

These objectives are underpinned by the following guiding principles:

- Management decisions will be evidence-based, supported by high quality scientific data and robust monitoring
- Treatment of Saltwater Crocodiles must be humane and in accordance with the requirements of Animal Welfare legislation, and relevant codes of practice
- The cultural totems, traditions and rights of Aboriginal traditional owners will be respected
- There will be ongoing active engagement with traditional owners and other key stakeholder groups such as industry, tourism operators, fishers and pastoralists.

This Management Program recognises the shifting focus in management of the Saltwater Crocodile population from recovery and growth towards maintenance and containment. In general, the Program reflects the policies and approaches from the previous Program, with several notable enhancements:

- Increased focus on managing and, where feasible, reducing crocodile populations in key areas where they pose a significant risk to human safety
- Increased focus on enhancing Aboriginal livelihoods and recognition of their cultural traditions and rights
- Revised egg quota allocation system to enable better linkage between landholders and permitted collectors
- Extended tenure from five to ten years (i.e. 2024 to 2034), with a five year interim review.



The population of Saltwater Crocodiles in the NT is estimated to be around 100,000 individuals and, although current monitoring data indicate the population is continuing to increase, it is thought to be approaching (or at) pre-hunting levels and near carrying capacity.

Saltwater Crocodiles are a significant economic driver for the NT, both through the farming industry and tourism. The NT crocodile industry is based largely around wild harvest of eggs and ranching on farms. In recent years, the industry has invested significantly in crocodile farming infrastructure to increase its capacity. Crocodiles contribute significantly to visitor experiences of the Top End and viewing crocodiles is an important expectation and often referred to as a “must see” for most Top End visitors.

Whilst their economic value is significant, Saltwater Crocodiles present a clear risk to human safety and welfare, with attacks most likely to occur in areas where there are high populations of both humans and crocodiles, such as around coastal and riverine townships in the Top End of the NT.

To achieve the objectives of this Management Program, NT Government agencies, in conjunction with the crocodile industry and land managers, will implement a range of management practices and policies to regulate the harvest, farming and trade of saltwater crocodiles and manage the risk to human safety whilst meeting the conservation requirements for the species. This will be achieved through the implementation of:

- A robust monitoring program to ensure that the harvest of eggs and live animals does not have a negative impact on the overall Saltwater Crocodile population or on local populations outside of management areas where there is a population reduction goal
- Appropriate regulation of both consumptive and non-consumptive uses, via:
  - Permit system for harvest of crocodiles/eggs and farms
  - Implementation of controls on export of crocodile products and associated requirements of the [Wildlife Trade Management Plan- Crocodile Farming in the Northern Territory 2021-25](#)
  - Ensuring relevant legislative and best-practice requirements for animal welfare and biosecurity are met
- Providing support to Aboriginal organisations to increase participation in crocodile management and associated economic opportunities
- The NT [Saltwater Crocodile Risk Management Framework 2021 – 2026](#), which includes:
  - Management of crocodiles according to their location (e.g. urban versus remote areas). Where resources are available, efforts will be increased to expand and intensify the removal program in key areas where the risk of crocodile attack is high
  - A comprehensive public awareness program that is regularly reviewed and refreshed to deliver a clear message around living with crocodiles (i.e. ‘Be Crocwise’)

Key areas of research and development have been identified and will be pursued where resources are available over the life of the Management Program. These include:

- a) Improved detection and surveillance programs
- b) Social research into understanding drivers of community views
- c) Improved understanding of risks and better methods to safely and economically protect and access nesting areas, especially on Aboriginal land.

The life of this Management Program is intended to be ten years (2024 to 2034) and it will be reviewed after five years to determine whether any significant changes need to be made.

# 1. Introduction

The Saltwater Crocodile Management Program (Management Program) covers the conservation and management of *Crocodylus porosus* in the Northern Territory (NT) for multiple community benefits. This includes the regulation of a farming industry that exports legally sourced product under international wildlife trade rules and procedures. Whilst there is currently no farming or wild harvest of Freshwater Crocodile (*Crocodylus johnstoni*) in the NT, some management activities for Saltwater Crocodiles such as monitoring and management of threat to human safety may involve both species.

The Saltwater Crocodile is the largest living crocodylian species, with a wide distribution in Northern Australia and throughout the Indo-Pacific region (Webb *et al.* 2010). It is an apex predator that will attack humans and its co-existence with people presents significant challenges for the NT community.

Between the Second World War period and the early 1970s, Saltwater Crocodile populations were significantly depleted throughout their range, including in Australia. This was due to both degradation of habitat and hunting for the commercial skin trade (Webb & Manolis 1989, Webb *et al.* 2010). In the NT, intensive hunting reduced the wild populations to the point of extinction and consequently, the species was fully protected in 1971 (Webb *et al.* 1984).

By the early 1980s, the crocodile population had rapidly increased from an estimated low of 3,000 at the time of their protection, to around 30,000. At the time, there were calls by the public to end protection of the species, following a number of attacks (including fatalities), with a proposal to return to widespread culling (Webb *et al.* 1984).

In 1985, Australia was successful in transferring its population of Saltwater Crocodiles from Appendix I to Appendix II of the Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES) specifically for ranching, allowing farms to export the skins produced from harvested eggs. In 1987, the first NT Crocodile Management Program was approved by the Commonwealth and skins derived from the ranching program began to be exported. In 1994, Australia obtained an unrestricted CITES Appendix-II listing to allow landowners with crocodiles, but no nesting habitat, to also receive commercial benefits from crocodiles through a wild harvest.

Saltwater Crocodiles are now recognised as a valuable commercial resource, generating wealth and employment that promotes their conservation. With the increase in the NT crocodile population to near pre-hunting levels, the Management Program no longer needs to focus on population recovery. Rather, the continued growth of a prosperous and sustainable crocodile farming industry is a key driver for Saltwater Crocodile conservation. The tourism value of crocodiles, both in the wild and in captivity, also generates significant economic benefits. These benefits flow to landowners and particularly Aboriginal communities, whilst encouraging the protection and management of wetland habitats.

Through this Management Program, the NT Government will continue to support industry to maximise the investment, commercial activity and employment generated through crocodiles. The farming industry's vision (see the *Northern Territory Crocodile Farming Industry Strategic Plan 2024-2033*) is for the NT to continue as the world leader in the reliable production of the highest quality Saltwater Crocodile skins, and for the industry to grow its role as a significant contributor to the economic and social prosperity of the NT.

Management actions that favour a high natural abundance of a dangerous predator such as Saltwater Crocodiles, require a key focus on public awareness, safety and education. As both

human and crocodile populations in the NT have grown, the potential for human-crocodile conflict has increased.

This Management Program and its associated policies build on previous successful iterations. Key drivers for the Management Program are:

- i) The need to promote crocodile awareness and safe behaviours in light of increasing high crocodile numbers and an increase in the negative interactions between crocodiles and people
- ii) A recognition that harvest levels have not been detrimental to the recovery of the species and that the crocodile population has recovered to near carrying capacity
- iii) A greater focus on managing crocodile numbers in key areas where they pose the greatest risk to human safety
- iv) An increasing demand from landholders, particularly Aboriginal landholders, to derive economic benefit from crocodiles
- v) The maintenance of a vibrant and expanding crocodile farming industry.

This Management Program focuses on mechanisms to respond to and support these key drivers.

## 1.1. Purpose and Objectives

The purpose of this Management Program is to ensure the “protection, conservation, sustainable use, control and management” of Saltwater Crocodile for the benefit of current and future generations of Territorians, in accordance with Part 4, Division 2, Subdivision 3 of the *Territory Parks and Wildlife Conservation Act 1976* (TPWC Act).

The program acknowledges the socio-economic value of the annual harvest of Saltwater Crocodile to the NT by continuing to support Aboriginal and non-Aboriginal use. The significant threat this species poses to human life is also recognised and management practices will continue to be implemented and strengthened to mitigate this risk.

The program has five principal objectives:

1. To maintain this iconic keystone predator species at appropriate densities<sup>1</sup> across its range within the Top End of the NT
2. To enhance public safety through the identification and management of problem Saltwater Crocodiles and reduction of crocodile densities in selected areas, within a best practice risk management framework
3. To enable a robust and profitable crocodile industry through a sustainable harvest, that facilitates its economic growth and ensures that landholders receive real benefits from their continuing support for the conservation of the Saltwater Crocodile and its habitats
4. To enhance Aboriginal livelihoods through active participation in the crocodile industry and development of new, culturally appropriate economic opportunities

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<sup>1</sup> Appropriate densities in this context equates to approximate levels that the population would reach in natural habitats across the Top End without the direct intervention of management and does not preclude density reduction in priority areas as per Objective 2.

5. To improve community awareness of the risks posed by Saltwater Crocodiles and appreciation of their natural and cultural values, through appropriately targeted education programs.

Underpinning these objectives are four guiding principles:

1. Management decisions will be evidence-based, supported by high-quality scientific data and robust monitoring
2. Treatment of Saltwater Crocodiles must be humane and in accordance with the requirements of Animal Welfare legislation, and relevant codes of practice
3. The cultural totems, traditions and rights of Aboriginal traditional owners will be respected
4. There will be ongoing active engagement with traditional owners and other key stakeholder groups such as industry, tourism operators, fishers and pastoralists.

## 1.2. Responsible Authority

The NT Government, through the Department of Environment Parks and Water Security (DEPWS), manages wildlife in the NT pursuant to the TWPC Act. The management and regulation of all aspects of harvest from the wild and the use of protected wildlife in the NT is administered under this legislation. The Department of Industry, Tourism and Trade (DITT) has regulatory responsibilities for wild and farmed crocodiles under the *Animal Protection Act 2018*. DITT also has regulatory responsibilities for crocodile farming under the *Livestock Act 2008* and the *Meat Industries Act 1996*. These responsibilities and other related responsibilities are outlined below.

## 1.3. Legislative Context

### 1.3.1. Northern Territory

#### 1.3.1.1. Territory Parks and Wildlife Conservation Act 1976

The TPWC Act provides for the study, protection, conservation and sustainable utilisation of wildlife (native plants and animals). The Saltwater Crocodile, as a native vertebrate species, is classified as protected wildlife under s43 of the Act but is not considered a threatened species.

The Act specifies that the management of species be carried out in a manner that accords with its classification, and promotes the survival of wildlife in its natural habitat and the sustainable use of wildlife and its habitat. Management should aim to control or prohibit anything that adversely affects, or is likely to adversely affect the capacity of wildlife to sustain its natural processes. These principles of management need to be adhered to in the development of any management program under the Act.

The Act prohibits the taking or interfering with, the keeping of, or the import or export of protected wildlife in the NT (including dead, or parts of wildlife) without authority to do so. Authority is provided via a permit issued by the Director of Parks and Wildlife (or delegate) under s56 of the Act.

The taking of protected wildlife by Aboriginal people for traditional purposes, including food, is provided for under s122 of the Act. Aboriginal people are not bound by hunting regulations when taking animals for food or other traditional purposes.

### 1.3.1.2. Animal Protection Act 2018

Crocodiles are classed as ‘animals’ under the [Animal Protection Act 2018](#). The objectives of this Act are to ensure that animals are treated humanely, to prevent cruelty to animals and to promote community awareness about responsibilities and legal obligations associated with the care and protection of animals, and to regulate the activities of persons who use animals for scientific purposes.

Persons in control of crocodiles must provide a minimum level of care and must not be cruel to them.

Under the Act, a regulation may adopt or prescribe a code of practice relating to animal welfare that if complied with, demonstrates meeting the requirements of the Act.

Animal welfare standards for crocodiles are detailed in the *Code of Practice for the Humane Treatment of Wild and Farmed Australian Crocodiles* (Code of Practice). The Code of Practice is approved under the Act, as specified in Schedule 1 of the *Animal Protection Regulations 2022*. All crocodiles must be managed in accordance with the Code of practice and at the time of drafting this Management Program, it was being reviewed by the Commonwealth government, with the expectation that a revised Code of Practice would be adopted during 2024.

### 1.3.1.3. Waste Management and Pollution Control Act 1998

The [Waste Management and Pollution Control Act 1998](#) provides for the protection of the environment through encouragement of effective waste management and pollution prevention and control practices. It includes a general environmental duty: when conducting an activity or performing an action that causes or is likely to cause pollution resulting in environmental harm or that generates or is likely to generate waste, a person/business must take all reasonable and practicable measures to prevent or minimise the pollution or environmental harm, and reduce the amount of the waste.

### 1.3.1.4. Environment Protection Act 2019

New developments for the farming, processing and display of crocodiles that may have a significant environmental impact will need to meet the requirements of the [Environment Protection Act 2019](#).

### 1.3.1.5. Meat Industries Act 1996

Farmed crocodiles may be killed in abattoirs licensed for human consumption. The [Meat Industries Act 1996](#) provides for the safety and suitability of food for human consumption. The Saltwater Crocodile was declared as a game animal on 10 June 2004 (Government Gazette No. G24, 16 June 2004) under the Act, which enables crocodiles harvested from the wild to be killed. This is strictly monitored and requires approval of the NT’s Chief Inspector (Meat).

### 1.3.1.6. Livestock Act 2008

Farmed crocodiles are treated as livestock under the [Livestock Act 2008](#), which provides for disease surveillance, disease control, identification of and tracing of animals and regulation of the movement of animals and animal products for the purpose of disease control. The Act and the [Livestock Regulations 2009](#) govern the administration of the biosecurity regulatory framework, to both protect and support the needs of the livestock industries in the NT.

At the time of this Management Program's preparation, the livestock biosecurity legislation framework was under review by DITT, to ensure it meets contemporary biosecurity management requirements for the NT. Currently, the livestock biosecurity legislative framework provides for the development and implementation of an 'approved property management plan' for specific property-based biosecurity risks.

Key changes proposed to the *Livestock Act 2008* impacting on the NT Crocodile Industry include:

- Extending the Property Identification Code (PIC) requirements to include crocodiles to enable tracing of all livestock species
- Uniformity in the event of a disease incursion, with all livestock species being subject to the same biosecurity risk measures
- Recognition of property-based quality assurance programs to provide industry with greater flexibility to manage biosecurity risks
- Adoption of agreed national animal welfare standards
- Simplification of the fees and charges process.

## 1.3.2. Commonwealth

### 1.3.2.1. Environment Protection and Biodiversity Conservation Act 1999

The [Environment Protection and Biodiversity Conservation Act 1999](#) (EPBC Act) regulates imports and exports to and from Australia of all Australian native animals, or their parts. Part 13A of the EPBC Act regulates imports and exports of crocodiles and crocodile products. It also fulfils Australia's legislative requirements as a signatory party to the Convention on International Trade in Endangered Species (CITES) (see below). Section 303CH of the Act lists specific conditions that must be met for the export or import of CITES specimens. For export of CITES Appendix-II species, 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.

A [Wildlife Trade Management Plan](#) (WTMP; Clancy & Fukuda, 2021) is in place to provide for the sustainable farming of crocodiles in the NT, specifically to fulfil the requirements under Part 13A, Section 303FO of the Act and requirements of relevant international rules, notably the CITES of Wild Fauna and Flora. Commercial export permits for crocodiles are issued under Section 303CG.

The Saltwater Crocodile is also a listed marine species under section 248 of the Act and a listed migratory species under s209 of the Act. When there is potential for an impact as part of a development for which an approval is required, the species may be considered as a 'Matter of National Environmental Significance' under the Act.

A State/Territory management program for wild populations is not required if it elects to limit use to captive breeding. However, crocodile farms based solely on captive breeding in Australia must be registered under provisions of the Act before permission to export products is granted.

### 1.3.2.2. Aboriginal Land Rights (Northern Territory) Act 1976

The [Aboriginal Land Rights \(Northern Territory\) Act 1976](#) (ALRA) establishes Land Councils in the NT, providing them with legal powers to help Aboriginal people negotiate with governments and private companies over projects on their land. They also support Aboriginal people to manage their land and sea, including issuing permits to enter, fish, film and perform other activities on Aboriginal land.

Another function of the Land Councils is to confirm that the correct landholders (traditional owners) have given their permission for any commercial wildlife harvest before TPWC Act permits can be issued. This Act provides for s19 Land Use Agreements (referred to as Indigenous Land Use agreement, or ILUA), which should be in place for commercial crocodile harvesting. These agreements provide the conditions of access to land for the purpose of harvesting and there should be consistency between ILUAs and TPWC Act permits.

Crocodile harvesting governed by ILUAs are operating within areas administered by both the Northern Land Council and the Tiwi Land Council.

### 1.3.3. International

#### 1.3.3.1. 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 a signatory. Those species most threatened in the wild by international trade are listed on CITES Appendix I and all remaining species are listed on Appendix II. In most range states, Saltwater Crocodiles are listed on Appendix I but the Australian, Indonesian and Papua New Guinean populations are included in 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.

Under CITES provisions and EPBC Act regulation, up to four Saltwater Crocodile products can leave Australia within a passenger's personal luggage without a CITES permit if they are personally owned, non-commercial, and legally acquired.

#### 1.3.3.2. Convention on Wetlands of International Importance (Ramsar Convention)

Australia is a signatory to the [Ramsar Convention](#). There are plans of management for all three of the Ramsar-listed areas within the NT (i.e. Stages One and Two of Kakadu National Park, and Garig Gunak Barlu National Park) which seek to protect internationally-significant wetlands and their dependent fauna, including Saltwater Crocodile.

## 2. Management Context

### 2.1. Socio-economic Significance

In the NT, crocodiles are an iconic species that attract considerable publicity and a wide range of community views and opinions regarding their abundance, distribution and cultural and economic importance.

#### 2.1.1. Cultural Values

The importance of crocodiles in Aboriginal culture is reflected in a complex system of totems and ceremonies, which is still evident among most coastal Aboriginal communities in northern Australia (Lanhupuy 1987). Aboriginal communities also regard Saltwater Crocodiles as dangerous animals. The non-Aboriginal community has a diversity of views on crocodiles from being reviled as dangerous pests to being admired and recognised as a significant component of the environment. Crocodiles are an important natural resource for many sectors including Aboriginal communities, the tourist industry and the crocodile farming industry.

#### 2.1.2. Community Attitudes

There are a variety of attitudes to the management of crocodiles in the NT, ranging from a complete protection mindset through to a desire to see all animals removed, at least around any areas that may be used by people. Whilst there are limited data on the prevalence of these attitudes in the NT, Benzaken (1992) found in the North Queensland context that there was significant regional and cultural factors that impact on support and successful implementation of policies. An important finding of this study was that knowledge of crocodiles was not connected with 'empathy towards' them but with higher perception of risk.

#### 2.1.3. Economic Values

The harvesting of crocodiles, primarily for their skins but also for their flesh and body parts, supports a significant industry in the NT. The crocodile farming industry was worth approximately \$25 million annually in 2019/2020 and has the potential to grow considerably (*Northern Territory Crocodile Farming Industry Strategic Plan 2024-2033*).

The NT crocodile farming industry is the world leader in the production of high quality Saltwater Crocodile skins. Australia accounts for approximately 60% of the reported global trade in Saltwater Crocodile skins, with about two-thirds of this (~21,000 skins in 2011) grown and exported from the NT.

The mainstay of the crocodile farming industry is the annual harvest of eggs from the wild under a 'ranching' program. This harvest has operated continuously since the first small trial harvest in the 1983/84 nesting season. The annual harvest of eggs (up to 70,000 live eggs in the previous Management Program- a live egg was defined as an egg placed in an incubator) provides a significant employment and commercial opportunity to landholders, in particular remote Aboriginal communities. During the term of this plan, the wild harvest of eggs will continue to be the predominant form of harvest.

Commercial live harvest (hatchlings, juveniles and adults) has been permitted since 1994, when all restrictions and conditions on the CITES listing of the Australian population of Saltwater Crocodile were removed. The commercial live harvest has always been small -



substantially less than the quota of 500 adults in the previous program and almost zero for hatchlings and juveniles (Saalfeld & Fukuda 2014).

Crocodiles contribute significantly to visitor experiences of the Top End and viewing crocodiles is an important expectation and often referred to as a “must see” for most Top End visitors. In visitor surveys, Tremblay (2003) reported that seeing crocodiles dominates the best experiences in wildlife-viewing. The fascination with crocodiles has led to a vibrant tourism industry in the NT based on viewing crocodiles, both in captivity and in their natural habitat. The Top End offers a wide range of experiences from observing in the wild, observing modified behaviour in the wild (jumping crocodiles), research/educational displays and immersive captive encounters. These types of experiences regularly receive very high satisfaction ratings from tourists according to online travel review websites such as TripAdvisor and Expedia.

#### 2.1.4. Environmental Values

There is a growing appreciation of the role top level predators like the Saltwater Crocodile play in maintaining the health of natural ecosystems and delivery of a range of services (termed ‘ecosystem services’ (Costanza *et al.* 1997, Jones *et al.* 2016)) that benefit humans (Close *et al.* 2009). Top level (or apex) predators have the potential to impact positively on species diversity, reduce numbers of pest animals, enhance ecosystem function and resilience and contribute to systems’ carbon storage (Allen *et al.* 2012, Atwood *et al.* 2015, Beschta & Ripple 2009, Pace *et al.* 1999, Sergio *et al.* 2008). The functional role of the Saltwater Crocodile in supporting the delivery of ecosystem services is not well studied but has been the subject of some recent research. For example, Campbell *et al.* (2022) hypothesised that by shifting their food preferences to feral pigs, the rising Saltwater Crocodile population may help suppress pig population growth and increase the flow of terrestrially derived nutrients into aquatic ecosystems.

## 2.2. Policy Drivers

### 2.2.1. Sustainable Use and Conservation

The International Union for Conservation of Nature (IUCN) recognises that the wise and sustainable use of wildlife can be both consistent with and contribute directly to species conservation (IUCN SSC 2012). This position depends on the social and economic benefits derived from use of species providing incentives to conserve species and their habitats. The NT Government has fostered the crocodile farming industry, and in recent years this industry has invested significantly in crocodile farming infrastructure to increase its capacity. The industry has grown in conjunction with the crocodile population, to the point where the NT now leads the world in the production of high quality Saltwater Crocodile skins.

The increasing value of the crocodile industry has coincided with an increasing wild Saltwater Crocodile population. A recent review of the impacts of harvesting of the NT Saltwater Crocodiles on their population found that the species is secure by all IUCN criteria used to assess the status of threatened species. The population is large, although previous unregulated harvest had driven numbers down, and has been increasing and/or stable across its range. In the NT, the species has a broad geographic range, or *extent of occurrence* relative to the IUCN threshold and has around 20 times the area of utilised, good quality habitat (area of occupancy) than would be considered to be of immediate conservation concern.

## 2.2.2. Risk Management

Given the clear risk that Saltwater Crocodiles pose to human safety and welfare, management is targeted to mitigate this risk. This is consistent with legislation, with the TPWC Act recognising that the protection of the safety and welfare of the public is paramount e.g. s56 (1)(g) governing the granting and refusal of permits. The EPBC Act, whilst not explicitly recognising the pre-eminence of human safety, does strongly imply this. For example, Part 13 Division 1A s197 recognises that an action 'reasonably necessary to prevent a risk to human health' is not an offence under the Act. In a practical sense, the policy position of the NT Government is that any action that is necessary to protect human safety and wellbeing is compliant with this Management Program, noting that where possible both environmental harm and adverse animal welfare impacts are to be avoided.

Between 1971 and 2023, there were 23 fatalities and 58 reported incidents resulting in injuries from Saltwater Crocodile attacks in the NT (Figure 1). At the time of preparing this Management Program, the most recent fatality was in October 2018 at a billabong at Gan Gan in East Arnhem Land. As at December 2023, the last non-fatal attack occurred at Salt Lake, located on 6 Mile Beach on the east coast of Groote Eylandt.

Since 2014, when the delivery of public awareness initiatives became well-established in the NT, there have been only two recorded fatalities from crocodile attacks, in 2017 and 2018. There have been no fatalities in areas managed to reduce the crocodile risk for recreational use in parks and reserves managed by the NT or local government. There has only been one reported case of injury from crocodile attack in these areas in the last two years, to the end of 2023 (i.e. an incident in 2023 at Wangi Falls in Litchfield National Park).

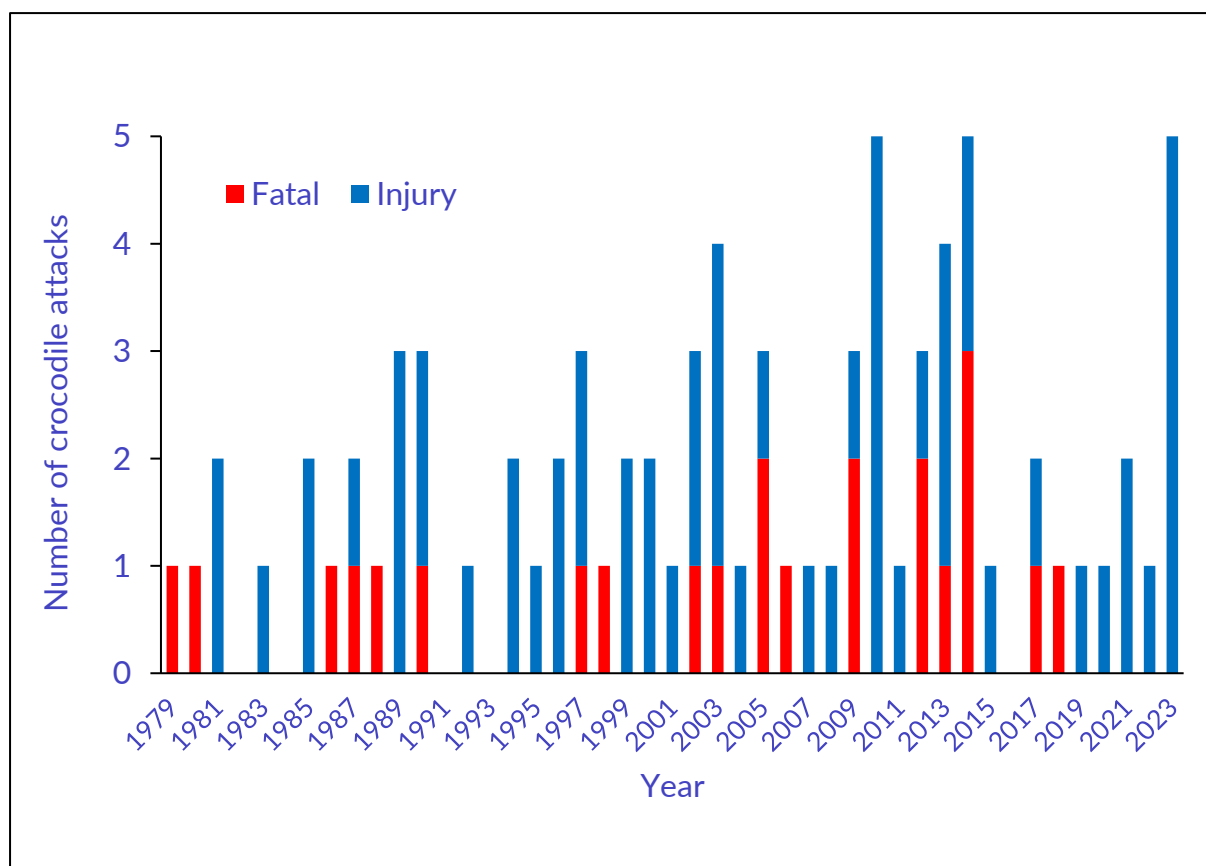


Figure 1. Number of fatal and non-fatal incidents involving Saltwater Crocodiles reported in the NT since formal records commenced.

## 2.3. Habitats and Distribution

The Saltwater Crocodile is one of two species of crocodile found in Australia, the other being the smaller Australian Freshwater Crocodile. The Saltwater Crocodile inhabits coastal rivers and swamps, the open sea and island shorelines, and their distribution extends well inland, through major rivers and floodplain billabongs into freshwater rivers, creeks and swamps.

Saltwater Crocodiles may potentially occupy almost any water body throughout their distribution in the NT (see Appendix 1, Saalfeld *et al.* 2014). Suitable nesting habitat is limited to freshwater wetlands within this distribution (Fukuda *et al.* 2007, Fukuda & Cuff 2013). Fukuda & Cuff (2013) estimated the area of high quality Saltwater Crocodile nesting habitat in the NT at 41,154 km<sup>2</sup>. This is approximately 11% of the total area of extent (378,000 km<sup>2</sup>) of Saltwater Crocodiles in the NT (see Appendix 1).

Approximately 70% of Saltwater Crocodile habitat is Aboriginal land and approximately 10% (4,680 km<sup>2</sup>) of high quality habitat falls within declared protected areas (Fukuda & Cuff 2013, Saalfeld *et al.* 2014). Kakadu National Park contains 58% of NT crocodile habitat within protected areas (Saalfeld *et al.* 2014). No harvesting is currently permitted in Kakadu, apart from removal of problem animals.

Key potential threats to Saltwater Crocodile populations include:

- Overharvesting, if not appropriately regulated and monitored
- Flooding and climate change e.g. intense rainfall, sea level rise, and
- Habitat degradation, especially of nesting habitat, by weeds and feral animals (notably buffalo and pigs).

Further details on the conservation status, distribution, biology, ecology, population and habitat of the Saltwater Crocodile are provided in Appendix 1.

## 2.4. History of Crocodile Use

### 2.4.1. Consumptive Use

Crocodile meat and eggs are thought to have been used as a food source by Aboriginal people for at least 40,000 years (McBryde 1979, Flood 1983). However, the harvest of crocodiles by Aboriginal people for food is believed to have declined (Altman 1987, A Griffiths (DENR), G Wightman (DENR) and J Altman (ANU) cited (Saalfeld *et al.* 2016).

Saltwater Crocodiles were commercially hunted in the NT before they were fully protected in 1971. Experimental egg harvests commenced in 1983 and ranching operations with CITES approval commenced in 1987 (Webb 2020, 2021). Initial management programs for crocodiles (both *C. porosus* and *C. johnstoni*) in the NT included harvest of eggs, hatchlings, juveniles and adults from the wild to rear in captivity for production. From 1998, the Management Program (PWCNT 1998) also allowed non-hatchlings to enter trade directly after harvesting, without the need to spend time in a farm. However, the poor quality of skins from wild animals means this source is rarely used. The harvest of eggs is a critical component of the NT crocodile farming industry. Since farming started in the early 1980s, the total number of eggs collected annually has increased from 298 in 1982/83 to around 35,000 to 51,000 in recent years (Table 1).

## 2.4.2. Non-consumptive Use

Viewing of Saltwater Crocodiles is an iconic part of the NT visitor experience by domestic and international tourists (Ernst & Young 2016). Whilst specific figures on the economic value of crocodiles to the NT are not available, it is likely to be substantial. For example, around 27 % of the activities undertaken by visitors to Darwin are attributed to wildlife experiences and it is likely that crocodiles are a major driver of this interest, as this figure includes visits to crocodile related attractions (Austrade tourism research, cited Ernst & Young 2016).

A reflection of this interest is the large number of tourism experiences that either directly or indirectly relate to crocodiles such as:

- Zoos with crocodiles as the primary attraction
- Working crocodile farms that accommodate visitors
- Viewing of crocodiles in the wild, including:
  - River cruises
  - Guided tours, often by workers in the farming/ranching industry with strong local crocodile knowledge
- Crocodile artisan and products made by local craftspeople (Ernst and Young 2016).

Crocodiles also feature prominently in national and international promotions, advertising campaigns and media. It is estimated that local media feature crocodile related stories on at least a weekly basis, with many stories then getting national and international prominence. To provide background to this level of interest, a search of Google News stories featuring prominent Australian species over a 12-month period (limited to ABC as crocodile stories may relate to other species in an international context) returns around 4,700 for koala, 6,400 for kangaroo and 6,000 for crocodile.

### 2.4.2.1. Cultural Uses and Creative and Performing Arts

Heritage, Creative and Performing Arts is a broad industry and it is difficult to accurately determine the importance of crocodiles in this context. However, it is likely to be a significant motif, especially in the context of both Aboriginal cultural products and experiences and in western art and performances with a Top End foundation (Ernst & Young 2016).

### 2.4.2.2. Feeding of crocodiles

Feeding of wild crocodiles as part of tourism enterprises, whilst popular in the NT, is not without risk. Animals are conditioned to associate humans with food and specifically to jump towards boats to receive a reward. Wildlife feeding is often viewed as undesirable because the short-term benefit of attracting the target species and facilitating viewing and interaction with tourists can be outweighed by the negative long-term effects on animals' health and wellbeing. These negative effects include the production of unnatural behaviours and habituation, undesirable dietary impacts, and increased risk of pathogen transmission (Burgin & Hardiman 2015, Dubois & Fraser 2013, Murray *et al.* 2016, Orams 2002; Shannon *et al.* 2017).

Feeding of wildlife for tourism, especially large carnivore species, is not allowed in most countries, due to the negative effects on the animals. Some examples of exceptions where tourism feeding is still conducted legally include:

- Dolphins in Australia (Corcoran *et al.* 2013, Orams & Hill 1998, Patroni *et al.* 2018)
- Sharks in French Polynesia (Clua 2018, Vignon *et al.* 2010)
- Stingrays in British Caribbean (Corcoran *et al.* 2013)
- Whale sharks in the Philippines (Ziegler *et al.* 2018)
- Brown bears in European countries (Kojola & Heikkinen 2012, Selva & Huber 2018)
- Komodo dragons in Indonesia (Walpole 2001)
- Saltwater crocodiles in Australia (Ryan 1998, Ryan & Harvey 2000).

There are numerous cases where wild animals fed by humans have become ‘unnaturally aggressive towards people’ (Orams 2002) and these include dingoes (Burns & Howard 2003); baboons (Kamal *et al.* 1997); grizzly bears (Albert & Bowyer 1991; Gunther *et al.* 2004); sharks (Clua *et al.* 2011) and coyotes (Schmidt & Timm 2007).

Jumping crocodile attractions on the Adelaide River are a very popular tourism activity and if appropriately regulated, the associated risks can be minimised. These activities provide an opportunity for disseminating educational information about both the species conservation and the need to pay appropriate respect to crocodiles in the broader landscape (consistent with the *Be Crocwise* messaging).

The basis of the success of these attractions to date is the ability to effectively train the species (i.e. via ‘operant conditioning’: Skinner 1948, Brena *et al.* 2015) to only approach and jump near specific boats running deliberate feeding activities only in designated area of the Adelaide River. On this basis, tightly controlled feeding of Saltwater Crocodiles can be continued but only for this species and only in the specific area currently utilised (Figure 4). Feeding of other predators (including Freshwater Crocodiles) to attract them to a specific area or alter their behaviour is prohibited under this Management Program.

#### 2.4.2.3. Other Eco-tourism

The potential to observe Saltwater Crocodiles in natural conditions is a significant but unquantified driver of interest in visiting the Top End. There are a number of locations close to population centres where a sighting of a crocodile can be almost guaranteed, at least in certain seasons (e.g. from the middle to the end of the dry season at Cahill’s Crossing viewing platform).

### 2.4.3. Sustainable Use Trends

Saltwater Crocodiles in the NT have been subject to a regulated harvest since 1983 (Webb *et al.* 1984b, Webb 2020). The harvest is predominately based around egg collection for commercial farming (Clancy & Fukuda 2020, Fukuda *et al.* 2021). Juveniles and adults are also harvested for breeding or direct production of skins and meat (Fukuda *et al.* 2021). Since its inception the harvest quota has increased substantially to the current level of 90,000 viable eggs (Table 1). The harvest of juveniles and adults commenced in 1997 and has remained far below the established sustainable quota of 1,200 (see Fukuda *et al.* 2021). Crocodiles posing risks to people or domestic animals near human settlements have been removed from the wild since 1977 with the numbers included within the allowable sustainable quota. The number of problem crocodiles removed is typically around 300 animals per annum over the last decade (Figure 2). In recent years, the year to year variation in the number of problem crocodiles taken is driven mainly by seasonal conditions which impact on how many crocodiles enter the designated removal zones.

Hatchlings are very rarely caught or removed for any purpose (Leach *et al.* 2009) with no permits being issued in recent times. Between 1977 and 2017, just under 800,000 eggs and 8,600 live crocodiles were harvested or removed from the wild (Fukuda *et al.* 2021).

Egg mortality caused by flooding in the peak of the nesting season (January to March) can be as high as 75% with flood-related mortality varying according to habitat type. As flooding occurs at the same time of year as egg harvesting across the NT, it is highly likely that harvesting removes a large number of eggs that would otherwise be lost to flooding (Fukuda *et al.* 2021). Therefore, mortality from direct harvesting is partially compensatory to natural mortalities, as occurs in many vertebrates (Mills 2013, Morris & Doak 2002).

Table 1. The number of Saltwater Crocodile viable eggs harvested for commercial use from the 2013/2014 to 2021/2022 egg collection seasons\*.

Season	Maximum Harvest Quota	Total Eggs permitted	Eggs harvested (actual)
2013/2014	70,000	60,750	51,238
2014/2015	70,000	68,000	50,022
2015/2016	70,000	70,000	47,194
2016/2017	90,000	70,000	41,218
2017/2018	90,000	77,000	44,950
2018/2019	90,000	77,000	34,658
2019/2020	90,000	77,000	41,462
2020/2021	90,000	84,950	46,836
2021/22	90,000	87,700	51,292

\* Note: for 2013/2014 through 2015/2016 the maximum annual harvest quota was for 'live' eggs and from 2016/2017 onwards, has been for 'viable' eggs. Refer to Section 3.3.1.1 for explanation of egg status classification.

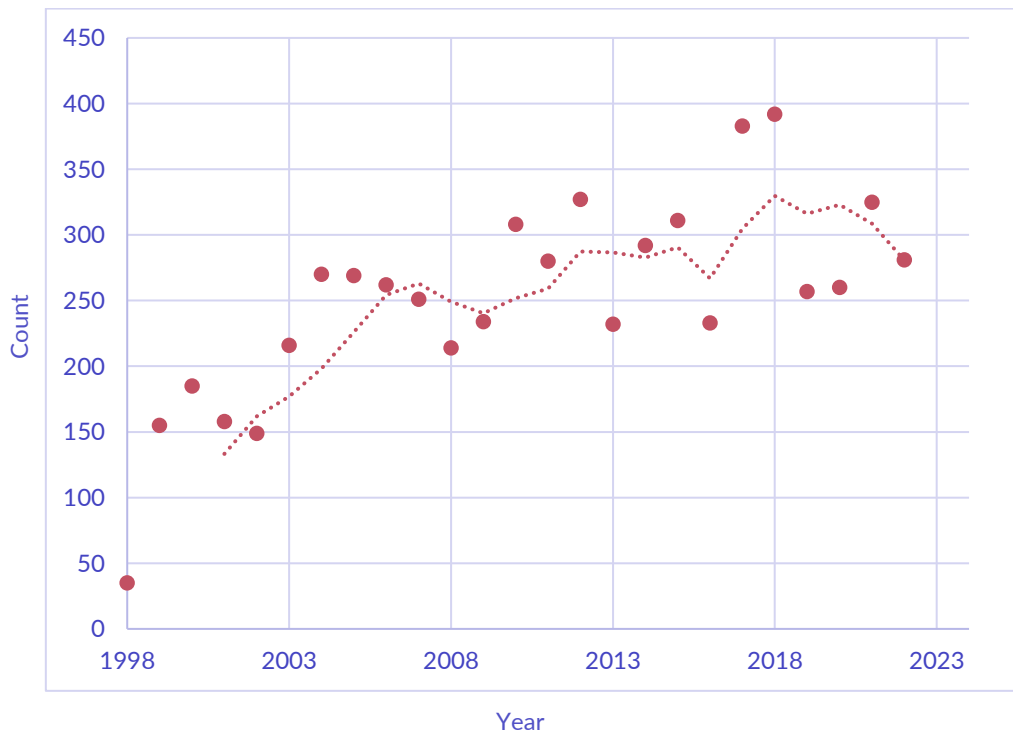


Figure 2. Number of Saltwater Crocodiles removed annually by the DEPWS Wildlife Operations Branch from 1998 – 2021. Dotted line shows running average over a 4-year period.

Key features of the sustainable use phase of management have included: ensuring direct benefit of the industry to land holders to encourage both protection of habitat and broad support for crocodile conservation; increasing focus on public education as to both the risks and values of the species; and implementation of specific initiatives to ensure Aboriginal communities were beneficiaries of the sustainable use program (Webb 2020).

## 2.5. Population Trends and Current Estimate

Since European settlement, three distinct population phases can be identified for Saltwater Crocodiles (Figure 3). Firstly, there was the period of unregulated hunting which greatly intensified after the Second World War up until the early 1970s. Following protection in 1971, there was a period of recovery through the early 1980s. In 1983, sustainable use management programs began to be implemented for the species. Under these programs, the population continued to increase, albeit at a decreasing rate. This sustainable use phase has transitioned from a small-scale ranching trial involving wild harvesting of eggs and rearing on-farm to the full-scale industry that exists today.

The NT population of Saltwater Crocodiles was estimated at about 100,000 non-hatchling individuals in 2017 (Fukuda *et al.* 2021). This has been more than thirty-fold increase from the 1971 estimated population of approximately 3,000 non-hatchling individuals, with between 30,000 to 40,000 individuals in 1984 (Webb *et al.* 1984) and between 70,000 to 75,000 individuals in 1994 (Webb *et al.* 1994). Refer Appendix 1 for more information.

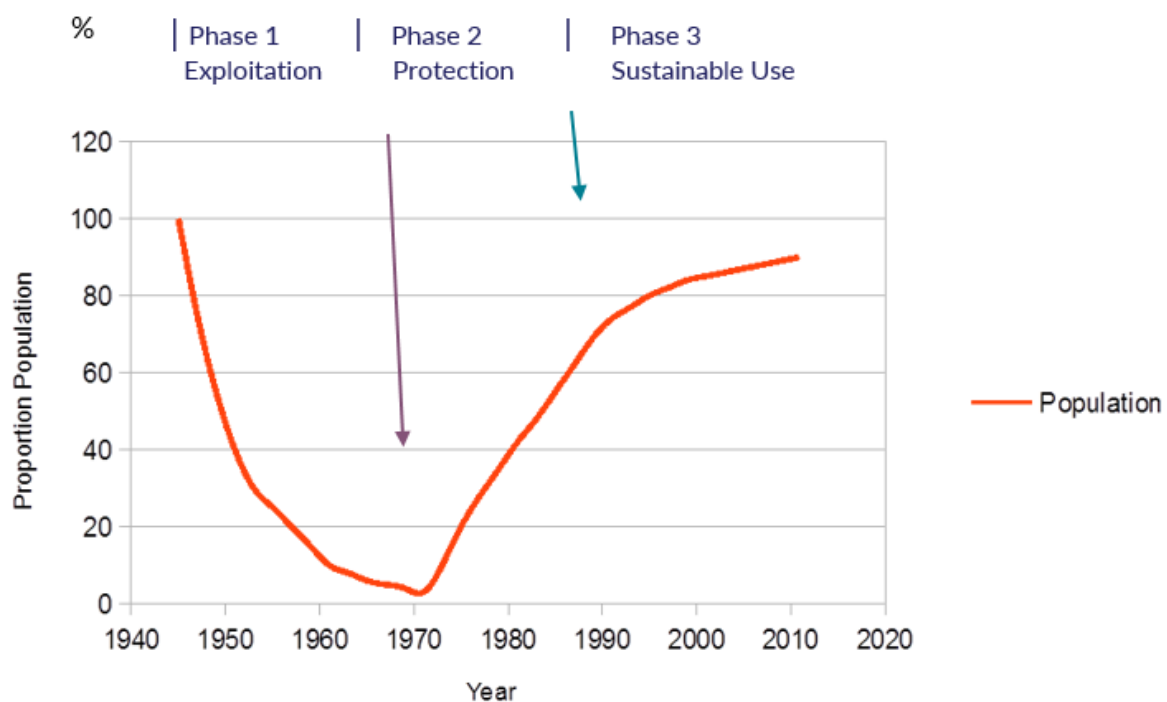


Figure 3. Three phases of management of NT Saltwater Crocodile management and representation of impact on relative population size (After Webb 2020).



## 3. Management Program

The objectives of this Management Program will be met through the implementation of a range of management practices and policies. These will be implemented by NT Government agencies, in conjunction with the crocodile industry and land managers, and in accordance with the relevant legislation, in order to manage the risk to human safety whilst meeting the conservation requirements for the species. This section provides the rationale for and details of management approaches that will be used. Corresponding specific management actions, responsible entities and timelines are detailed in Section 4.

### 3.1. Population Monitoring

**Program Objective: To maintain this iconic keystone predator species at appropriate densities across its range within the Top End of the NT.**

Standardised spotlight surveys of selected river systems within the NT have been used for decades to monitor Saltwater Crocodiles and they will continue to be used under this Program. The survey method provides an index of the density and size structure of crocodile populations (Messel *et al.* 1981, Stirrat *et al.* 2001, Fukuda *et al.* 2013). This includes counts of the 0-2 foot (0-0.6 m) size class, which equate to hatchlings (less than one year old) and so provides a measure of recruitment from the last nesting season. The rivers monitored under this program are where most crocodile harvesting occurs, and for which long-term datasets obtained using comparable techniques are available.

The monitoring program uses existing knowledge of the variability in data from a particular river to detect any significant trend in numbers or biomass. There is inherent variability in both the survey data and the actual crocodile population, which are independent of harvesting. Survey data from each of the monitored rivers is rigorously analysed to detect any significant population decline.

If monitoring were to detect a clear trend of population decline across multiple years, then the potential need to modify harvest quotas would be assessed. The population trend must be distinguishable from natural fluctuations associated with environmental conditions, such as rainfall and the seasonal availability and quality of breeding habitat (Fukuda *et al.* 2011, 2007, Fukuda & Saalfeld 2014). Because of this, the NT Government would generally not review the harvest regime on the basis of the monitoring results from a single year.

The potential requirement for management intervention would also be informed by information on the annual crocodile harvest (i.e. size and sex of non-hatchling crocodiles, numbers of total, live and viable eggs) obtained from permit holders, and environmental conditions (e.g. wet season effect on breeding success).

### 3.2. Management of Risk to Public Safety

**Program Objective: To maintain this iconic keystone predator species at appropriate densities across its range within the Top End of the NT.**

**Program Objective: To enhance public safety through the identification and management of problem Saltwater Crocodiles and reduction of densities in select areas within a best practice risk management framework.**

Addressing the risk to human safety from crocodile attacks is a complex policy and management area, characterised by:

1. A need to mesh ecological and human social dimensions in a changing landscape (i.e. increasing crocodile population size, increasing environmental pressures), whilst ensuring that underlying cultural traditions and knowledge systems are integral to any policy approach and program implementation
2. A strong link to its history (e.g. past use patterns or past perceptions of crocodile population size), characterised by lags between management activities and responses (e.g. between problem crocodile detection and removal)
3. A system controlled by inherently complex feedback loops (e.g. between risk taking behaviours, actual risk and perception of risk related to management activities like crocodile removal)
4. The potential that management actions taken can lead to perverse outcomes (e.g. unrealistic expectation about risk reduction) which can result in unproductive effort to allocate blame rather than a mindset of personal responsibility and continual improvement.

The NT Government's [Saltwater Crocodile Risk Management Framework 2021 - 2026](#) (Risk Management Framework) outlines the crocodile management actions and public education initiatives aimed at reducing human/crocodile interactions. Administered by the Parks and Wildlife Commission within DEPWS, the Risk Management Framework outlines how different areas within the NT are managed under three broad management objectives, as detailed in Table 2 below. Maps showing the locations of these management zones across the NT are provided in the Risk Management Framework.

Table 2. Management Aims and approach for the three broad management zones identified in the NT Government's Saltwater Crocodile Risk Management Framework.

	MANAGEMENT ZONE		
	Barrier and removal	Active removal	General management
General management approach	Complete removal and maintain barriers to crocodiles	Maximum removal of all crocodiles	Removal of problem crocodiles only
Level of people-water interaction	High (i.e. predominantly swimming)	Moderate (i.e. water-based recreation e.g. kayaking, surfing, some swimming)	Low (e.g. camping, fishing)
Target crocodile numbers	Absent	Minimal	Natural
Management Activities:			
• Control public access to water	Yes	No	No
• Level of signage	High	Some	Some
• Public informed when crocodiles seen	Yes	Yes	Problem crocodiles only
• Awareness campaign	Yes	Yes	Yes
Risk of attack following management actions	Low	Moderate	High

The three basic approaches that have been adopted to improve public safety are:

- Reducing crocodile numbers in areas where people and crocodiles significantly overlap around major population centres
- Increasing public awareness and responsibility
- Maintenance of barriers to prevent either human entry to the water or the movement of crocodiles into high public-use areas, supported by a program of intensive survey and ongoing monitoring (noting that these are impractical at anything other than a small scale at specific locations).

Although management methods can reduce the risk of crocodile attack to negligible levels in the barrier and removal zones, there can never be a guarantee of safety in natural waters. It should therefore be assumed that any body of water in the Top End may contain large and potentially dangerous Saltwater Crocodiles. Many waterways that are isolated in the dry season are connected to other river systems during the wet season, allowing crocodiles to move over a large area. Saltwater Crocodiles have always occurred not only in coastal and tidal rivers, but also in floodplains, billabongs, and freshwater streams and habitats hundreds of kilometres inland. The recovering crocodile population also means that animals are recolonising areas where they have not been seen for many years.

Problem crocodiles in remote areas are managed by the NT Government, depending on resourcing and access. Permits can also be issued to community-based ranger groups or landowners to deal with a problem animal, and police officers can be requested to shoot a problem animal.

Captured problem crocodiles may be utilised for commercial gain, noting that the over-riding concern is public safety and commercial considerations should never influence the removal of an identified problem animal. All problem crocodiles removed from the wild, either by NT Government staff or under a Permit to Take Protected Wildlife will be counted against the live harvest quota, to ensure sustainability of the total harvest. However, the live harvest quota will not limit the capacity of the NT Government to remove problem crocodiles.

Within the Darwin, Katherine and Borroloola Crocodile Active Removal Management Zones and the Barrier and Removal Zones for designated swimming areas in National Parks (e.g. Wangi Falls in Litchfield National Park), all Saltwater Crocodiles are considered problem animals. These areas are intensively managed through an active surveillance and trapping program and have detailed crocodile risk management plans that address the management requirements of each area.

The risk management plans provide strategic and operational detail for each area on the following aspects of crocodile management:

- Crocodile removal
- Monitoring to detect any crocodiles
- Reporting process for crocodile sightings
- Crocodile awareness signage and education
- Risk assessment.

On pastoral land, problem crocodile removal is generally associated with livestock protection and is usually managed by the landowner under the authority of a Permit to Take Protected Wildlife issued to the landowner or their designated nominee. Where public safety is at risk from a problem crocodile on pastoral land, depending on the circumstances, the problem

crocodile may be dealt with either by NT Government staff, or under a Permit to Take Protected Wildlife. These animals can be utilised for commercial gain by the landholder, but commercial considerations must not hinder a timely response to the presence of a problem crocodile.

On Aboriginal land declared under the ALRA, where the commercial use of resources (including crocodiles) requires a s19 Land Use Agreement, public safety must have a higher priority than the potential commercial use of problem crocodiles. Where the risk posed by a problem crocodile is immediate and precludes obtaining a land use agreement, problem animals will be removed either by NT Government staff, local Aboriginal Ranger group, authorised private operator or NT Police officers and these animals cannot be used by the landholder for commercial gain. Traditional Owners do not need a permit to hunt for cultural purposes but do require a permit for any commercial use of wildlife. Where the threat of a problem animal is assessed as 'present but not immediate' the landholder can apply for a Permit to Take Protected Wildlife and seek a s19 Land Use Agreement to allow the crocodile to be used for commercial gain.

The capture and handling of problem crocodiles must comply with the *Animal Welfare Act 2018* and the Code of Practice.

### 3.2.1. Detection and Surveillance

Parks and Wildlife uses both proactive and reactive management actions in reducing the risks associated with Saltwater Crocodiles. The active removal programs are implemented through regular surveillance (night and day surveys), harpooning and a trapping program within the Darwin, Katherine and Borroloola active removal zones and designated swimming areas in NT parks and reserves (e.g. Wangi Falls in Litchfield National Park). In addition to the proactive management actions, on-call staff respond to public-reported sightings, especially in priority removal areas.

Where resources are available, new technologies for detection and surveillance will be investigated during the term of this Management Program, as discussed in Section 3.6.1.

### 3.2.2. Removal Programs

Saltwater Crocodiles can pose an extreme risk to human safety (Fukuda *et al.* 2014, 2015) and can also be a significant risk to livestock and domestic animals.

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

- It has attacked or is about to attack a person or persons
- It is behaving aggressively towards a person or persons
- Its location makes it a threat or potential threat to human safety or wellbeing, and/or
- Its activity is affecting the productivity of industry or commercial enterprises.

Crocodiles are regularly removed in accordance with the Risk Management Framework. Currently, three mechanisms are used to manage the removal process:

1. Dedicated staff from the Parks and Wildlife Commission are responsible for capture of crocodiles in the barrier and active removal zones. The vast majority of crocodiles removed by the 'Croc Teams' are from the Darwin active removal zone (Table 3).

2. Parks Wildlife Commission staff, with the support of the Croc Teams, are responsible for the maintenance of the barrier and removal zones in NT parks
3. Permitted crocodile industry people, private contractors and land managers who have the need and capability to remove problem crocodiles from areas outside of the barrier and active removal zones.

During the term of this Program, existing crocodile removal programs will be strengthened and extended. To further alleviate the risk to public safety, additional resources will be allocated to prevent crocodile populations in higher risk areas from continuing to grow beyond current levels and to additional targeted local population reduction in active removal management areas. This may include extending existing management areas or creating additional ones, based on monitoring data and expert scientific advice.

Table 3. Total number of problem crocodiles removed by Parks and Wildlife, according to sex and location, from 2012 to 2022

Year	Problem crocodiles	Percentage Males	Percentage Darwin Harbour	Percentage Greater Darwin Zone
2012	327	77.1	65.4	91.1
2013	232	77.6	70.7	87.1
2014	292	79.1	70.2	92.5
2015	311	74.3	66.6	86.2
2016	233	72.1	73.0	93.1
2017	383	76.8	80.7	93.0
2018	392	74.0	66.8	83.9
2019	257	73.9	58.4	82.5
2020	260	68.8	65.4	86.5
2021	325	74.7	59.1	86.9
2022	281	76.7	63.7	90.4

### 3.2.3. Management on Aboriginal land

On Aboriginal land, Parks and Wildlife Commission staff are regularly requested to assist in the management of problem crocodiles. In these areas, problem crocodiles may be captured and removed if they pose a risk to people or commercial productivity. Any assistance provided by Parks and Wildlife will be at the request of the local community, Aboriginal Ranger group, Corporation/Association or land council.

Parks and Wildlife Commission staff respect the cultural and ecological value of Saltwater Crocodiles and recognise that they are a significant cultural totem to many Aboriginal people. For this reason, a valid agreement must be in place before any management of crocodiles will be undertaken.

Captured Saltwater Crocodiles will not be released back into the wild, so must either be taken to a farm or destroyed. Captured animals can become trap shy and therefore more difficult to capture if they are released, which increases their potential risk to public safety.

Where possible, Parks and Wildlife Commission staff will assist Aboriginal Ranger groups or local community groups in the management of Saltwater Crocodiles through:

- Provision of training
- Provision of equipment
- Provision of staff to assist in the capture and removal of problem Saltwater Crocodiles
- Provision of advice for management of crocodiles
- Actively participating in local community education initiatives.

### 3.2.4. Community Awareness and Participation

***Program Objective: To improve community awareness of the risks posed by Saltwater Crocodiles and appreciation natural and cultural values of this species through appropriately targeted education programs***

The public profile of Saltwater Crocodiles and their management in the NT is high. Maintaining effective communication between NT Government agencies, industry stakeholders, regional land management and conservation groups, and the wider community will be critical to the success of this Management Program in meeting its objectives. Effective communication frameworks are also essential for adaptive management and incorporating feedback from industry and community groups into future management policies and practices for crocodiles. The community must be well-informed about safe behaviours for living with crocodiles.

The NT Government promotes crocodile awareness through the *Be Crocwise* safety education program. Developed in 2009, *Be Crocwise* formalised the 'living with crocodiles' presentations that had been delivered on an *ad hoc* basis by Parks and Wildlife Commission staff for many years prior to this. The contemporary approach to the development of *Be Crocwise* messaging is iterative, incorporating feedback from stakeholders, experts, coronial inquiries, behavioural psychology, and by targeting key audiences and considering local contexts.

*Be Crocwise* delivers proactive and tailored messaging to individual audiences, raising awareness and bringing about behaviour change through community-based marketing strategies. Initially focused on in-school presentations, the reach of *Be Crocwise* has widened greatly over the years and now engages with local and visiting audiences through various mechanisms including, but not limited to:

- Advertising and editorials in local and nationwide publications
- Local radio announcements in appropriate languages
- Announcements over community PA systems
- Design and production of specific merchandising, vehicle wraps, social media messaging
- Online advertising (e.g. Google), and
- Presentations at appropriate public forums and to industry groups.

Public-facing engagement continues to be a strong feature of the program, with *Be Crocwise* presentations being delivered to schools and community and industry groups, and through displays at public events.

Queensland and Western Australia are within the range of Saltwater Crocodiles and both jurisdictions now deliver a *Be Crocwise* program to complement and support crocodile management activities. Recently, the programs in the NT, Queensland and Western Australia

have worked closely together, creating efficiencies and sharing knowledge and learnings. This collaborative approach to the management of human / wildlife interaction and education has also resulted in brand recognition and message uptake in cross-border audiences, further enhancing the efficacy of all three programs.

The NT Government will also promote relevant legislation, policy and guidelines to the commercial crocodile industry and wider community via promotion of this Management Program, relevant fact sheets, and through the permit system.

### 3.3. Regulation of Crocodile Industry

***Program Objective: To enable a robust and profitable crocodile industry underpinned by the sustainable harvest of Saltwater Crocodiles that ensures that landholders receive real benefits from their continuing support for the conservation of the Saltwater Crocodile and its habitats.***

The NT's crocodile farming industry is based largely on the harvest of eggs and animals from the wild to supply crocodile farms and other crocodile processors. This ranching component of the industry is supplemented by captive breeding on some farms. The dependence on wild harvest is likely to remain the foundation of the NT crocodile farming industry into the future.

#### 3.3.1. Harvest Management

Commercial harvest of Saltwater Crocodiles has two components: a) egg harvest and b) the harvest of live animals (hatchling, juvenile and adult animals) from the wild. Both harvest components must be sustainable, in isolation and in combination.

To ensure sustainability of the wild harvest whilst optimising the number of both eggs and live animals available to industry, maximum harvest quotas have been derived from both empirical data and modelling of historical population and harvest data. The harvest quotas for eggs and live animals in early management programs were based on an adaptive management approach through setting of a conservative harvest, monitoring of the impact of that harvest and subsequent adjustment of the harvest level. The harvest quotas were set at levels above what was anticipated to be collected and below what was considered to be unsustainable. More recently and in this Management Program, the maximum harvest quotas have been established on the basis of explicit modelling of the crocodile population processes (Fukuda *et al.* 2021).

Under the current model, the number of eggs and live animals allowed to be taken in any year is often below the maximum allowable harvest quota due to insufficient demonstrated demand from industry. Animals taken under problem crocodile management activities may be utilised for commercial return and are included as part of the overall take. The maximum number that may be used commercially under this Management Program must directly align with the associated Saltwater Crocodile Wildlife Trade Management Plan [\(2021-2025\)](#) currently set at 90,000 viable eggs and 1,200 live animals (Clancy & Fukuda 2020), or subsequent approved Plans.

##### 3.3.1.1. Egg Harvest

Fukuda *et al.* (2021) reported that harvest models show the population can support an annual harvest of 120,000 eggs (in conjunction with a live harvest of 1,200 animals) with no detriment to population abundance over a simulated 30 year period. Based on harvest, incubation and farm data (DEPWS unpublished data), a harvest of 120,000 eggs would equate to 100,000 live eggs (the harvest unit used in early management programs) or 90,000

viable eggs (i.e. an egg which hatches to produce an animal usable for skin production). The maximum harvest quota and egg allocation in this Program is based on viable eggs.

The shift to viable eggs was based on input from both industry and regulators in regard to measures to streamline harvest and farming compliance processes. Viable eggs are the basic measure of input used by the farm industry. Coupling the harvest quota and allocation to this measure has streamlined compliance monitoring and reporting for both industry and regulators. It also supports industry to optimise efficiency as the high cost of egg collection means it is undesirable to collect more eggs than are needed to maintain production levels.

The annual egg harvest quota is currently set at 90,000 viable eggs. The current harvest represents less than 50% of the total number of eggs laid each year and because a very low percentage of eggs would normally survive to later age classes in the wild (Webb & Manolis 1993), the egg harvest mostly represents a displaced mortality rather than additional mortality.

Ongoing monitoring of both harvest and population parameters will ensure that the permitted level of egg harvest remains sustainable. Currently, all of the monitored rivers are harvested, except those in Kakadu National Park. All monitored rivers have shown an increase in both abundance and biomass of Saltwater Crocodiles (Clancy & Fukuda, 2020), consistent with the continued increase in the overall population in the NT (Appendix 1), providing supporting evidence for the sustainability of the increase in the permitted egg harvest.

Should industry growth over the period of this Management Program lead to higher demand for eggs, monitoring data and population and harvest modelling will be used to determine if further increases in the harvest quota are appropriate. It is envisaged that any such change, if supported by scientific evidence, would need to be implemented within the context of the WTMP.

Egg harvest is permitted and regulated by DEPWS. In considering whether or not to grant a permit for egg harvest, consideration will be given to the geographic location of the proposed collection area, and whether the harvest provides any direct benefit to Aboriginal landholders. DEPWS will endeavour to ensure that harvest activities are not concentrated within a relatively small area within the species distributional range.

The following changes to the annual egg collection quota are proposed for the term of this Management Program:

1. Permit Holders with multiple permits may be allowed to shift allocations between their respective permits, providing that their overall combined allocation of all permits is not exceeded
2. Egg allocations for each permit can be set over a three-year period (rather than annually), to provide flexibility to adjust harvest levels according to seasonal conditions. For example, an area which has a 1000 egg allocation per year could take more than 1000 eggs in a given year, provided the total allocation (3000) is not exceeded over three years
3. Individual permit quotas may be reviewed and adjusted, according to actual numbers taken, to facilitate re-allocation of eggs within the overall NT-wide quota. For example, if a permit holder takes fewer eggs than their allocated quota over a prolonged period, then a proportion of their allocation could be returned to the 'common pool' (i.e. the maximum total viable egg harvest of 90,000) and reallocated.



Prior to implementation of the above, a Crocodile Egg Quota Management Guideline will be developed in consultation with industry, providing specific details about how egg collection quotas are managed with worked examples.

### 3.3.1.2. Live Harvest

The increased focus of the crocodile industry on harvesting eggs has been mirrored by a decreasing take of live crocodiles. Over recent years, a fewer than 600 live crocodiles have been taken annually, and this includes all animals (hatchling, juvenile or adult) taken from the wild, either for commercial use or as problem animals (Clancy & Fukuda 2020, 2021).

Fukuda *et al.* (2021) reported that harvest models indicate the population can support an annual harvest of 1,200 non-hatchling crocodiles (in conjunction with an egg harvest of 120,000 eggs) with no detriment to population abundance over a 30-year period. A harvest of 1,500 non-hatchling crocodiles and 90,000 viable eggs over the same period would produce a very slight decline (< 5%) over the same 30 year period. A harvest level of 1,200 crocodiles represents less than 2% of the estimated total NT Saltwater Crocodile population.

Under this Management Program, a nominal live harvest quota has been set at 1,200 Saltwater Crocodiles (hatchling, juvenile or adult) annually. This allows for a potential 100% increase in the number of crocodiles that can be taken. This figure is consistent with the level identified in the WTMP. Should the annual live harvest quota be reached during the life of this Management Program, monitoring data and population and harvest modelling will be used to determine if further increases in the harvest quota would be sustainable, in the context of not resulting in a significant overall population decline outside of management areas where local population reduction is the key objective. This would be carried out in conjunction with any review of the egg harvest to ensure the overall take is sustainable.

The NT Government may prohibit the taking of crocodiles in some situations. In general, harvesting of live crocodiles will not normally be permitted:

- i) In waterways where the watercourse forms the boundary between two or more properties, without the agreement of all property holders
- ii) In mainstream channel of rivers that are heavily used by the tourism and fishing industry, such as the East Alligator River, the Mary River downstream of the Arnhem Highway, the Adelaide River downstream of the Marrakai Crossing and the Daly River downstream of Ooloo Crossing. Where low level harvest is permitted it will be tightly regulated to ensure that tourism interests are not damaged
- iii) From sites where crocodiles are particularly significant to local Aboriginal people.

This does not preclude the removal of problem crocodiles from these areas.

### 3.3.1.3. Harvest review

Maximum harvest quotas have been set for the life of the Management Program and have sufficient scope to allow for projected industry growth over the next five years. Harvest levels (both via the crocodile industry and active removal programs to protect human safety – see Section 3.2.2) and population trends will be monitored during the life of the Program. Should monitoring detect a significant population decline or a clear trend of population decline in any of the monitored rivers, then the need for harvest reductions will be assessed (see above). The population trend must be distinguishable from natural fluctuation due to environmental conditions such as rainfall and the seasonal availability and quality of breeding habitat (Fukuda *et al.* 2007, 2011, 2021).

### 3.3.2. Permits

Saltwater Crocodiles are a protected species in the NT. The take (harvest) of or interference with any Saltwater Crocodiles from the wild, the keeping of and/or trading in Saltwater Crocodiles, and the import or export of Saltwater Crocodiles requires a permit issued under Section 56 of the TPWC Act.

Commercial use of Saltwater Crocodiles under this program will be regulated by permit. The NT.GOV.AU web site provides details of the types and conditions of permits relating to wildlife (<https://nt.gov.au/environment/animals/wildlife-permits>). Other NT legislation may apply to certain aspects of crocodile farming, as described in Section 1.3.1. A permit from the Australian Government is required for wildlife that occurs on Commonwealth land such as Kakadu National Park.

#### 3.3.2.1. Permit to Take Protected Wildlife

Harvest of Saltwater Crocodiles (animals or eggs, live or dead) by non-Government individuals or entities, including removal of problem crocodiles, requires a [Permit to Take Protected Wildlife](#) from the NT Government. On land that is not freehold, royalties may also be payable.

In the assessment of permit applications, DEPWS will consider the capacity and capability of the applicant to safely and humanely deal with live crocodiles including their transport and dispatch.

Permits are issued for a specific number of crocodiles, duration and locality with landholder approval a requirement. The Permit Holder, Nominees and Authorised Persons must undertake Collections and handle the Protected Wildlife in accordance with the following:

- i) the Protected Wildlife may be taken from the Permit Area, either alive or dead, by trapping and/or harpooning and/or shooting
- ii) the Permitted Vehicles may be used to access the Permit Area and transport the Protected Wildlife
- iii) all Collections and handling of the Protected Wildlife must be carried out in accordance with the *Code of Practice for the Humane Treatment of Wild and Farmed Australian Crocodiles*.

Failure to lodge a permit return or insufficient or incorrect information in the permit return may result in the issue of a warning letter, caution notice or infringement notice, and could also result in cancellation of the current permit, refusal to issue any further permits, or prosecution.

The NT Government may also vary or cancel a permit if information becomes available that indicates conservation management measures may be required to protect a Saltwater Crocodile (sub) population.

#### 3.3.2.2. Permit to Keep Protected Wildlife

A [Permit to Keep Protected Wildlife](#) is required to keep and/or trade Saltwater Crocodiles and/or their parts. Permits are valid for one or more years and subject to terms and conditions including identification of who is authorised to keep and/or trade Saltwater Crocodiles under the permit, where and the quantity of Protected Wildlife that may be kept and the requirement to provide returns.

### 3.3.2.3. 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 Saltwater Crocodiles or their parts from the NT to other Australian States and Territories.

The overseas export of live crocodiles and commercial shipments of crocodile skins, products or by-products from Australia requires a CITES permit from the Australian Government department responsible for administering the EPBC Act. DEPWS issues CITES skin tags on behalf of the Australian Government for commercial shipments of skins from crocodile farms. Other international exports require an export permit from DEPWS prior to the Australian Government issuing a CITES permit.

Under CITES provisions and EPBC Act regulations, up to four Saltwater Crocodile products can leave Australia within a passenger's personal luggage without a CITES permit if they are personally owned, non-commercial, and legally acquired.

An [import](#) permit issued by the Australian Government is required for the commercial shipment of crocodile products or their parts into the NT from overseas. A NT import (including re-import) permit, issued under the TPWC Act is required for all shipments of crocodiles or their parts entering the NT. Imports from other Australian jurisdictions must also be accompanied by an export permit from that jurisdiction.

### 3.3.2.4. Crocodile Farm Permits

Crocodile farms require a [Permit to Keep Protected Wildlife](#) to authorise the keeping and trade of Saltwater Crocodiles and Permit(s) to Import and Export Protected Wildlife to import or export Saltwater Crocodiles from the NT. A Crocodile Farm 'Enterprise Permit' combines all three permits in a single document. An Enterprise Permit is valid for a period of ten years and authorises the permit holder (crocodile farm) to keep, trade, import and export Saltwater Crocodiles subject to terms and conditions of the permit.

Farm records are administered by DEPWS. The holder of a Crocodile Farm Enterprise Permit is required to provide an annual permit return to DEPWS detailing stock gains/losses, transfers, sales, mortality, and skin and meat processing figures. This information is used to compare farm holdings with wild harvest permit returns and ensure compliance with wild harvest permits. The annual permit return is provided to both DEPWS and DITT.

An Enterprise Permit authorises the permit holder to import or export Saltwater Crocodiles without the need to apply for individual permits for each shipment. It is a condition of the permit that the holder provides prior notice to DEPWS of any shipment. The shipment is then authorised unless the permit holder is advised otherwise by either DEPWS or DITT.

Individuals or companies trading products derived from Saltwater Crocodiles taken under this Management Program are required to hold either a Permit to Keep Protected Wildlife or a Crocodile Farm Enterprise Permit. It is a condition that the permit holder maintains detailed records, and to mark certain products with a product label in accordance with the DEPWS product label guidelines. DEPWS issues product labels 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 for Saltwater Crocodiles

- Shows the permit holder name and permit number of the Enterprise Permit or Permit to Keep Protected Wildlife that the product was produced under
- Shows the date that the product label was affixed to the product.

These labels provide the means to identify products originating from a legitimate source.

### 3.3.3. Shipping Requirements

#### 3.3.3.1. Shipment Inspections

The Australian Government requires an inspection be undertaken of any skins and hides intended for international shipment.

#### 3.3.3.2. Skins

Each whole skin (belly, horn-back or cape) entering trade or being exported will be marked with a non-reusable plastic skin tag issued by the Australian Government in compliance with the provisions of CITES Resolution Conf. 11.12 (Rev. CoP15) (<http://www.cites.org/eng/res/11/11-12.shtml>). Excised back-straps are packaged into a carton and the skin tag is attached to the carton. The permit issued for back-straps states that the tag is attached to the box and records the total number of back-straps in the carton.

Each farm must complete a Specimen Export Record (SER), which lists the skin tags that have been attached to either whole skins or cartons of back-straps and return it to the Australian Government Department of Climate Change, Energy the Environment and Water. Each skin tag is uniquely numbered and the number serves as an identification for all subsequent record keeping related to the skin of that particular animal. DEPWS is responsible for issuing skin tags on a cost-recovery basis, and skin tags are issued annually.

#### 3.3.3.3. 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 need 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.

#### 3.3.3.4. By-products

Product labels are required for derived parts from animals under 2.3 metres in length. This includes taxidermy products (whole animal or heads), skulls, whole belly and horn-back skins, and back-straps. A Permit to Keep Protected Wildlife is required for parts derived from animals over 2.3 metres in length.

Skins that have a CITES skin tag affixed do not require either Permit to Keep Protected Wildlife or product label. Products to which a product label has been affixed do not require either a Permit to Keep Protected Wildlife or an import/export permit for movement into/out of the NT; the product label is the authority to keep and import/export.

### 3.3.3.5. Manufactured Items

Product labels are not required for a range of finished manufactured products. Items included are: bags, belts, wallets, back scratchers, hat bands, necklaces, bracelets, key fobs, drink coasters, book covers and trimming. While labels are not required for these items, they can be affixed at the permit holder's discretion. Manufactured items which do not require a product label do not require an import/export permit for movement into/out of the NT. The NT Government exempts these items from the provisions of the TPWC Act.

### 3.3.4. Compliance Activities

DEPWS will monitor the compliance of crocodile farms in regards to permits, provisions in this Management Program, relevant legislation and the Code of Practice by:

- Inspecting new permitted crocodile farms at least once during the first year of operation
- Inspecting a sample of farms annually, taking into consideration:
  - farms identified as having matters of concern in a previous audit
  - farms that have been reported by members of the public or other government departments as being potentially in non-compliance
  - open source data, such as newspaper reports or legal cases involving the legal entity
  - time since the last inspection
- Collecting information on the movement of crocodiles into and out of a state/territory using an import/export report linked to the farm permit
- Investigating alleged breaches of NT legislation in relation to the commercial take, keep and use of crocodiles in the NT.

The holder of Crocodile Farm Enterprise Permits for processing crocodile products must maintain records in an approved form (hard copy or an electronic record system) and submit annual return data in an approved form (i.e. a Permit Return, as defined in the permit).

Failure to lodge a Permit Return or the supply of insufficient or incorrect information may result in the issue of a warning letter, caution notice or infringement notice, and could also result in cancellation of the current permit, refusal to issue any further permits, or prosecution.

Allegations with respect to animal cruelty or a failure to provide a minimum level of care to crocodiles will be investigated by the Animal Welfare Branch of DITT, which has agency responsibility for administering animal welfare legislation.

The movement of crocodiles (including eggs) into and out of the NT will be monitored and any apparent anomalies will be investigated in conjunction with relevant jurisdictions.

The NT Government will implement the following actions to help ensure compliance in respect of egg collection:

- Random checks on eggs and farm stock to ensure compliance with permit conditions and reporting

- Collaboration with other jurisdictions and agencies (Kakadu National Park, Queensland, Western Australia, Australian Governments, tanneries etc.) to help eliminate illegal trade of eggs, animals or products between states
- Investigation of any reports of potentially illegal incidents and pursuit of legal action where sufficient evidence is obtained.

The NT Government may vary or cancel a permit if information becomes available that indicates conservation management measures may be required to protect a Saltwater Crocodile population.

### 3.3.5. Animal Welfare

The *Code of Practice for the Humane Treatment of Wild and Farmed Australian Crocodiles* (Code of Practice) recommends minimum standards to be applied based on knowledge of crocodile welfare issues and best practice in humane handling techniques. The Code of Practice provides for a number of appropriate methods for capture of wild crocodiles, including traps, snares, hooks, nets, harpooning and shooting dependent on the size of the animal and the context of the capture and handling activity. Harvesting or capture of problem crocodiles and farming of Saltwater Crocodiles must be in accordance with the Code of Practice.

The Code of Practice is approved under the NT's *Animal Protection Act 2018* as specified in Schedule 1 of the *Animal Protection Regulations 2022*. Compliance with the Code of Practice is a condition of all permits issued for the take, keeping and movement of Saltwater Crocodiles. Non-compliance with the Code of Practice may result in the issue of a warning letter, caution notice or infringement notice, and could also result in cancellation of the current permit, refusal to issue any further permits, or prosecution under the TWPC Act.

The Australian Government Department of Climate Change, Energy, the Environment and Water commenced an independent review of the Code of Practice in July 2023, with the review expected to be completed in 2024.

Any breach of the *Animal Protection Act 2018* relating to duty of care or cruelty is an offence and may result in the issue of a warning letter, caution notice or infringement notice, or prosecution under the Act.

### 3.3.6. Biosecurity

It is recommended that permitted crocodile farms develop and implement a site specific biosecurity plan (or any equivalent process resulting from the current review of the *Livestock Act 2008*), for all holdings over 10 live adult crocodiles or 50 eggs and juvenile crocodiles that involve transfer of animals from other farms or off the site.

## 3.4. Enhancing rural and Aboriginal livelihoods

***Program Objective: To enhance Aboriginal livelihoods through active participation of traditional owners in the crocodile industry and development of new, culturally appropriate economic opportunities.***

Landholder support for the sustainable harvest and conservation of Saltwater Crocodiles and their habitat is crucial to the long-term viability and growth of the crocodile farming industry. The *Northern Territory Crocodile Farming Industry Strategic Plan 2024-2033* identifies the economic return that landholders receive as the most important component of the egg harvest program. The Industry Plan recognises this as the driver of the incentive-driven

conservation program. It is important to protect landholder rights to determine who can access their crocodile resource and ensure that benefits that may be derived from the resource are maximised.

Regulation of economic return to landholders (Aboriginal, pastoral, private and Government) is not included within this Management Program, as the TPWC Act does not provide for this. However, the Management Program aims to implement sustainable harvest regimes that are most likely to provide appropriate economic return.

Protection of landholder rights and maximising the benefit they receive is achieved indirectly by ensuring that landholder permission is obtained before any Saltwater Crocodile eggs or live animals can be harvested. Under the TPWC Act, a Permit to Take Protected Wildlife gives authority to take animals from the wild but does not authorise entry onto the landholder's property (s60). To ensure that an applicant for a permit to harvest either crocodile eggs or live animals has the landholder's permission, the applicant must provide a copy of the landholder's written permission for the applicant to access the property and to take the protected wildlife. The written permission is to cover the permit applicant and nominees, the harvest type (egg or live animal), quantity and harvest period. The permit will not be issued without proof of landholder permission.

On Aboriginal lands declared under the ALRA, s19 of the ALRA provides for Land Use Agreements, which should be in place for commercial harvest of crocodiles (eggs and/or live animals). The Land Use Agreement is negotiated between the Aboriginal traditional owners and the crocodile harvest proponents and facilitated through the appropriate Land Council. Amongst the matters covered by the Land Use Agreement are the conditions of access to land. A harvest permit will not be issued until the issuing agency is advised by the relevant Land Council that a Land Use Agreement has been agreed.

### 3.4.1. Hunting and Cultural Experience Tourism

Economic returns from hunting of crocodiles has been supported in principle in previous Management Programs. However, such initiatives have not been implemented to date as they were not supported at by Australian Government, mainly due to negative perceptions associated with the concept of 'trophy' or 'safari' hunting. During the term of this Program, the Australian Government will be consulted on opportunities for economic activities associated with cultural uses. Any such activities would need to be consistent with Commonwealth legislation and the [WTMP](#).

The approach of this Program is to provide traditional owners with an opportunity to develop enterprises to deliver economic benefits through highlighting the cultural value of Saltwater Crocodiles. The content and delivery of such tourist experiences should be consistent with the Program and may include activities such as observing the removal of problem crocodiles from their land. This is likely to result in a financial gain that is orders of magnitude greater per individual crocodile than harvest for the skin or meat market. There was strong support for this activity during the public consultation undertaken during development of this Program.

## 3.5. Other Management Issues

### 3.5.1. Miscellaneous Permitting

Other activities involving human interaction with Saltwater Crocodiles may require a permit to interfere with protected wildlife under s55 and s66 of the TPWC Act

<https://nt.gov.au/environment/animals/wildlife-permits/permits-take-interfere-with-wildlife>).

These include:

- 1) Scientific purposes. A scientific research permit is required for any activity that involves capturing, handling, sampling or otherwise physically interfering with wild crocodiles. Approval from a recognised Animal Ethics Committee is also required. Animals taken from the wild for research purposes will generally not be permitted to be released back to the wild, and these will contribute to the annual wild harvest quota.
- 2) Collection of animals for wildlife displays. Permits to Take Protected Wildlife or Keep Protected Wildlife (see Section 3.3.2) will be required and crocodiles taken from the wild will contribute to the annual wild harvest quota. Due to potential disease issues, animals kept in captivity are generally not permitted to be released back to the wild.
- 3) Collection of animal parts. In support of the crocodile industry, the taking of parts of crocodiles from the wild (e.g. bones/skulls found from previously deceased animals) will not be authorised, unless an animal part is being sold in support of Aboriginal livelihoods.
- 4) Eco-tourism activities. Many eco-tourism activities that are based on observing wild crocodiles do not require a TPWC Act permit. However, activities that can be considered 'interfering with wildlife' due to disturbance or which result in behaviour modification require a permit. The potential requirement for permits will be assessed on a case-by-case basis, including consideration of whether modifying the behaviour of wild Saltwater Crocodiles may pose increased risks either to individual crocodiles, crocodile populations, or the public. Feeding of crocodiles will not be permitted except in a designated zone of the Adelaide River (see below) and only from appropriate vessels/boats (not from the land).
- 5) Pet crocodiles. Permits are required to keep crocodiles as pets in captivity. Under this Program, the guidelines for new and existing permit holders will be reviewed to ensure the risks associated with public safety, animal welfare and biosecurity are managed. The review will provide for matters such as the tagging of pets, evidence of disposal, enclosure design and material to stop escapes. Restrictions on the numbers of freshwater crocodiles to be kept under permit will also be reviewed.

### 3.5.2. Jumping Crocodiles

The existing 'jumping crocodile' tourism activities on the Adelaide River are a popular and unique tourism draw card for the NT. However, food provisioning is a controversial activity in wildlife management, particularly when it involves large carnivores where there is a real risk of increasing the probability of attacks on humans (for more detail refer to Section 2.4.2.2). Under this Program, the existing area (see Figure 4) will continue to be available for current permitted operations (valid permit in place inclusive of 1 January 2024) but no permits will be issued for wild feeding and related activities involving interference outside the existing designated area; and with no feeding from land permitted. Feeding is also not permitted within 200m (measured along the length of the river) of the Adelaide River Arnhem Highway Bridge and not within 100m of any pontoon, boat ramp or jetty.

It is expected that the jumping crocodile operators will develop an appropriate Code of Practice to cover all activities associated with their use of Saltwater Crocodile that is compliant with this Management Program, the requirements of the *Animal Protection Act 2018* and any relevant legislation governing tourism operations, safe vessel operations and workplace safety practices. The national Code of Practice for the Humane Treatment of Wild



and Farmed Australian Crocodiles should be considered in the development of this industry code.

Permits for jumping crocodile tourism operations are issued on the following basis:

- Permit holders and authorised employees must operate in accordance with relevant codes of practice and NT Worksafe requirements
- Appropriate messaging regarding crocodiles (consistent with *Be Crocwise* messaging) must be included as part of any interactive demonstration
- Limits are set to ensure there are not too many vessels and too frequent feeding of crocodiles
- Permit holders must be respectful of the rights of other permit holders and other users of the public waterway
- Feeding in a manner that may induce antagonistic interactions among crocodiles is prohibited
- Measures are in place to limit the probability of increased risk to human safety, including mandatory minimum boat size and with due regard to potential for conditioning in animals involved (i.e. animals can clearly discriminate between a feeding event and unrelated activities on the river)
- Appropriate measures must be in place to minimise harm to Saltwater Crocodiles and other fauna due to their operations

On expiry of existing permits the following policy is proposed:

- Current permit holders can obtain a new permit providing the conditions of the permit have been complied with, and there are no disqualifying circumstances. Currently there are four permitted operators
- The expiry date for any new permits issued during the term of this Management Program (2024-2034) will not go beyond the Programs end date, noting this does not preclude the issuing of new permits beyond this date
- New permit holders may be considered, providing:
  - a) there is no net increase in the number of permits
  - b) there is no undue additional interference of the local crocodile population
  - c) the activity is within the designated zone on the Adelaide River
  - d) applicants can demonstrate they have the capacity and capability to manage operations including the necessary experience in dealing with Saltwater Crocodiles.


No permits will be issued for feeding of Freshwater Crocodiles. Operators may use incidental sightings of Freshwater Crocodiles to inform clients of the species' characteristics, conservation status and consistent *Be Crocwise* messaging.



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Projection: Geographic  
Horizontal Datum: GDA94

0 1 2 4 Kilometres

 Crocodile feeding exclusion zone

 Permitted feeding area



Figure 4 Designated jumping crocodile area. NB No feeding is allowed outside this zone and interfere activities can only occur under permit.

## 3.6. Research and Development

The sections below outline three high-priority areas for research and development (R&D), if resources are available during the period of the Management Program. These are intended to address key program objectives related to both human safety and enhancing Aboriginal livelihoods.

### 3.6.1. Innovation in Detection and Surveillance

The ability to mitigate risk to human safety depends on the ability to detect and monitor Saltwater Crocodiles, especially in areas of human use. Tied into this is an understanding of population level information on population size and movements, especially of large and/or aggressive individuals posing the greatest hazard to life and livelihoods. Some specific areas for R&D are outlined below, noting that these may vary according to management priorities and available resources.

The development of genetic detection tools is a promising R&D area that could greatly assist management. This would entail transitioning the e-DNA research for detection/surveillance from its current 'proof of concept' status through to full application. Similarly, the use of multi-beam sonar technology coupled with image recognition may assist in the detection of Saltwater Crocodiles in high-risk locations.

Surveillance and threat assessment could also be enhanced by ongoing collection of tissue biopsies to analyse genetic structuring to better track crocodile movements at a landscape scale. This could be supplemented by telemetry studies of movements focusing on the 2.5 to 4 metre male cohort (the cohort presenting the greatest risk to human safety) in representative rivers such as the Daly, Adelaide, Mary, Glyde/Arafura and Roper. Improving the ability to detect animals in boat-based surveys could be strengthened by research into survey effort and modelling.

### 3.6.2. Social Drivers

The successful implementation of a complex Management Program for crocodiles which has a diverse set of values and objectives, including avoiding direct threats to human safety and livelihoods, requires a strong 'social licence' and maintenance of community appreciation and understanding for this large predator, as well as confidence in Government regulatory and management arrangements. Further work is needed to a) assess the current community awareness programs and where relevant, inform their future direction in assisting both the species conservation and safe behaviours and b) better understand and track drivers of the community's acceptance of the current management practices.

### 3.6.3. Enhancing Livelihoods and Safety on Aboriginal Lands

There is considerable scope to enhance Aboriginal livelihoods around crocodiles and their management through targeted research. Areas for R&D include increasing economic returns from egg collection on Aboriginal land through sympathetic habitat management (through reducing the impacts of pests and weeds)

### 3.7. Reporting

Implementation of the management actions listed in this program will be assessed annually by NT Government (DEPWS and DITT) staff responsible for implementing the Management Program. The NT Government will provide annual reports to the Australian Government in relation to the associated WTMP. Additionally, there will be an annual summary of activities under this Program and relevant statistics placed on the DEPWS internet site, which will include:

- Progress in implementing management actions
- Harvest statistics including:
  - Number of viable Saltwater Crocodile eggs taken
  - Number of live Saltwater Crocodiles taken (hatchling, juvenile and adult)
  - Sex ratio and average size of live Saltwater Crocodiles taken (where required)
  - Number of problem crocodiles taken
- Number of permits issued for commercial live crocodile harvest and problem crocodile removal
- Number of Saltwater Crocodile eggs and live animals exported by destination
- Industry compliance indicators.

### 3.8. Review of the Management Program

The 2024–2034 Saltwater Crocodile Management Program will be reviewed during the 2028/29 financial year or sooner as required under s32(2) of the TPWC Act. The Management Program will be revised if there are any changes to management actions, legislation or administrative arrangements during the life of the Program or due to subsequently implemented Wildlife Trade Plans under the EPBC Act, unless any such changes are so significant that the NT Government determines that a new program is required.

## 4. Management Actions and Responsibilities

Actions under the Management Program have been mapped against the primary objectives.

Objectives and sub-objectives	Actions	Agency	Timeline
<b><i>Objective: Maintain the species at appropriate densities across its range within the Top end of the NT.</i></b>			
Saltwater Crocodile remain a species of Least Concern in the NT and are not moved to Appendix I under CITES	Objective and transparent conservation assessment	DEPWS, Flora and Fauna	Every Five years or more frequently if evidence suggests decline
Trajectories and drivers of population change outside exclusion and strategic cull zones are tracked and interpreted	Conduct population monitoring as described in this Management Program and report publicly	DEPWS, Flora and Fauna	Annually
Non-permitted take is minimised	Investigate and take appropriate action on all suspected illegal take	DEPWS, Parks and Wildlife	As required
	Maintain reporting mechanism for suspected illegal take	DEPWS, Parks and Wildlife	Ongoing

**Objective: Enable a robust and profitable crocodile industry through a sustainable harvest, that facilitates its economic growth and ensures that landholders receive real benefits from their continuing support for the conservation of the Saltwater Crocodile and its habitats.**

Sustainability of harvests can be demonstrated	Ensure that the annual commercial harvest of Saltwater Crocodiles does not exceed the approved quota and implement population monitoring regime.	DEPWS, Flora and Fauna	Annually
Industry is appropriately regulated to meet NT and Commonwealth requirements	Assess applications and issue permits under the <i>TPWC Act</i> .	DEPWS, Flora and Fauna, Parks and Wildlife	Ongoing
	Assess harvest applications, and monitor and audit approvals and returns and investigate and resolve any discrepancies	DEPWS, Flora and Fauna, Parks and Wildlife	Annual reporting by farms and operators a requirement.
	Conduct checks on eggs and farm stock numbers.	DEPWS, Flora and Fauna, Parks and Wildlife	Annual check of 50% of farms with all farms inspected at least once in 3-year period.
	Conduct inspections of farms to ensure they are managed in accordance with Code of Practice for the Humane Treatment of Wild and Farmed Australian Crocodiles	DITT - Animal Welfare Branch DEPWS, Parks and Wildlife	Annual check of 50% of farms with all farms inspected at least once in 3-year period.
	Develop a code of practice for operation of jumping crocodile tourism activities on the Adelaide River	Jumping crocodile permit holders DEPWS, Flora and Fauna DITT	By 2026

	Ensure compliance with all permit terms and conditions, including lodgement of annual returns, prior notification of import/export shipments, and any other term or condition	DEPWS, Flora and Fauna, Parks and Wildlife	Ongoing
	Address any permit breaches through warning letters, caution notices, infringement notices, permit cancellation or prosecution.	DEPWS, Flora and Fauna, Parks and Wildlife	As required
Real benefits accrue to landholders	Ensure all permit applications have correct landholder approval.	DEPWS, Flora and Fauna	Ongoing
	Ensure landholders have access to options to locally manage risk posed by crocodiles.	DEPWS, Flora and Fauna, Parks and Wildlife	As required
<b><i>Objective: Enhance Aboriginal livelihoods through active participation of traditional owners in the crocodile industry and development of new, culturally appropriate economic opportunities.</i></b>			
Direct returns to traditional owners from the crocodile industry	Maintain alignment of industry and royalty system to deliver direct returns to traditional owners	DEPWS, NLC, TLC and Industry	Ongoing. 5 or 10 year permits depending on landholder preference
	Identify new culturally appropriate enterprise opportunities	DITT	Ongoing

Greater involvement of traditional owners in industry value chains	Support for on-country farms including access to Government business support	DITT	Ongoing
<b>Objective: Enhance public safety through the identification and management of problem Saltwater Crocodiles and reduction of crocodile densities in selected areas, within a best practice risk management framework.</b>			
Risk to the community well understood and mitigation measures deployed in a timely fashion	Implement a comprehensive detection and surveillance program to support the DEPWS risk management framework	DEPWS, Flora and Fauna, Parks and Wildlife	Ongoing as resourced
	Issue permits to remove problem crocodiles as necessary and appropriate.	DEPWS, Flora and Fauna, Parks and Wildlife	Ongoing, as needs
Effective program of risk mitigation measures implemented.	Expand the program to remove crocodiles in designated zones	DEPWS Parks and Wildlife	Ongoing
<b>Objective: Improve community awareness of the risks posed by Saltwater Crocodiles and appreciation of natural and cultural values of this species through appropriately targeted education programs.</b>			
NT community and visitors well informed about the risks posed by saltwater crocodiles	Maintain Be Crocwise safety education campaign to educate audiences and raise awareness of the dangers of crocodiles in Top End waterways  Work with stakeholders to have consistent messaging.	DEPWS Parks and Wildlife	Ongoing



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# Appendix 1 Background Information – Saltwater Crocodile *Crocodylus porosus*

## Conservation status

Northern Territory (*Territory Parks and Wildlife Conservation Act 1976*: protected species listed as least concern. Least concern is the lowest threat status under the TPWC Act for native species.

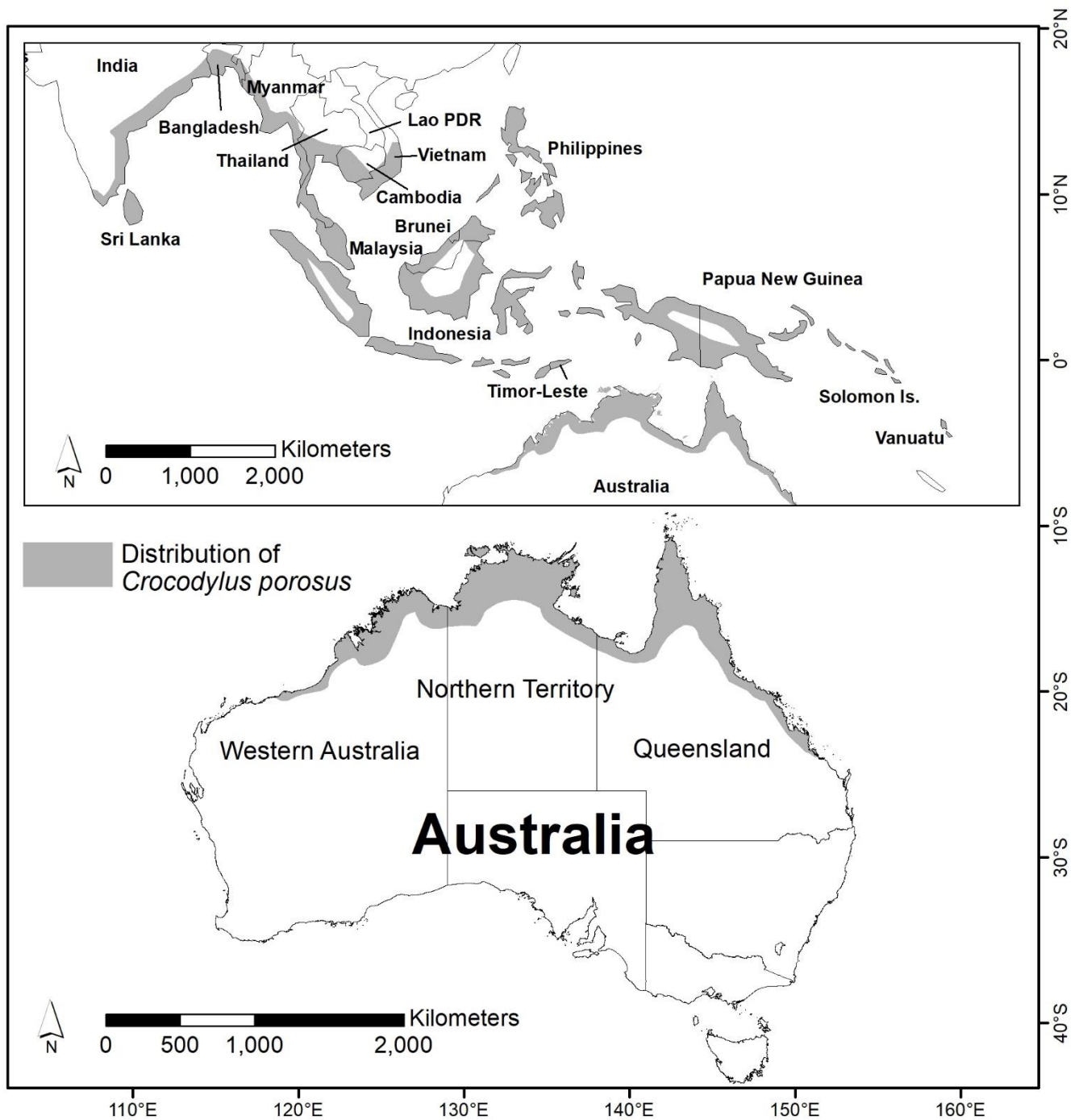
Australia (*Environment Protection and Biodiversity Conservation Act 1999*: listed marine and migratory species.

International (Convention on the International Trade in Endangered Species (CITES)): Appendix II for the Australian population.

## Distribution

The range of *C. porosus* extends throughout Southeast in the Indo-Pacific region (Figure 1). The historical range included southeast Indian and Sri Lanka in the west, southern China and the Philippines in the north, northern Australia in the south, and Vanuatu and Fiji in the east (Grigg and Kirshner 2015, Groombridge, 1987, Spennemann 2021). Wild populations in China, Fiji, Thailand, and Vietnam are considered extinct for previous hunting and habitat loss (Grigg and Kirshner 2015, Webb *et al.* 2010), but itinerants are increasingly sighted in some of the previous habitats (Sideleau *et al.* 2021, Spennemann 2021).

In Australia, *C. porosus* is commonly found in marine, coastal, estuarine, floodplain and riverine areas in the Northern Territory (NT), Queensland, and Western Australia. They are distributed across the NT coast to around Gladstone in Queensland (Queensland Department of Environment and Heritage 2017) and Port Hedland in Western Australia (Department of Environment and Conservation 2009). There have been many records of vagrants sighted well outside the range (Grigg and Kirshner 2015; Mawson 2004; Spennemann 2021). However, it is unlikely that these animals settle there as the cold climate does not allow their breeding.



**Figure 1:** The approximate distribution of *Crocodylus porosus* (modified from Webb *et al.* (2010) and Fukuda *et al.* (2015)).

## Ecology

Webb and Manolis (1989) provides a general description of the crocodylian biology with a particular focus on the Australian species (*C. porosus* and *C. johnstoni*). Richardson *et al.* (2002) provides a general description of the anatomy, morphology, and physiology of these Australian species. More up-to-date biology for the crocodylians including *C. porosus* for non-scientific readers is provided by Stevenson (2019). More comprehensive biology of crocodylians for scientific readers, with a particular focus on the

physiology of the Australian species, is provided by Grigg and Kirshner (2015). Considerable research on the ecology, population dynamics, recovery since protection, and management of *C. porosus* has been conducted in Australia, particularly in the NT over the last 40 years, the details of which are contained in a variety of publications (e.g. Messel *et al.* 1981).

**Table 1:** Summary of the biological characteristics of *C. porosus* (Source: Webb & Manolis 1993 and citations therein).

Characteristic	<i>Crocodylus porosus</i>
Size and age at sexual maturity (males)	3.3 m; 16 yrs
Size and age at sexual maturity (females)	2.3 m; 12 yrs
Normal maximum length (males)	4.6-5.2 m
Normal maximum length (females)	3.1-3.4 m
Maximum length (males)	6.7 m (Fukuda <i>et al.</i> , 2018)
Maximum body weight	>800 kg
Nesting Season; months	Wet Season; Nov.-May.
Duration of egg laying	28 weeks
Mean clutch size; (range)	50.0 (2-78)
Mean egg weight; (range)	113.0 g (65-147)
Mean hatchling weight	69.4 g
Egg incubation time (days)	75 (at 33°C)-106 (at 29°C)
Nest defence by female	Common

### Nesting ecology

Crocodylians' reproduction is highly seasonal and *C. porosus* breeds in the wet season (Nov-Apr) in Australia (Fukuda and Saalfeld 2014, Webb 1991). All Alligatoridae species and about half of the Crocodylidae species, including *C. porosus* make a mound nest (Grigg and Kirshner 2015). *C. porosus*, as in all the other crocodylian species (Brazaitis and Watanabe 2011), prefers freshwater habitats for nesting (Fukuda *et al.* 2022a, Fukuda and Cuff 2013, Magnusson 1980) although their hatchling can survive the saline environment with limited access to the freshwater (Grigg *et al.* 1980; Taplin 1984). Using the rear legs, females construct a mound with grasses, leaf litter, and soil near freshwater or hyposaline water body. *Oryza* and *Eleocharis* species in tall, closed tussock grassland are most commonly used for building a nest in the NT (Fukuda and Cuff 2013, Harvey and Hill 2003, Magnusson 1980, Webb *et al.* 1983). Open forests or woodland with *Eucalypts*, *Melaleuca*, and *Pandanus* species are also commonly used. Some nests are found on the floating vegetation mats of several species in freshwater billabongs (Hill and Webb 1982). *C. porosus* nests are prone to flooding during the wet season, and the mortality of eggs tends to be very high (approximately 75% on average) although highly variable among years (Webb *et al.* 1984a, 1983).

The average clutch size of *C. porosus* in the NT is 53.1 eggs (Webb and Manolis 1989, Webb *et al.* 1983) although more recent reports from commercial egg collectors in many locations indicate a smaller number (45-50 eggs, DEPWS 2023 unpublished data). The size of an average egg is 7.97 cm long, 4.95 cm wide and 113.4 g body mass (Webb *et al.* 1983). The clutch and egg sizes may vary between females, but the total clutch mass of an average female is around 6 kg (Webb and Manolis 1989). Incubation time ranges from 71 to 114 days (Magnusson 1979; Webb *et al.* 1983), depending on the incubation temperature. The viable range of the incubation temperature of crocodylians is between 28°C and 34°C (Lang and Andrews



1994). With higher incubation temperature, incubation time becomes considerably shorter (Webb and Cooper-Preston, 1989, Webb et al., 1987). Incubation temperature determines the sex of an embryo 30-45 days after laying (González *et al.* 2019, Lang and Andrews 1994). Below 30.1°C and above 33.9°C, all eggs will be female while 31.9° produces all males (González *et al.* 2019). Based on previous studies, González *et al.* (2019) established that the male-female pivot temperature (50% males) for *C. porosus* is 30.6° and 33.3°.

#### *Survivorship and maturation*

Mortality rates for crocodiles from egg to maturity are high. Webb and Manolis (1993) estimated rates of survival for several size classes of *C. porosus* in the wild: approximately 30% of eggs usually hatch; 12% of hatchlings survive to one year; 85% of crocodiles survive each year between one and five years. This is equivalent that about 6 crocodiles would survive to five years from 1,000 eggs laid.

In the wild, females normally reach maturity at 2.3 m total length and approximately 12 years of age while males mature at around 3.3 m and about 16 years (Table 1) (Webb and Manolis 1993). Because of the competition among females for suitable nesting sites, not all females that are sexually matured breed annually (Fukuda *et al.* 2021, Webb *et al.* 1984a). Webb and Manolis (1993) suggested that less than one per cent of eggs survive to breed. Individual *C. porosus* may live for more than 70 years (Webb and Manolis 1989). The survival rate of mature animals is unknown, but Webb *et al.* (1984a) speculated 99% for 12-60 years old and 95% for 60-70 years old.

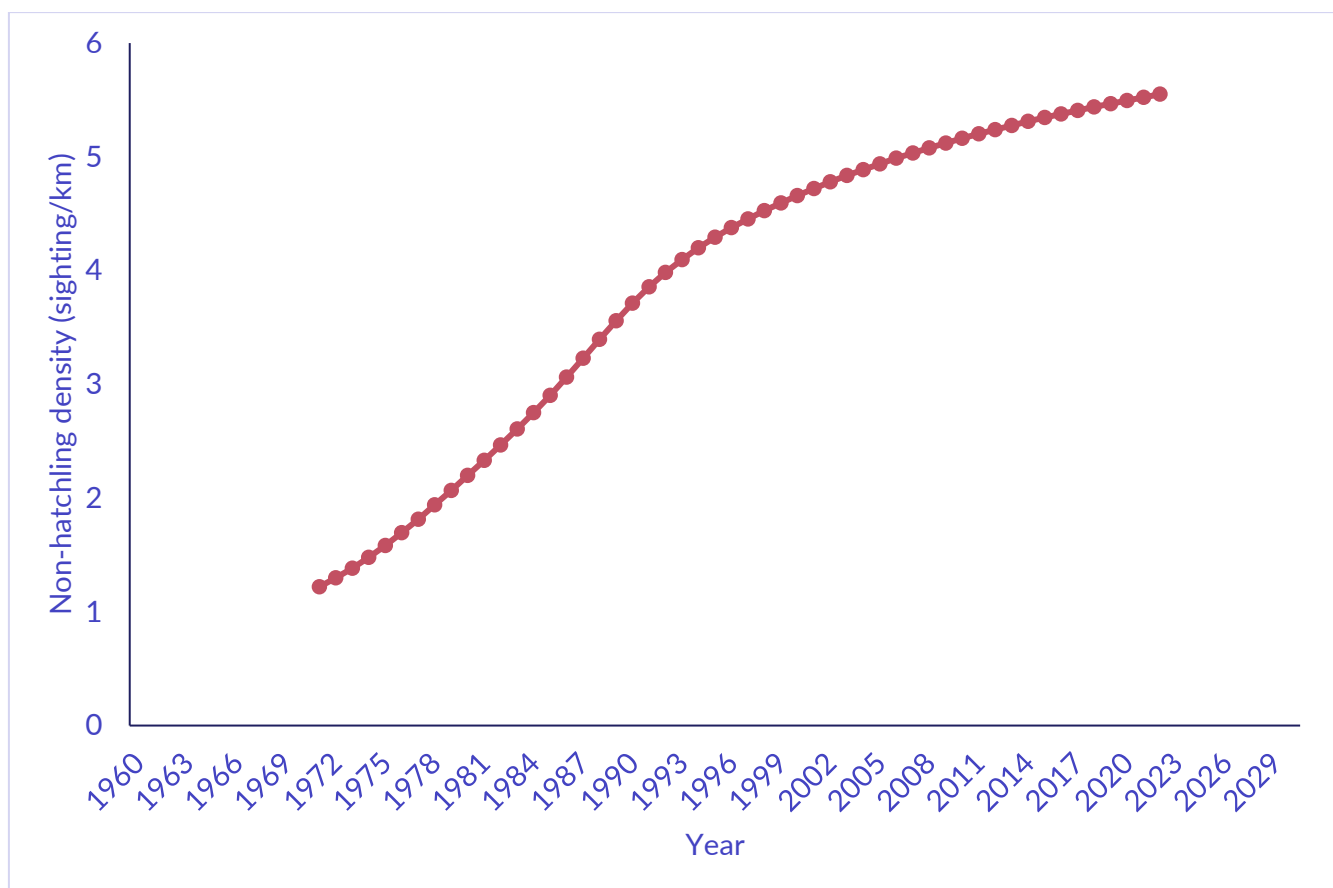
#### *Population size and dynamics*

The NT population of Saltwater Crocodiles was estimated at about 100,000 non-hatchling individuals in 2017 (Fukuda *et al.* 2021). This is more than thirty-fold increase from the 1971 population of approximately 3,000 non-hatchling individuals through between 30,000 to 40,000 individuals in 1984 (Webb *et al.* 1984) and between 70,000 to 75,000 individuals in 1994 (Webb *et al.* 1994).

The population of Saltwater Crocodiles in the NT continues to increase as demonstrated by the trends in the pooled data from the monitored rivers (Figure 2) and individual rivers. In many of the rivers, rates of increase have slowed and may be approaching a carrying capacity (Fukuda *et al.* 2011, Saalfeld *et al.* 2016, Webb *et al.* 2000).

The continuing increase in the Saltwater Crocodile population is also demonstrated by:

- The biomass of crocodiles in some rivers continues to increase, including rivers in which increase in numbers is levelling off (Clancy and Fukuda 2021, Fukuda *et al.* 2011). This is consistent with the expectation of the maturing size and age structure of a large, slow-growing species that is recovering from the serious depletion before 1971.
- The distribution of Saltwater Crocodiles is expanding far upstream to recolonise accessible freshwater habitats where their presence was not known previously (Letnic and Connors 2006, Webb 2012).
- There is an increase in the number of crocodiles that are living in marginal habitats where suitable nesting areas (e.g. freshwater floodplains) are limited, such as the coasts and seas (Fukuda *et al.* 2022b, 2014, Fukuda and Cuff 2013).
- The number of crocodiles removed from the Darwin Harbour Management Zone has increased consistently (Tim Clancy and Fukuda 2021, Fukuda *et al.* 2014), indicating that animals in expanding populations continue to disperse in search of new territories (Fukuda *et al.* 2023, 2022b).



**Figure 2:** Modelled abundance density of non-hatchling (>0.6 m, including eyes-only) of *C. porosus* calculated from standardised spotlight surveys in 12 tidal rivers between 1971 and 2022.

### Diet

Depending on their size, crocodilians prey on a wide variety of animals in different habitats (Hanson *et al.* 2015, Platt *et al.* 2013, Webb *et al.* 1982, 1991). In *C. porosus* smaller individuals are more generalist feeders, consuming lower trophic prey (Hanson *et al.* 2015) while larger ones may be more specialised on particular prey items such as terrestrial mammals (Adame *et al.* 2018, Campbell *et al.* 2022b, Hanson *et al.* 2015). Small (<1 m TL) crocodiles typically prey on small fish and invertebrates such as insects and crustaceans while larger animals add to their diet both aquatic and terrestrial vertebrates such as birds, reptiles and small mammals. Large crocodiles (e.g. >4.6 m TL) are able to take large mammals such as feral pigs, cattle, horses, and water buffalo. Large crocodiles also scavenge.

## Population Threats

### Natural Predators

The only significant predator of adult crocodiles apart from humans is other, larger crocodiles. Saltwater Crocodiles predate smaller individuals of both Australian crocodilian species (Webb and Manolis 1989). A variety of natural predators prey on hatchlings, and these include raptors (e.g. sea eagles and kites), herons, egrets, large fish (e.g. barramundi and catfish), monitors, snakes, turtles, and other crocodiles (Somaweera *et al.* 2013, Webb and Manolis 1989). Predation on eggs is not common because maternal females actively guard their nests. Saltwater Crocodiles are less susceptible than Freshwater Crocodiles (*C. johnstoni*) to Cane Toad (*Rhinella marina*) toxin and their populations have not been impacted (Fukuda *et al.* 2016, Smith and Phillips 2006).

### *Flood and climate change*

Heavy rainfall and subsequent flooding can cause high mortality of eggs (Webb and Manolis 1989, Webb, 1991, Webb *et al.* 1983, 1977). Long-term monitoring in the NT rivers shows that a higher number of hatchlings are observed after a prolonged wet season with early (Nov-Dec) and late (Apr-May) rainfalls, but intensive rains in the middle of the wet season (Jan-Mar) can lower the number (Fukuda and Saalfeld 2014). Climate change could shift rainfall patterns and impact the production and survival of eggs.

Another major effect of climate change is an anticipated rise in the sea level. The Intergovernmental Panel on Climate Change (IPCC) Assessment Report predicts 0.63-1.01 m of sea level rise by 2100 under the moderate emission scenario (Masson-Delmotte *et al.* 2021). Sea level rise driven by continuing global warming and saltwater intrusion into freshwater habitats can be a threat to *C. porosus*. Fukuda *et al.* (2022a) estimated 49.8% of the suitable nesting habitats in the Kakadu Region can be lost to the saltwater intrusion caused by 1.1 m sea level rise predicted by 2100 although crocodiles may be able to expand into new areas created by the expansion of tropics.

Incubation temperature determines the sex of a hatchling (Lang and Andrews, 1994; Webb *et al.*, 1987). Although climate warming is expected to interfere with the sex ratio of crocodilians, there is much uncertainty in predicting likely impacts (Bock *et al.* 2020, González *et al.* 2019, Maciejewski 2006). The possible impacts of climate change remain in the realm of great uncertainty over a time frame much longer than the life of the Management Program. As such they cannot be mitigated within the program, but monitoring should be capable of detecting significant population changes through whatever cause.

### *Habitat loss and modification*

The habitats of *C. porosus* in the NT are generally not threatened by development although clearing within or near freshwater floodplains and wetlands can lead to a loss of the nesting areas. The availability of suitable nesting habitat is one of the most important environmental factors, influencing the abundance of Saltwater Crocodiles (Fukuda *et al.* 2022b, 2007). Nesting habitat can be degraded by introduced plants such as Mimosa (*Mimosa pigra*) that produces an impenetrable thicket and displaces the grasses and sedges needed by *C. porosus* for nesting (Bayliss *et al.* 2012, Clancy 2020a, Webb and Manolis 1989). Feral animals, especially buffalo (*Bubalus bubalis*) and pigs (*Sus scrofa*), also negatively impact the nesting habitat (Saalfeld 2014, Webb and Manolis 1989). Although the eradication campaigns in the 1970s and 1980s reduced the disturbance of floodplains and wetlands by these animals, their numbers have been increasing again since the programs ceased (Clancy 2022, 2021, 2020b). The increased value of crocodile eggs encourages improved control of *M. pigra*, feral herbivores and fire by landowners to favour crocodile nesting habitat (Crocodile Farmers Association of the NT and NT Government, 2015; RMCG,2008).

### *Disease*

There are no diseases of crocodiles known to present a major threat to the NT population in the wild.

## **Attacks on Humans**

In a comprehensive investigation of crocodile-human interaction in the NT, Fukuda *et al.* (2014) observed a steady increase in the number of non-fatal crocodile attacks over time, which is strongly related to the increasing human and crocodile populations, and the increasing size of individuals in the crocodile population. This study provided recommendations for reducing human-crocodile conflict, including strategic and efficient management of problem crocodiles and continuous public education. It also highlighted the importance of improved communication, especially in remote areas, in reporting and mitigating crocodile attacks. It was unclear why the observed increase in interactions was not reflected in a commensurate increase in the number of fatal attacks over the period. It is thought that the rate of crocodile attacks might continue to increase because both human and crocodile populations are expected

to keep increasing; although, the rate of increase in both may slow over time (Fukuda *et al.* 2011, ABS 2013). This is consistent with the number of non-fatal attacks by American alligators (*Alligator mississippiensis*) being higher in Florida, USA, where the populations of humans and alligators are also high (Conover and Dubow, 1997, Harding and Wolf 2006, Langley 2010, 2005).

Fatal and non-fatal attacks occur more commonly in the daytime, and the most common activities at the time of fatal attacks were swimming and wading, followed by diving and fishing. Hunting was also a common precursor activity to non-fatal attacks, likely related to the fact that hunting does not involve deep water interactions which is a major risk factor of death in an attack due to likelihood of drowning; (Fukuda *et al.* 2015a). Similar drivers of risk have been recorded in international studies; however, context is very important with factors like subsistence foraging, access to freshwater and cultural values (Ashepet *et al.* 2023, Brackhane *et al.* 2019, Gani *et al.* 2022, Sideleau *et al.* 2017, Van der Ploeg *et al.* 2019). Whilst most studies have looked at the implications of human behaviour, other factors may be at play. For example, González-Desales *et al.* (2021) found that attacks by crocodilians in Mexico were correlated with nesting season and Gani *et al.* (2022) found more *C. porosus* attacks during the wet season. In the NT, the peak in attacks coincided with the beginning (Sept-Dec) and end of the wet season (Fukuda *et al.* 2014, Figure 3).

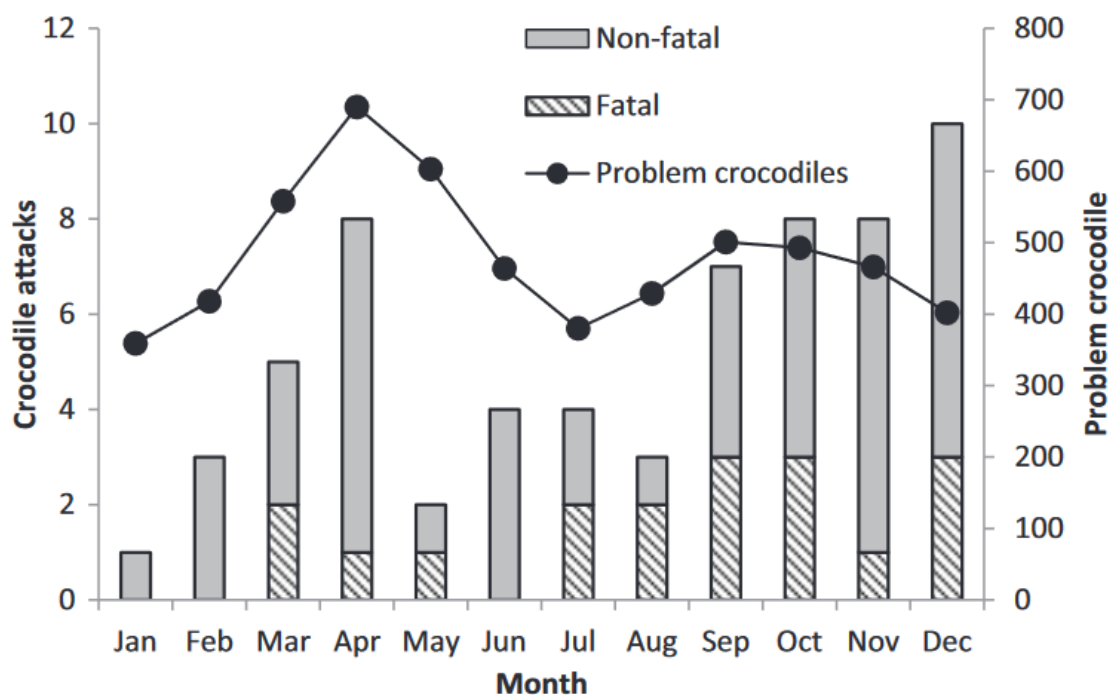


Figure 3. The number of saltwater crocodile attacks between 1979 and 2013 (n = 63) and the number of problem saltwater crocodiles captured between 1977 and 2013 (n = 5,763) by month in the NT, Australia. After Fukuda *et al.* (2014).

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