

***NT Saltwater Crocodile  
(Crocodylus porosus) Wildlife  
Trade Management Plan:  
2018-2019 Monitoring Report  
and Review***



<b>Document title</b>	NT Saltwater Crocodile ( <i>Crocodylus porosus</i> ) Wildlife Trade Management Plan: 2018-2019 Monitoring Report and Review
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Acronyms / Terms	Full form / Definitions
CDU	Charles Darwin University
CITES	Convention on International Trade in Endangered Species
DENR	Department of Environment and Natural Resources*
DEPWS	Department of Environment, Parks and Water Security (*formed from DENR and Parks component of DTSC post this reporting period)
DPIR	Department of Primary Industry and Resources
DTSC	Department of Tourism, Sport and Culture*
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
IUCN	The International Union for Conservation of Nature
NLC	Northern Land Council
NT	Northern Territory
TPWC Act	Territory Parks and Wildlife Conservation Act 1976

## NT Saltwater Crocodile (*Crocodylus porosus*) Wildlife Trade Management Plan: 2018-2019 Monitoring Report and Review

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Keith Saalfeld, Glenn Edwards, and Alaric Fisher provided invaluable comments on drafts of this program. Parks Australia North provided data on the East Alligator, South Alligator and Wildman Rivers. The traditional owners of the Indigenous lands assisted Department of Environment and Natural Resources with the surveys, giving permission to survey on their land. Industry economic data provided by CFA NT. Sally Egan, Kristen Hay, Dr Suzanne Fitzpatrick, Joseph Kuhn, Philip Chang, Glenn Edwards and Members of CFA NT provided input into the Wildlife Trade Management Plan review process.

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## SUMMARY

The WTMP was declared as an Approved Wildlife Trade Management Plan under Subsection 303FO(3) of the *Environment Protection and Biodiversity Conservation Act* 1999 on 21 December 2015. Under this arrangement, the NT government (through DEPWS) must provide an annual report to the Australian Government Department of Agriculture, Water Resources and the Environment (DAWRE) on the implementation of the WTMP. In addition, there is a requirement for the NT government to undertake a review of the Plan in its final year of operation.

This report fulfils both obligations and is in two parts. The first covers the implementation of the WTMP in 2018/2019, the fourth year of the Plan. The second part reviews the performance of the Plan across its period of operation. A new WTMP is being developed to cover the period 2021-2025.

The NT Department of Environment and Natural Resources (DENR, now DEPWS) conducted spotlight surveys in 3 of 8 monitoring rivers (3 scheduled) in 2019. Parks Australia North surveyed an additional 2 of 4 monitoring rivers in Kakadu National Park. The results of the surveys were consistent with recent trends showing either stable (believed to have reached an asymptote) or increases in both numbers and in biomass (more larger crocodiles observed). Monitoring will continue in 2020 as per the current Management Program but with modifications due to the constraints of the Covid-19 pandemic.

A total of 283 problem crocodiles were removed from the wild in 2018/2019 for public safety purposes and to protect stock in pastoral areas, of which 77% were males and 82% were caught in the Darwin Harbour. This number is down from the 335 recorded in 2017/2018 (which was the highest for several years) with indications being of an increasing trend in capture over the last two decades albeit, at a diminishing rate and with much year on year variation. Size trends do not reflect an increasing proportion of smaller animals, as would be expected in an “overharvest” situation. A higher proportion of smaller crocodiles are caught in the Darwin Management Zone than other regions but this likely relates to the greater capture effort targeting large crocodiles (>3.5m) in regions other than Darwin.

The NT Department of Tourism Sport and Culture continued to promote community awareness for safety and participation through the Be Crocwise campaign using a

variety of media. DTSC delivered 77 Be Crocwise face-to-face presentations to 8,871 people. Presentations occurred in schools, regional shows, urban and remote community group events, and camping and boating expos.

Under the annual ceiling of 90,000 viable eggs, 77,000 viable eggs were allocated to harvest, but only 34,658 viable eggs were collected in 2018/2019. All indications are that the current harvest of eggs is well within sustainable levels.

Under the annual harvest ceiling of 1,200 non-hatchling crocodiles, 37 live crocodiles were reported as harvested in 2018/2019. The majority of reported live-harvested crocodiles were adult males (65 %). The average body size of the harvested animals was about 2.70 metres for females and 3.15 metres for males.

The total number of crocodiles harvested is known to be a slight underestimate due to a number of harvest permits being multi-year permits that have not yet expired; consequently complete final return/harvest data are not yet available. Despite this underestimate, the total harvest of live crocodiles from all sources at 320 individuals was well below the 1,200 threshold. The bulk of removals was related to the NT Government run removal program in designated management zones.

Ten crocodile farms operated in 2018/2019 in the NT and production data these farms for the period 1 February 2018 to 31 January 2019 is reported here. Farm production reporting is limited to stock held (live crocodiles), total acquisitions and total disposals. As with previous years, most live crocodiles exported from the NT went to Queensland.

In 2018/2019, revenue from the NT's crocodile industry rose 13.3% to \$26.85 million. The industry economic value has been stable in recent years averaging \$25 million over the last 5 years and is an important source of employment and resources for regional communities. Stricter grading standards were introduced by industry in 2016/2017, leading to a larger number of crocodile skins being classified as lower grade skins. Around 57.7% of revenue was generated from the production of first grade skins in 2018/2019, compared to 63.2% in the previous years.

Permit and animal welfare compliance was closely monitored by DENR, DTSC and the NT Department of Primary Industry and Resources (DIPR). No significant permit compliance or animal welfare matters were reported in 2018/2019.



A review of the WTMP 2016 - 2020 was undertaken in the lead up to the development of the next plan covering the period 2021-2025. This included a review of the overall monitoring results over the period of managed harvests and a formal review of the activities and milestones. The review indicated that there is no evidence that the broader management approach has resulted in any threat to the conservation status of saltwater crocodiles, indeed it is likely that the commercial value attached to the wild populations has supported retention of good quality nesting habitat and made an important contribution to remote livelihoods. Also, the approach has mitigated demands from NT residents for aggressive culling of the species.

Consultation and the formal review process supported a business as usual approach for the next 5 year period of operation of the WTMP from both industry and management agencies as well as ongoing support from the peak Aboriginal management agency.

## INTRODUCTION

The *Wildlife Trade Management Plan for the Saltwater Crocodile in the Northern Territory of Australia, 2016 – 2020* (WTMP) (Saalfeld *et al.* 2015) and the linked *Management Program for the Saltwater Crocodile (Crocodylus porosus) in the Northern Territory of Australia, 2016-2020* (MPSC) set out the management requirements that underpin the sustainable use and conservation of the Saltwater Crocodile (*Crocodylus porosus*) in the Northern Territory (NT).

The Northern Territory Department of Environment and Natural Resources (DENR), Department of Tourism, Sport and Culture (DTSC) and the Northern Territory Department of Primary Industry and Resources (DPIR) review compliance to, and the operation of, the *Wildlife Trade Management Plan for the Saltwater Crocodile in the Northern Territory of Australia, 2016 – 2020* (WTMP) (Saalfeld *et al.* 2015) and the *Management Program for the Saltwater Crocodile in the Northern Territory of Australia, 2016-2020* (MPSC) (Saalfeld *et al.* 2016).

The WTMP was approved as an Approved Wildlife Trade Management Plan under Subsection 303FO(3) of the *Environment Protection and Biodiversity Conservation Act 1999* on 21 December 2015. Under this arrangement, the NT government (through DEPWS) must provide an annual report to the Australian Government Department of Agriculture, Water Resources and the Environment (DAWRE) on the implementation of the WTMP. In addition, there is a requirement for the NT government to undertake a review of the Plan in its fourth year of operation. This report fulfils both obligations and is in two parts. The first covers the implementation of the WTMP in 2018/2019, the fourth year of the Plan<sup>1</sup>. The second part reviews the performance of the Plan across its period of operation. A new WTMP is being developed to cover the period 2021-2025.

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<sup>1</sup> Saalfeld and Fukuda (2017) represents the first year reporting under this WTMP. Annual reporting commenced in 2009-2010 under the “The Management Program of the Saltwater Crocodile (*Crocodylus porosus*) in the Northern Territory of Australia, 2009 – 2014”. Prior to that reporting had been less regular.

# PART 1. IMPLEMENTATION OF THE WTMP IN 2018/2019

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## POPULATION MONITORING

The results of the population surveys are provided in Appendix 1 and are summarised here.

Populations of *C. porosus* have been monitored in the Northern Territory since the species was declared protected in 1971 through a range of varied monitoring projects undertaken by the University of Sydney, Parks Australia North (Kakadu National Park), Wildlife Management International (WMI), DENR and individual DTSC parks. A summary of NT surveys for the period of the current WTMP and the date surveying was originally commenced is given in Table 1.

The standardised spotlight surveys started in 1975 and have continued since then in the Adelaide River, Blyth River, Cadell River, Daly River, Glyde River, Liverpool River, Mary River and Tomkinson River on a biennial basis (Figure 1; Appendix 2). In addition, four rivers (Wildman River, West Alligator River, South Alligator River and East Alligator River) in Kakadu National Park are surveyed annually by Parks Australia North. Whilst the park is outside the land directly managed under the WTMP, it provides an important reference point for understanding the population dynamics of the species.

Table 1 Summary of the standardised crocodile surveys in the monitored rivers in the NT between 2015 and 2019 along with date of first survey.

River	Frequency	Agency responsible	First surveyed	2015	2016	2017	2018	2019	Total Years surveyed
Adelaide	Annual	DENR	1977	√	√	√	√	√	36
Blyth	Biennial	DENR	1975		√		√		35
Cadell	Biennial	DENR	1975		√		√		34
Daly	Biennial	DENR	1978		√		√		26
East Alligator	Annual	Parks Australia	1977		√	√	√	√	32
Glyde	Biennial	DENR	1975		√		*a		14
Liverpool	Biennial	DENR	1976		√		√		32
Mary	Biennial	DENR	1984	√		√		√	23
McArthur	Irregular	DENR	1979					√	4*b
Roper	Irregular	DENR	2000			√			3*b
South Alligator	Annual	Parks Australia	1977	√	√	√		√	26
Tomkinson	Biennial	DENR	1976		√		√		32
Victoria	Irregular	DENR	1987			√			7*b
West Alligator	Annual	Parks Australia	1977		√			*c	22
Wildman	Annual	Parks Australia	1978			√		*c	23

\*a Survey was scheduled but cancelled as the traditional owner approval to access not granted

\*b Different survey methods (e.g. helicopter) used for some years

\*c Planned river section not fully completed

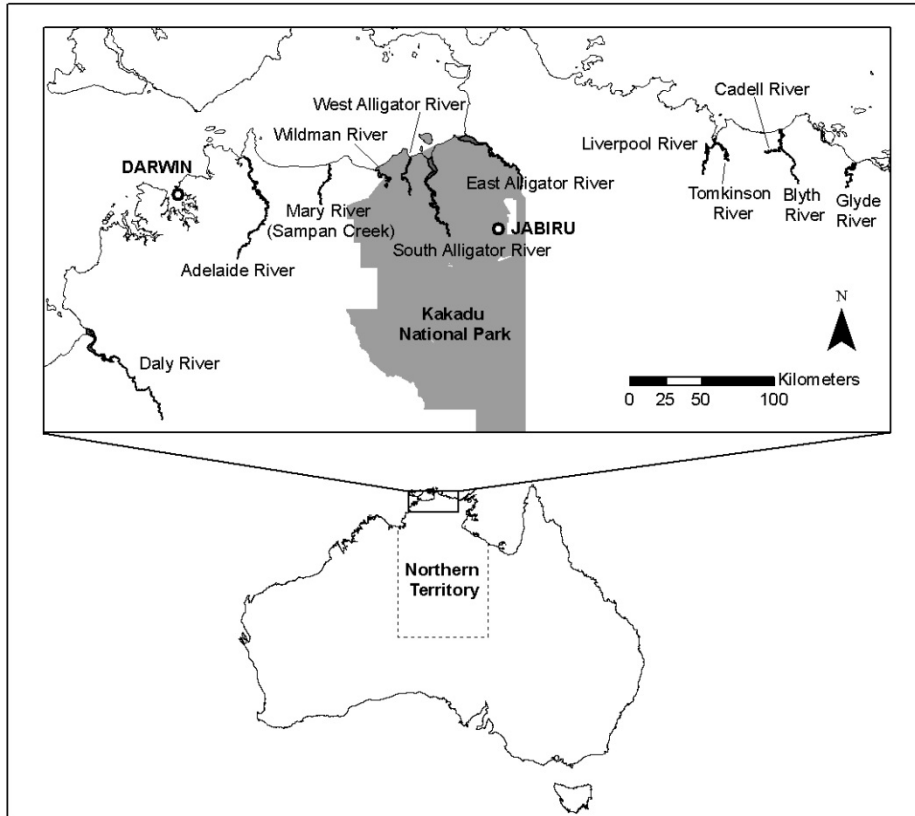


Figure 1 Rivers where *C. porosus* population is monitored in the Northern Territory.

## General trends

Results from modelling of monitoring data show that the population of non-hatchlings (>2 ft or >0.6 m) of *C. porosus* has increased since protection in 1971 (Figure 2). Most subpopulations in the monitored rivers have shown large increases since protection and some have stabilised at an asymptote in recent years. Results for each individual river are provided in Appendix 1 including that for 2019. There is no evidence that the harvesting program has had a detrimental impact on the crocodile population in the NT nor any indication of any harvesting signal on any of the important determinants of population processes (recruitment, dispersal, adult survivorship etc.).

Under the WTMP, evidence of either a catastrophic decline (defined as a 50% or greater decline in assessed density in a single river system in a single year) or an ongoing clear downward trend, is a trigger for a review of harvest parameters. All rivers monitored continued to exhibit either upward or stable trend (see Appendix 1, Figure 2). A 'catastrophic decline' has not been detected in any river, with largest survey to survey

decline being found in the Tomkinson River which declined by approximately a 40 % over a 2 year interval (2017-2019).

Such variation is not beyond the general level of variability in surveys of this type. It is worth noting that there is no significant live harvest from this river and it is unlikely that harvests of eggs from the region would impact this river causing a single survey to survey drop-off. It is also worth noting that smaller crocs were observed here and in the linked Liverpool River and the adjacent Cadell/Blyth Rivers reflecting ongoing recruitment.

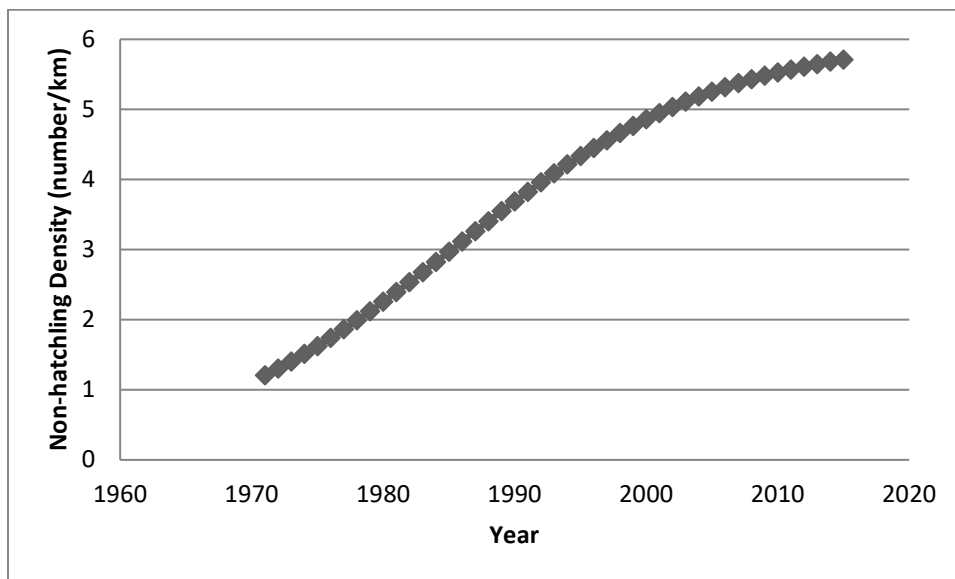


Figure 2 Modelled abundance density of non-hatchling (>0.6 m, including eyes-only) of *C. porosus* calculated from standardised spotlight surveys in 12 tidal rivers since 1975.

## Size Structure

Biomass estimation for all monitored rivers are given in Appendix 1. The recent monitoring data indicate a shift in the size structure of the crocodile population, as previously reported, from smaller to larger crocodiles compared with immediately post-protection and through the 1980s, 1990s and early 2000s (Figure 3, Appendix 1). In broad terms there has been a decline in the proportion of crocodiles in the 1 to 3 metre size range in the population in recent years, and increases in the proportion of crocodiles in the 3 to 4 metre size range and in the proportion greater than 4 metres in length. It is worth noting that this pattern is also inconsistent with any ongoing

overharvest of either live animals (given the targeting of larger animals) or eggs (given on-going recruitment) but is consistent with a population moving from an extrinsically driven growth phase to intrinsically regulated population at close to full habitat occupancy.

The monitored rivers represent prime nesting habitat and as the population reaches carrying capacity it would be expected that these areas would be dominated juveniles (1 to 2 metre), breeding females and sub-adult males (2 to 3 metre) and dominant breeding males (> 4 metre). There is little or no change in the 3 to 4 metre proportion of the population from 2015/2016 to 2018/2019 and at this juncture no requirement for management intervention. A more detailed review of the changes in population structure, incorporating 2020 survey data is planned in the lead up to the next review of the MPSC.

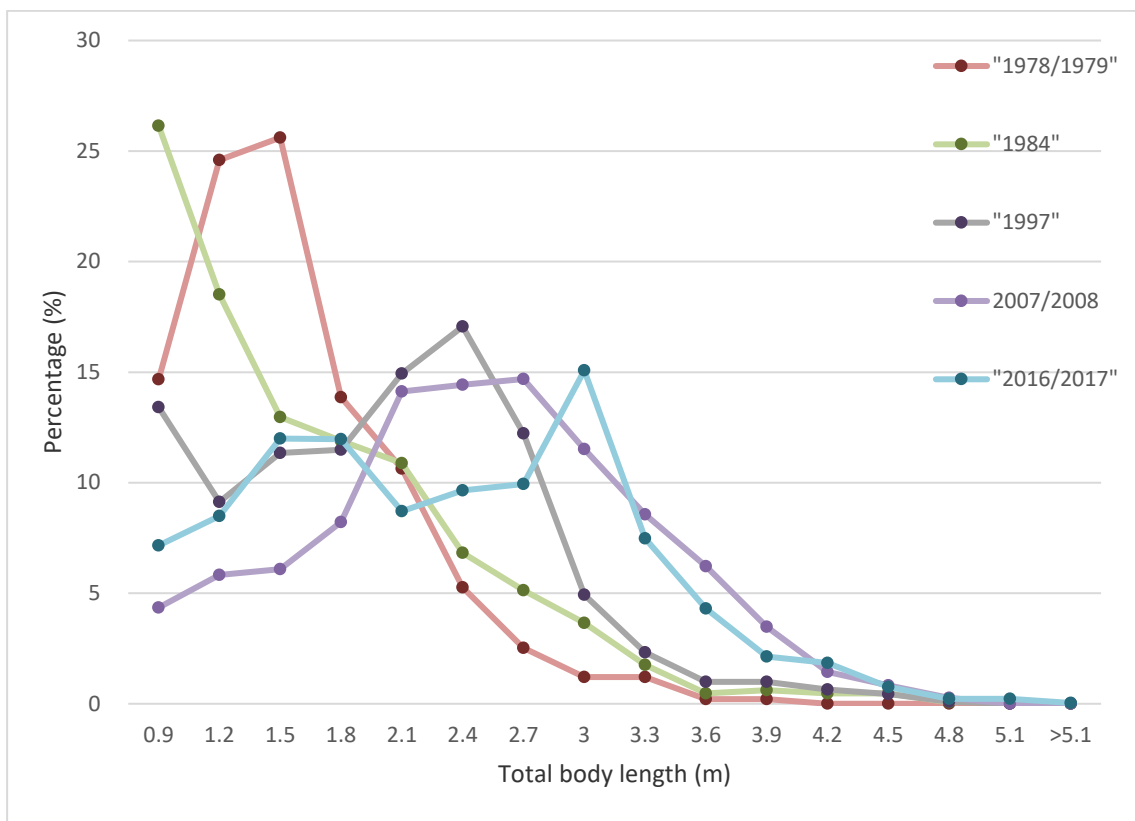


Figure 3 Mean percentage of saltwater crocodiles in incremental 0.3m size classes range (0.3 - >5.1 m) (1 - >17 ft) in 12 monitored rivers combined in the NT, Australia between 1978 and 2016/2017.

## Impacts of harvesting and population trends

In the fourth year of this WTMP it is timely to examine the evidence of impact of current management on population size across the NT. The IUCN Red List (IUCN 2012) process provides a suitable framework to evaluate longer-term trends in distribution and abundance and how they relate to conservation management of this iconic species.

The NT population of the saltwater crocodile is secure by any criteria used to assess status (Table 2). 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 (EoO) 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 (Table 2).



Table 2 Analysis of conservation status of Saltwater Crocodile against IUCN criteria for the NT segment of the population with reference to the WTMP 2015-2020. See text for details

IUCN Red List Criterion Summary <sup>1</sup>	Threshold for Vulnerable <sup>2</sup>	Status in Year 1	Status in Year 5 / Future	Management prescriptions and attainment
A. Population size reduction	Greater than 30% decline over 3 generations	Criterion not satisfied. Population increasing by empirical data (Saalfeld et al. 2015)	Continued increase (This report)	Regulated harvest and controlled removals from specific zones. No apparent decline detected
B. Small geographic range	Extent of Occurrence (EoO) of < 20,000 Km <sup>2</sup> ; or, Area of Occupancy (AoO) of < 2,000 Km <sup>2</sup> ; Plus additional criteria <sup>3</sup>	Criterion not satisfied. EoO = 378,000 Km <sup>2</sup> (NT) AoO = 41,00 Km <sup>2</sup> (NT) <sup>4</sup> Greater than an order of magnitude above thresholds	No detectable decrease	Management aimed at maintaining habitat, especially nesting habitat on private land by providing a financial incentive
C. Small population size and decline	Declining population from less than 10,000 individuals	Criterion not satisfied. Population estimate in excess of 90,000, recovering from previous decline	No detectable decrease and likely slight increase	Not required
D. Very Small population size	Population less than 1000 and range AoO less than 20 Km <sup>2</sup>	Not applicable, see A- C above		Not required
E. Quantitative (Modelled) future decline	Modelled Decline of 10% in next 100 years	Criterion not satisfied. Modelled stability for defined harvest limits.	No new information or modelling to suggest any decline in the future	Management prescriptions set to ensure no future decline and take of eggs and live animals consistently well within modelled thresholds

<sup>1</sup> See IUCN Red List Process for full details of criteria (<https://www.iucnredlist.org/assessment/process>)

<sup>2</sup> Vulnerable is the least threatened of the IUCN “Threatened” Categories before endangered, critically endangered and extinct.

<sup>3</sup> Two additional conditions are needed to be met e.g. severe fragmentation to meet this criterion for listing (see footnote 1 for details)

<sup>4</sup> Based Fukuda and Cuff 2015 with area of high quality habitat used as a surrogate for the AoO

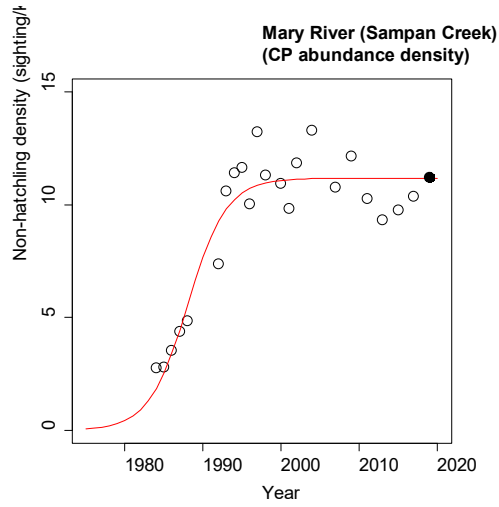
The appropriateness of protection levels to a species that is subject to an anthropogenic take for commercial or other purposes is best evaluated through a sustainable use lens. Sustainable use can be defined as “use of wildlife associated with a process aimed at ensuring the use can continue indefinitely and any adverse impacts can be contained within defined limits” (Webb 2014). Implicit in this definition is that the use of wildlife will always entail some impact and the critical issue is in determining whether such an impact is significant in the specific context (Webb 2014). In the context of the WTMP, the current level of protection and associated harvest controls have been effective in preventing any detectable impact on population processes (Table 2) as well as delivering on a suite of other objectives including management of threat to human safety.

When the changes in density over time are examined at the river level, there is no indication that offtakes are causing decline (Figure 4). The Mary and Adelaide Rivers, due to their proximity to Darwin were probably amongst the areas most targeted by hunters in the period prior to a cessation on wild harvesting that 1971. Both areas have bounced back strongly in the period since, with no detectable slowdown in rate of increase in the period post 1983 (when egg harvesting was first bought in, see Webb 2020) or subsequently when both live and egg takes increased in the early 2000s (when taking of live crocodiles was permitted, Webb 2020, DENR Unpublished data) (Figure 4 a, b). In the case of the Mary River, despite being within an area subject to egg harvesting and significant take of problem crocodiles, numbers rose rapidly during the early 1990’s and have reached an asymptote at over 10 non-hatchings per km from around 2000, some of the highest river densities recorded. Biomass density has also continued to rise in recent times (Appendix 2) which would not be observed in an overharvest scenario.

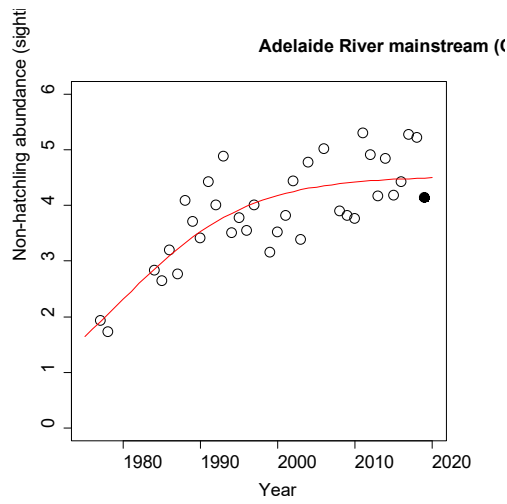
There is no evidence of decline in the abundance of crocodiles in harvested rivers (Fig 4 c-f) compared with paired reduced harvest (Fig 4 g) or unharvested (Fig 4 h-j), taking into account starting densities and river type.. While there is some indication of subpopulations in un-harvested rivers reaching an asymptote earlier than similar harvested rivers, peak densities appear similar in the harvested rivers) which would also be contraindicative of an over-harvest. This is also consistent with previous published accounts of the population recovery ((see Fukuda *et al.* 2011).

Harvested Rivers

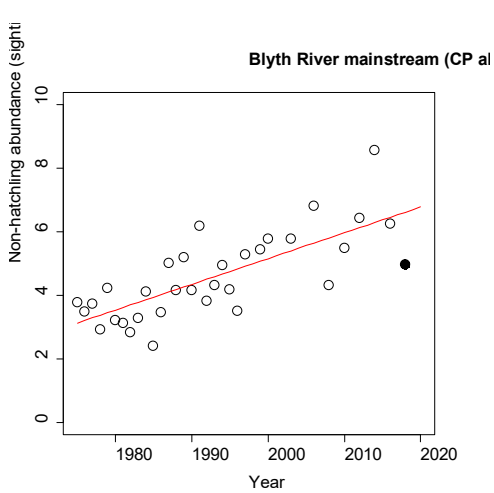
Partial harvested Rivers



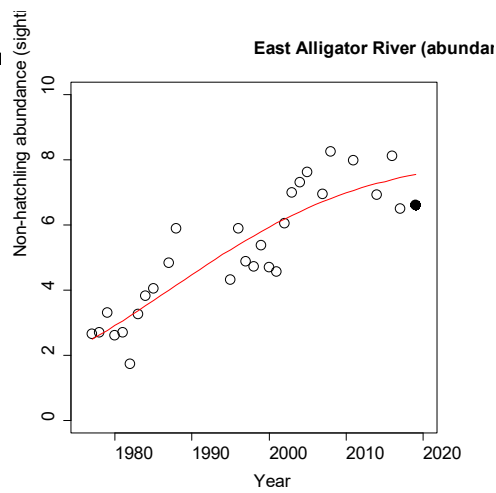
a)



b)



c)

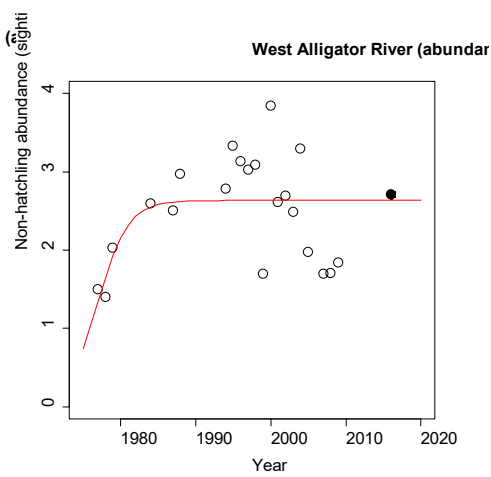
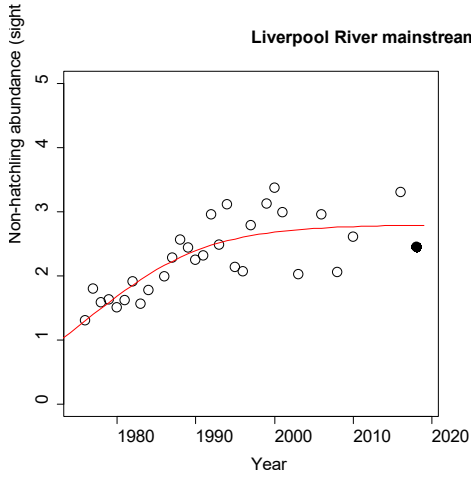


g)

Figure 4. Abundance of select rivers over time. a)-e) Currently harvested; g) Partial harvest; h)-i) Unharvested

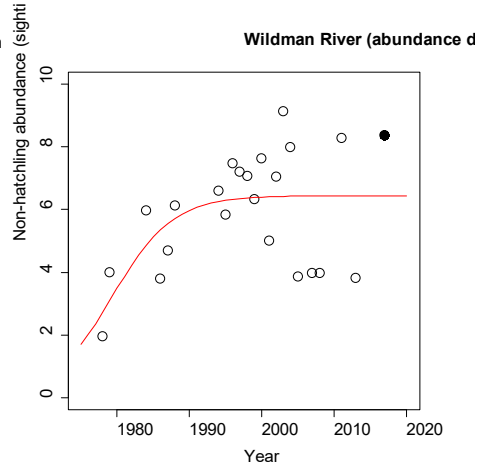
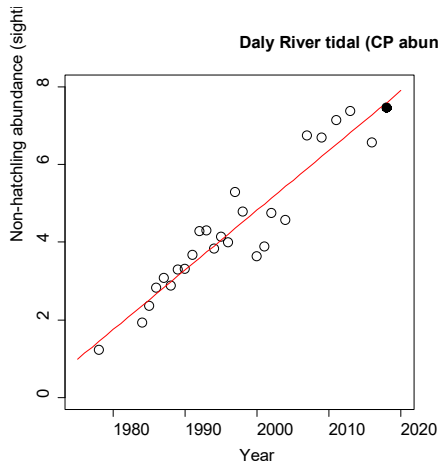
Harvested Rivers

Unharvested Rivers



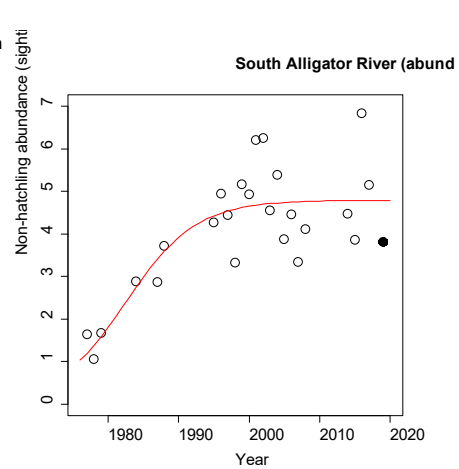
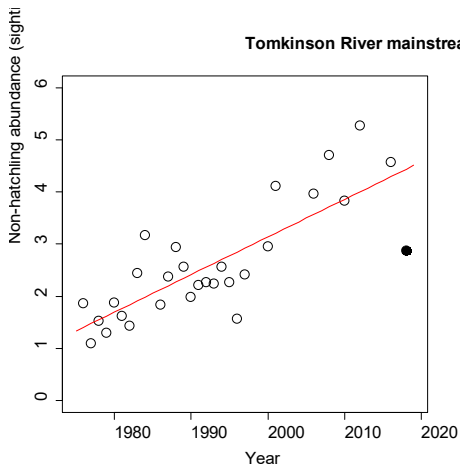
d)

h)



e)

i)



f)

j)

Figure 4 cont.

## PROBLEM CROCODILES

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

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

In a practical sense, this means that crocodiles, especially large ones that occur within settled areas or areas of recreational use, where public safety is a prime consideration are deemed problem crocodiles, as are those that attack stock in pastoral areas. In some areas, such as around Darwin, the Katherine River near Katherine and designated swimming areas in National Parks, any *C. porosus*, regardless of size, is classed as a problem animal.

### Removal of Problem Crocodiles

The NT Government removes problem crocodiles from specific problem crocodile management zones in the NT: Darwin Crocodile Management Zone, Katherine Crocodile Management Zone and Borroloola Crocodile Management Zone. In addition to the management zones, DTSC removes problem crocodiles at other settled locations upon request. Removed problem crocodiles are sold to crocodile farms to be utilised for skin and meat production or captured and used as stock in crocodile farms. Problem crocodiles are not relocated because relocated crocodiles rapidly return to the site of initial capture (Walsh and Whitehead 1993, Read *et al.* 2007).

A total of 283 problem crocodiles was removed between 1 July 2018 and 30 June 2019 (Table 3, Figure 5). This is less than the record high number of removals from 2017/2018 and numbers were closer to those for 2012-17. All information is that

effort has been relatively consistent in recent years. Lagged rainfall is a factor influencing monthly counts (Fukuda *et al.* 2014) so some overall yearly variation can be expected. There is a general trend for an increase in captures with time, but this increase has slowed in a logarithmic fashion (Figure 5) consistent with the broader population trend.

The large majority of problem crocodiles were removed from Darwin Harbour (71%). A further 53 were removed from the greater Darwin area, with a total 90% of captures from this region. A few animals were removed from the Katherine (6%) and Borroloola area (2%) and other communities.

Problem crocodiles that are removed are made available to NT crocodile farms through a tender process with the vast majority (>95%) sold under this arrangement.

*Table 3 Total number of C. porosus removed by DTSC staff as problem crocodiles, sex ratio as proportion of males, the proportion of problem crocodiles caught in the Darwin Harbour in 2012/2013 to 2018/2019.*

<b>Year</b>	<b>Problem crocodiles</b>	<b>Males</b>	<b>Darwin Harbour</b>
2012/2013	273	80%	71%
2013/2014	274	81%	74%
2014/2015	279	81%	71%
2015/2016	247	74%	74%
2016/2017	303	78%	81%
2017/2018	335	77%	82%
2018/2019	283	74%	71%

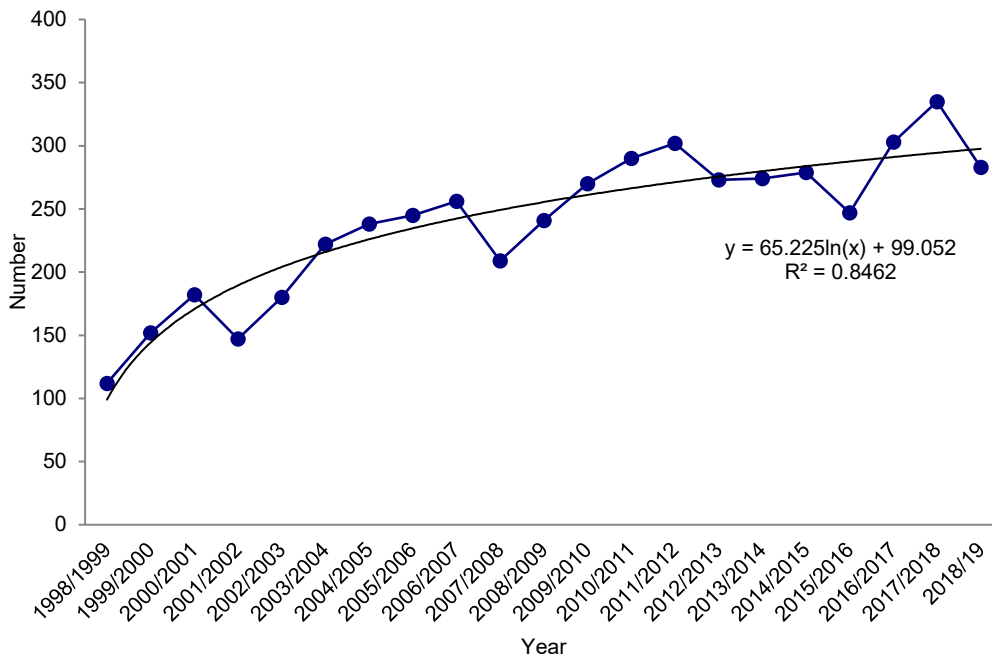


Figure 5 The numbers of *C. porosus* removed in 1998/1999 – 2018/2019. Black line show simple logarithmic regression fit to the data.

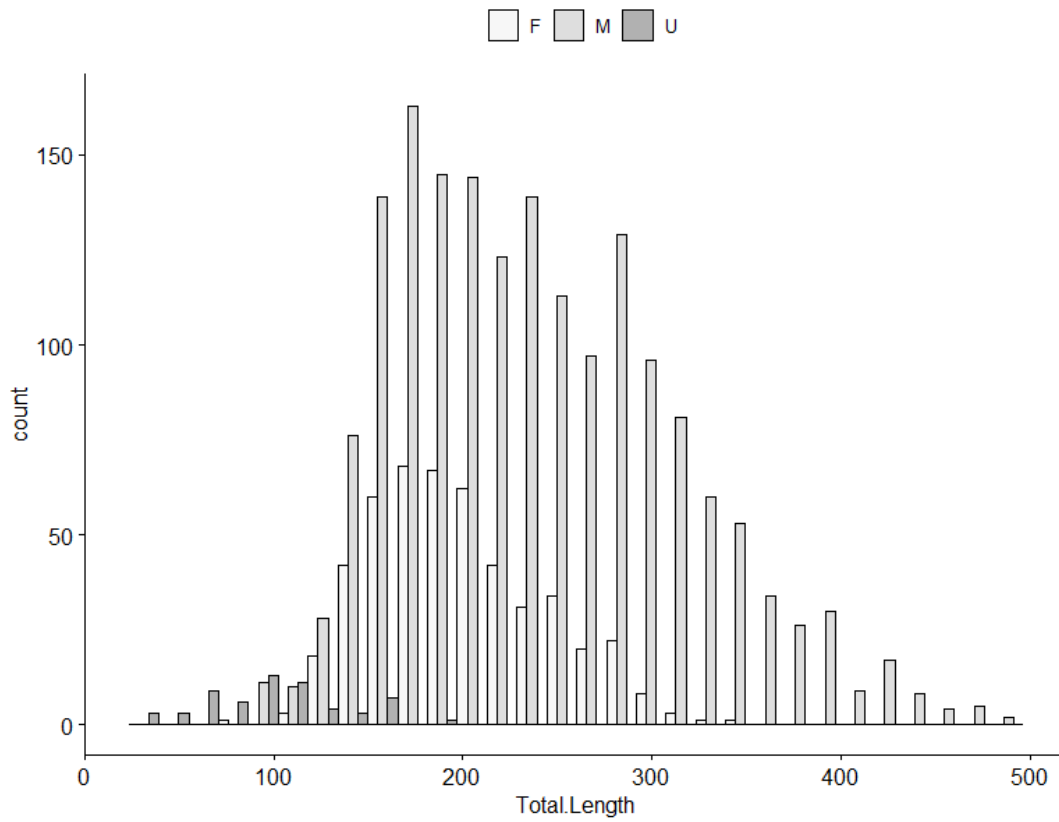


Figure 6 Size distribution of *C. porosus* removed over period 2012 to 2019. F=Female, M= Male, U = Unknown

Consistent with Fukuda *et al.* 2014 (which was based on pre-2012 data), the bulk of the captures since 2012 were in the 1.5 m to 2.5 m size class; however, a number of very large crocodiles have been removed from the management zones (Figure 6). Fatal attacks have been recorded by crocodiles larger than 3 m, with attacks possible across a broad range of size classes especially above 2 m (Fukuda *et al.* 2014).

While the sizes varied slightly across the management zones (Figure 7a), there is no indication of a significant trend to catching smaller crocodiles (Figure 7b) which might be expected if the overall source population was being reduced. Fukuda *et al.* (in press) show that the numbers removed, in conjunction with the number of live crocodiles taken from outside the management zones (see below) are well within modelled sustainable limits.

Whilst the average size of crocodiles caught in the Darwin management zone is less than others (Figure 7 a), this is most likely related to the much greater numbers removed from this area with large crocodiles still removed from the zone (Figure 8).



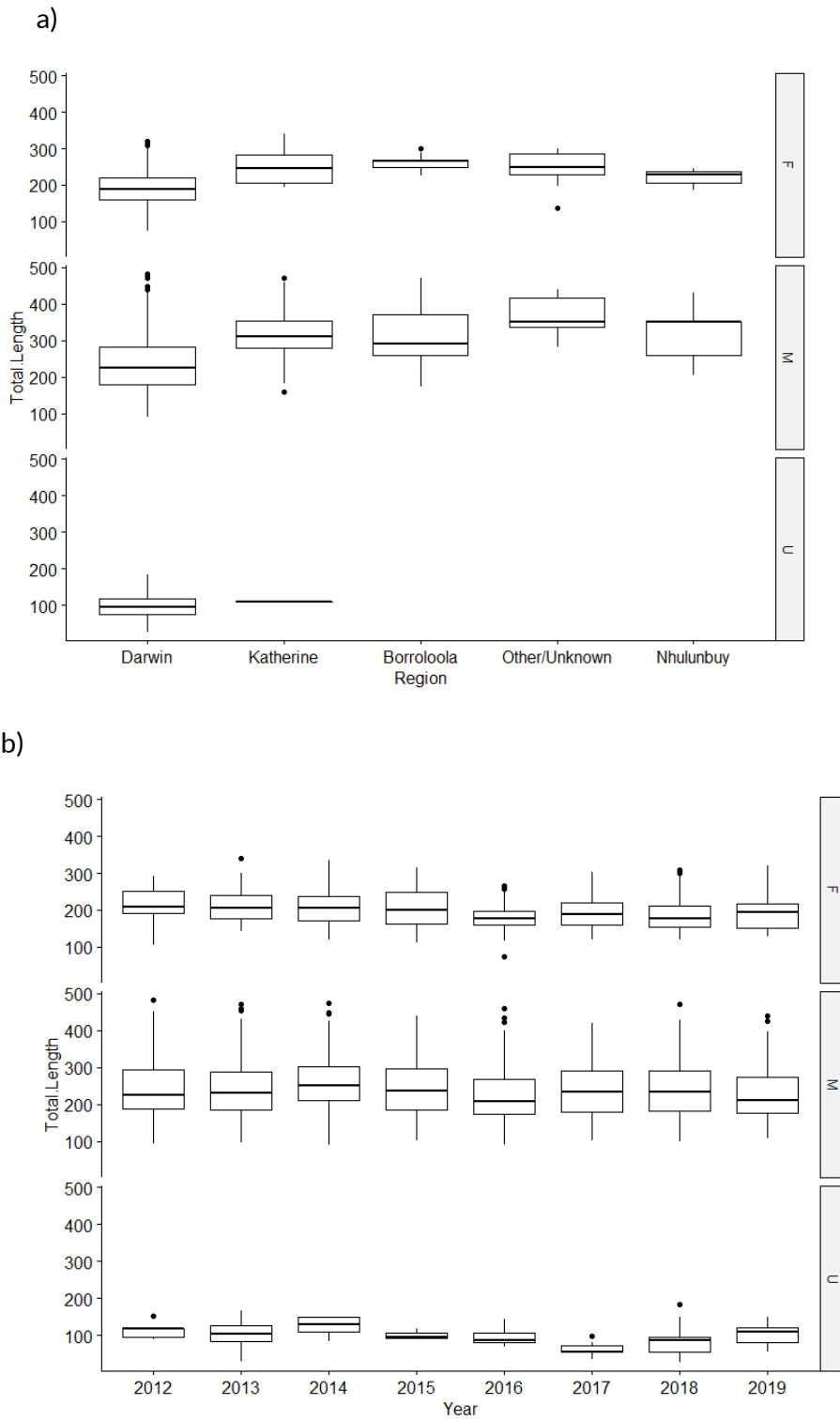


Figure 7 Box plots of size distribution of problem saltwater crocodiles removed by a) Management Region and b) Year. M = Male, F= Female, U= Unknown sex.

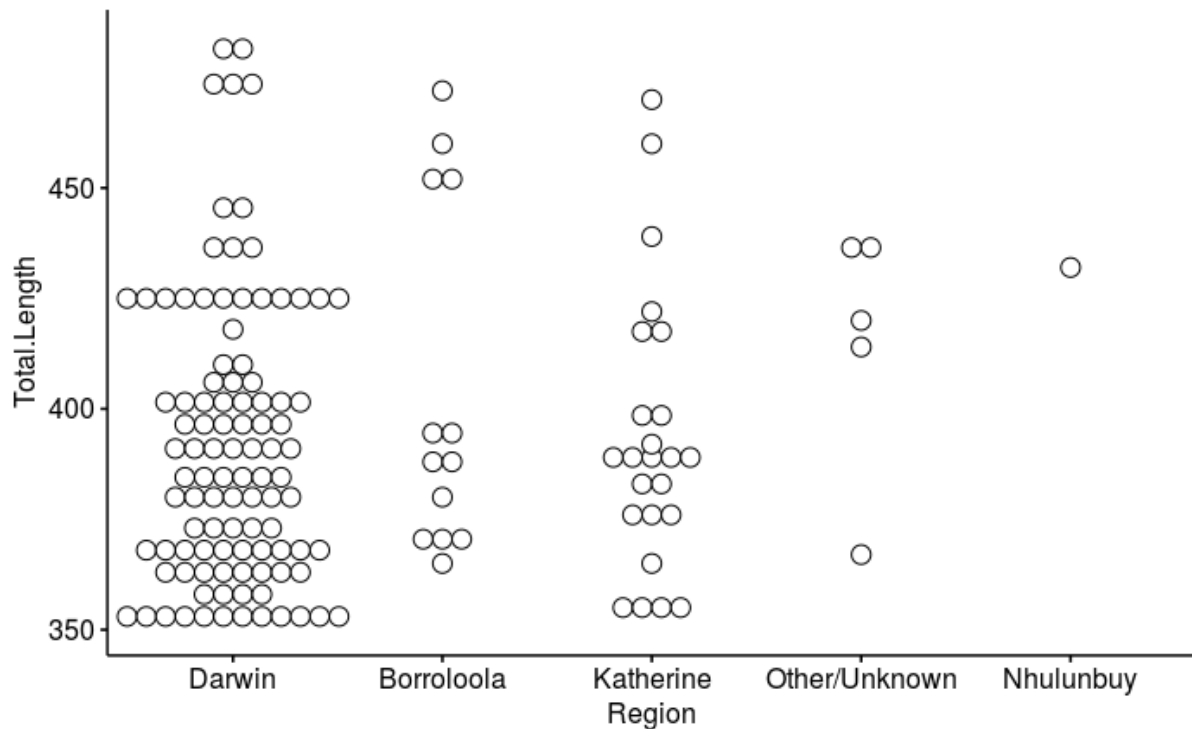


Figure 8 Dot plot of large (> 3.5 m) crocodiles removed under the DTSC Wildlife Operations removal program by Management Region

## Community Awareness and Participation

The Northern Territory Government promotes crocodile awareness among residents and visitors by disseminating educational information through the Be Crocwise strategy. Public awareness campaigns continue to be conducted regularly to minimise harmful interactions between people and crocodiles. These campaigns use a variety of the media including TV, DVD, social media sites, newspapers and radio to ensure messages about safe behaviour are effectively conveyed to both locals and visitors. Local events such as the show circuit, tour guides, park visitor centres, park ranger talks and boat expos are avenues to further disseminate messages in a face-to-face setting. The Northern Territory Government also promotes relevant legislation, policy and guidelines to the commercial crocodile industry and wider community via promotion of the management program, relevant fact sheets, and through the Northern Territory Government permit system.

DTSC continues to promote community awareness for safety and participation through Crocwise campaign programs using a variety of media. DTSC staff delivered 77 Be Crocwise face-to-face presentations to 8,871 people in 2018/2019.

## HARVEST FROM THE WILD

### Eggs

Under the WTMP a harvest ceiling of 90,000 viable eggs applies from the 2016/2017 egg harvest season onwards. The definition of “live”, “viable” and “total eggs” follows the WTMP.

The number of eggs permitted to be taken has been below the harvest ceiling in all years (Table 4). As in previous years, the harvest in 2018/2019 was lower than the number of eggs permitted and this was consistent across all permits. There was a drop in eggs collected in 2018/2019 compared to previous years; however, this most likely related to transition arrangements due to permit transfers. The end of 2019 represented the final year for a large number of multi-year permits and there were some changes in access to country arrangements due to these transfer arrangements. The larger operators who were continued to operate in 2019/20 and forward (i.e. had long-term collection permits in place) took between 90- 95% of their allotted quota per permit in 2018/2019; whereas smaller operators, and in one case a larger operating farm that had transferred ownership, often had permits that weren't fully utilised.

The number of eggs harvested varies between the different regional catchments (Figure 9), depending on a number of factors as outlined in Appendix 1 of the WTMP. The proportion allocated across catchments has been kept broadly similar across the life of the WTMP with some minor modifications based on the additional allocations discussed above. In 2018/2019 there continued a trend for the more remote (relative to Darwin) regions to be less utilised; however, it should be noted that these regions, although extensive in area, have limited good quality nesting habitat and permit applications for these areas have historically been both few and underutilised. Whilst

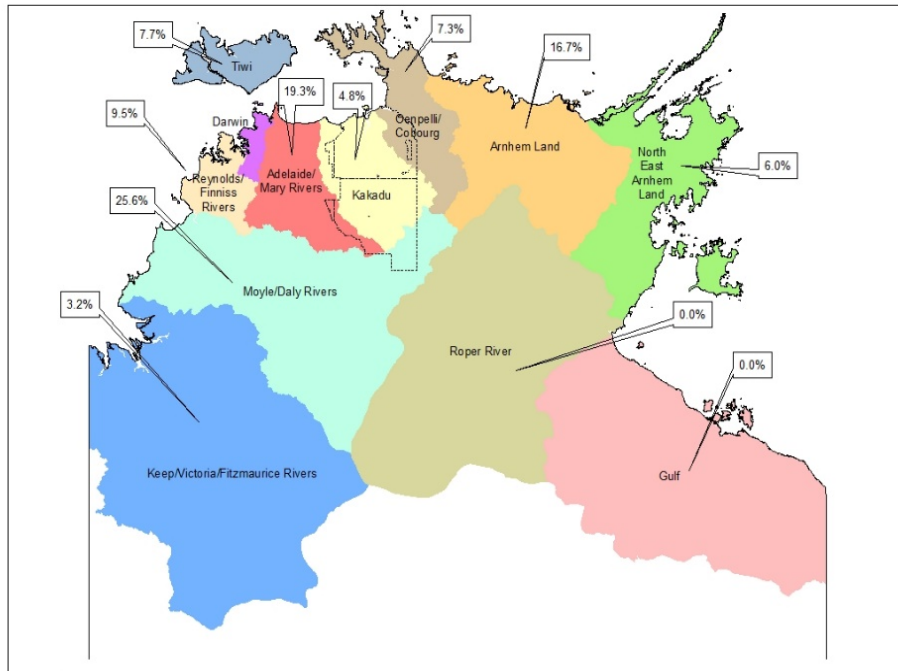
the proportion of eggs taken across the major egg producing regions vary from year to year they are below the regional cap in an absolute sense.

The returns of permit holders were closely monitored and incubator inspections were conducted to ensure that the stock taken under each permit complied with the conditions of the permit (see Permits & Compliance below).

*Table 4 The number of C. porosus eggs harvested for commercial use in 2013/2014, 2014/2015, 2015/2016, 2016/2017 and 2017/2018. Note that for 2013/2014 through 2015/2016 the annual harvest ceiling is for “live” eggs and from 2016/2017 onwards for “viable” eggs.*

<b>Season</b>	<b>Harvest Ceiling</b>	<b>Eggs permitted</b>	<b>Eggs harvested</b>
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

a)



b)

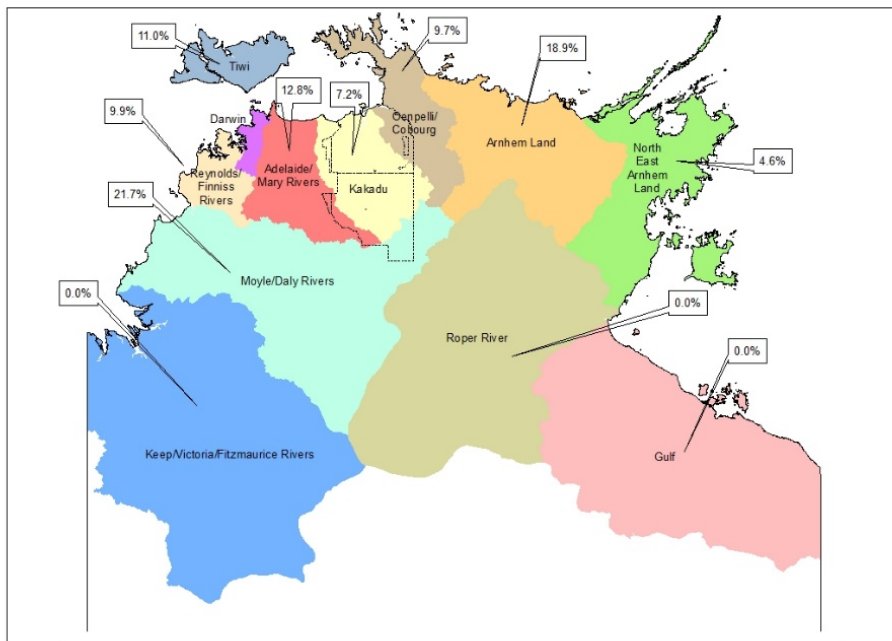


Figure 9 Proportion of *C. porosus* egg harvest per regional catchments in a) 2017/2018 and b) 2018/2019, relative to the total NT number of eggs harvested. Note that the boundary of Kakadu regional catchment is different from Kakadu National Park (KNP).

## Live harvest

The Wildlife Trade Management Plan allows up to 1,200 non-hatchling (animals greater than 0.6 metre in length) *C. porosus* to be directly harvested from the wild each year. This quota includes any problem crocodiles removed by DTSC (reported separately in Table 3). There was a total of 25 (including 6 new and 10 that expired during the period) problem crocodile permits in place during the reporting period for a maximum allowed take of 340 adult animals. There was an additional 10 crocodile harvest permits (including 5 new and 4 that expired) for an allowed take of 163 adult animals.

A total of 37 non-hatchling *C. porosus* were harvested from the wild in 2018/2019 (Table 5). Variation in the sex ratio of harvested adults is influenced by the harvest purpose (e.g. skin and meat harvest, female breeding stock for farms or problem crocodile removal). In 2018/2019 the sex ratio of live harvested animals was biased towards males (64.9 % (Table 6)), and harvested males were larger than harvested females (Table 7). However, the sex bias was much less than previous years due to one farm collecting nine adult females as breeding stock. The majority of the other animals taken were males deemed problem animals (harvested from near regional communities or pastoral properties to mitigate stock losses).

The number of crocodiles harvested in 2018/2019 as presented in Table 5 is potentially a slight underestimate of the actual harvest in the 12 month period reported. This is due to failure to submit returns that generally relates to staff turnover in remote communities. Best estimates in these cases were of nil captures rather than permitted amounts being taken and not reported. Notwithstanding the potential for some unreported take, the total regulated harvest of live crocodiles from all sources is well below the established limit of 1,200.

*Table 5 The number of hatchlings, juveniles and adults (2012/2013 to 2014/2015) or hatchlings and non-hatchling (2015/2016 onwards) of C. porosus harvested for commercial use in 2012/2013, 2013/2014, 2014/2015, 2015/2016, 2016/2017, 2017/2018, 2018/19.*

<b>Year</b>	<b>Hatchlings</b>	<b>Juveniles</b>	<b>Adults / Non-hatchlings</b>
2012/2013	0	16	59
2013/2014	0	29	119
2014/2015	0	-	61
2015/0216	0	-	121
2016/2017	0	-	53
2017/2018	0	-	39
2018/2019	0	0	37

*Table 6 Percentage of C. porosus harvested for commercial use in 2012/2013, 2013/2014, 2014/2015, 2016/2017 and 2017/2018 that were male.*

<b>Year</b>	<b>Male</b>
2013/2014	73.5 %
2014/2015	85.6 %
2015/0216	76.4 %
2016/2017	81.1 %
2017/2018	92.3 %
2018/2019	64.9 %

*Table 7 Average total length of C. porosus (non-hatchling) for each sex harvested for commercial use in 2012/2013, 2013/2014, 2014/2015, 2015/2016, 2016/2017, 2017/2018 and 2018/2019. Small juveniles whose sex was unknown are not included in the figures.*

Year	Female (m)	Male (m)
2012/2013	2.13	3.11
2013/2014	2.12	3.22
2014/2015	2.16	3.70
2015/2016	2.12	3.51
2016/2017	2.40	3.53
2017/2018	1.65	3.94
2018/2019	2.70	3.15

## Harvest review

The Wildlife Trade Management Plan sets a single harvest level for egg harvest (90,000 viable eggs) and for live harvest (1,200 non-hatchling animals) that applies annually for each of the five years that the WTMP is in force. There is no requirement for the harvest level to be reviewed within the life of the WTMP other than as a consequence of monitoring results and as part of the review of the WTMP prior to the expiry of the WTMP on 31 December 2020. Taking all monitoring data into account along with the reported size of the egg and live harvest, it is apparent that the existing thresholds are appropriate to ensure an ongoing sustainable harvest.

## FARM PRODUCTION

Ten crocodile farms operated in the NT in 2018/2019 (Table 8). Time periods used for farm permit returns were as for the 2017/2018 report (i.e. a Feb to Jan reporting



period) reflecting change in reporting timing implemented in 2013/2014 designed to be more in line with farm operational cycles.

In line with discussion at the annual Crocodile Managers Forum 2016, farm production reporting is limited to stock held, acquisitions and disposals. Breakdown of farm production by component is not required as a condition of permit. From 2018, transfers out were separated from other forms of losses (mainly mortality of juvenile crocodiles) as the summed values gave the impression of significant levels of unaccounted for losses.

Details of the stock held on each farm for the period 1 February 2018 to 31 January 2019 are provided in Appendix 2.

Table 8 The number of crocodile farms operating in the Northern Territory, showing details of *C. porosus* stock held (2013/2014 to 2018/2019).

Year	No. of farms	Stock held 1 February	Farm-bred hatchlings	Total acquired	Crocodiles processed	Transfers Out****	Total Losses (Mortalities/ Transfers****/ Unaccounted)	Stock held 31 January
2013/2014	8	114,550	7,497	50,665	17,689		46,572	118,656
2014/2015*	8	118,656	6,877	61,347	14,061		49,632	122,915
2015/2016	9	130,431	7,698	63,742	17,935		59,198	137,661
2016/2017**	11	132,311	4,798	47,138	23,839		58,747	120,697
2017/2018***	10	101,661	4,090	53,995	19,642	30,893	7,727	101,030
2018/2019	10	101,030	6,674	51,643	21,696	25,225	5,078	100,769

\* data for 7 of 8 farms only;

\*\* data for 10 of 11 farms only

\*\*\* One farm inactive; Data for Stock held does not include unhatched eggs

\*\*\*\* Transfers out separated from mortalities in 2017/2018 and 2018/2019

Trends in industry economic return (as measured by reported farm revenue) have been relatively steady and averaged \$25.2 M per annum over the past 5 years (NT Treasury and Finance Figures). In 2018/2019, revenue from the NT’s crocodile industry rose 13.3% to \$26.85 million (Figure10). Stricter grading standards were introduced in 2016/2017, leading to a greater quantity of crocodile skins being classified as lower grade skins. Around 63.5% of revenue was generated from the production of first grade skins reflecting an ongoing focus of quality over quantity.

A total of 33,329 crocodiles were converted into product in 2017/2018 (converted into skins or live sales including sales of hatchlings/juveniles to interstate farms). This was down from 42,681 in 2016/2017 due to a reduction in lower grade skins and fewer transfers to interstate farms. Note, the numbers do not compare directly with the Crocodiles processed reported in Table 8 due to different reporting periods.

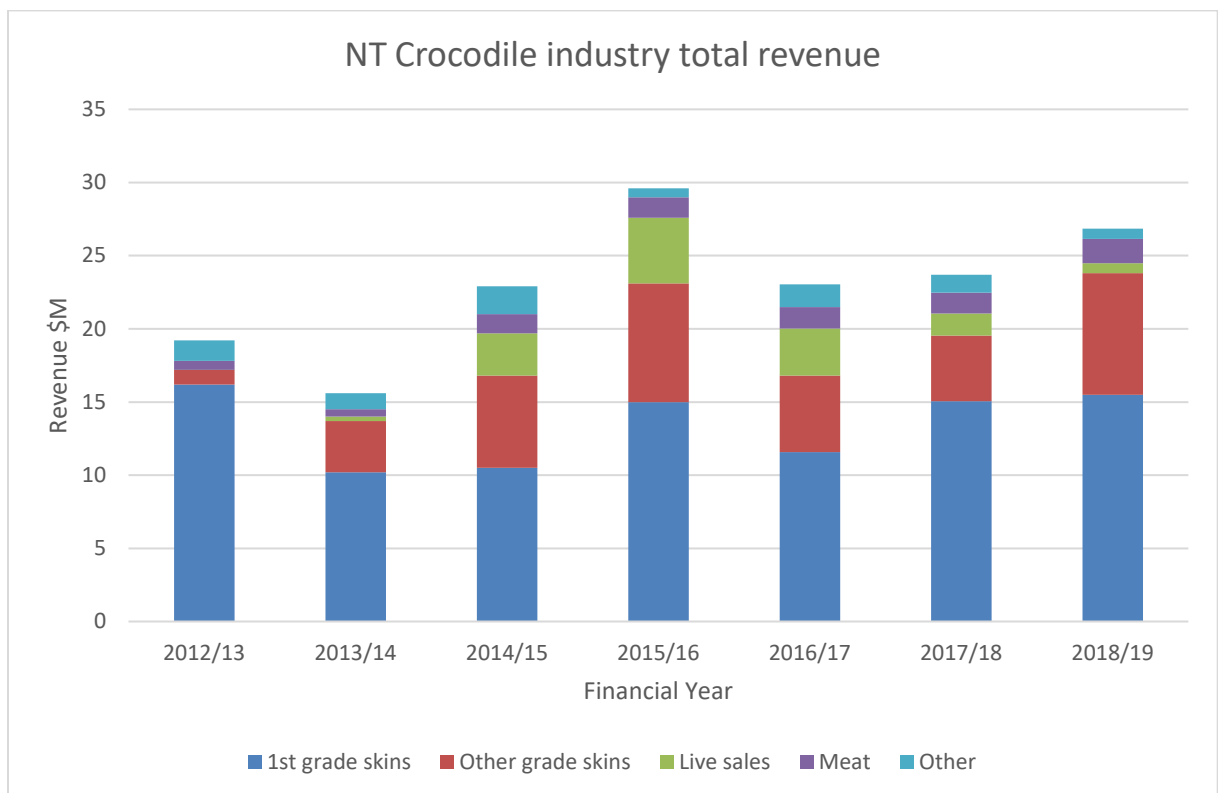


Figure 10 Trends in NT Crocodile Industry economic returns (revenue in \$ M) over years 2012/2013 to 2018/2019. Data are from industry return data to NT Department of Treasury and Finance.

## PERMITS & COMPLIANCE

The following is a summary of information pertaining to permits and compliance monitoring for the 2018/2019 egg harvest season:

- A total of 20 individual permits to collect crocodile eggs were in operation.
- For 2018/2019 crocodile egg harvesters were required to submit final returns only for egg collection. DENR has standardised the format of final returns of egg collection to obtain the necessary data as specified in the WTMP. The return forms were provided both electronically and in hardcopy with each permit as permit conditions.
- There were three audits of farm incubators and no field audits of collected nests during the 2018/2019 egg collection season. Compliance with record keeping standards for all inspected farms was very high with no significant issues detected. Less than 5 % of egg trays inspected had discrepancies regarding the number of eggs recorded and none were significant (usually out by 1 egg). Paperwork regarding nest locations was consistent with a high level of accuracy in ability to link specific trays with their collection origin.
- There were no reported compliance issues for the 2018/2019 egg collection season from Traditional Owners, property owners or the public.
- Crocodile egg collection permit holders were required to submit final returns for the 2018/2019 crocodile egg collection season (December - May) by 31 July 2017. No warning letters or infringement notices were issued for non-compliance for late submission of returns.
- For the 2018/2019 crocodile egg collection season, collectors were required as a condition of permit, to provide 48 hours prior notification of date and location of collection activity via a dedicated email address or a dedicated phone number and message bank. Compliance with this system was high. As with previous years, non-compliance was primarily in the form of late notification (either immediately prior or after actual collection) and in one instance there were issues with lack of telephone coverage making prior notification problematic. There was a high number of instances where harvesters had to postpone planned collection in response to changed weather

conditions. No warning letters or infringement notices were issued for non-compliance.

- There was regular interaction with all permit holders including crocodile egg collectors, live crocodile harvesters and crocodile farmers, to discuss issues related to permitting, compliance and enforcement.
- One reported instance of “suspicious” behaviour by a crocodile harvester/s were investigated by DTSC but no evidence was found of illegal activity.
- There was regular interaction between DENR and all other relevant jurisdictions.

## **ANIMAL WELFARE**

The Code of Practice on the Humane Treatment of Wild and Farmed Australian Crocodiles was endorsed by the Natural Resource Management Ministerial Council on 21 May 2009. This Code outlines an achievable minimum standard of humane conduct in regard to the treatment of wild and farmed crocodiles. This Code is recognised as a standard by the Northern Territory *Animal Welfare Act*.

There were no reported breaches of Code during the reporting period.

## **REPORTING AGAINST ANNUAL MILESTONE MATRIX**

All annual milestones of the WTMP were delivered or on track with details provided in Appendix 3.

# PART 2. REVIEW OF CURRENT WILDLIFE TRADE MANAGEMENT PLAN AND DEVELOPMENT OF NEW PLAN

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## Review and Revision Overview

Section 3.3 of the WTMP 2016–2020 states that the plan will be reviewed at the end of 2020 or sooner as required under subsection 303FO of the *EPBC Act*. This review is in four phases:

1. A review of the sustainability of the harvest based on monitoring of NT crocodile population and implications of the harvest on the conservation of the species against IUCN criteria (Part 1 of this Report).
2. An NT level review of the implementation of plan focused on the required activities as reported on here.
3. Drafting of a revised WTMP and assessment by the Commonwealth against the requirements of the *EPBC Act* occurring concurrently during 2020.
4. Public consultation phase of the revised WTMP and subsequent response to the input received including any applicable amendments. Public comment period is to be for a minimum of 20 business days after the date on which the notice was published on the internet as required under section 303FR of the *EPBC Act*.

## NT Review Process

The review process involved a desktop evaluation of the current WTMP taking into account the approach taken with the recently approved Queensland WTMP. Key stakeholders were consulted regarding any issues with the existing procedures including relevant NT Government agencies, the Crocodile Farmers Association of the Northern Territory (CFA NT) and peak Aboriginal Groups. A formal meeting of NT Government Agencies was held on September 9, 2020 to evaluate all milestones. The results of this meeting were presented to CFA NT on September 10 for discussion. The basic approach

was to look at each milestone and make an assessment of whether it was seen as working/not working, still relevant/no longer relevant, and any required additions/amendments.

### **Assessment against Actions and Performance Measures**

The results of the review of “Annual Actions and Performance measures for 2016-2020 Plan” (See Saalfeld et al. 2015; pages 25 -27) are summarised in Table 9. Milestones are mapped against core program objectives ((i) Sustainable use and (ii) Ensuring legality of harvest program) and coloured coded. From a program logic perspective any milestone/action not addressing either objective should be considered for omission.

Assessment of the WTMP against the requirements of the EPBC Act, Section 303FO to meet the requirements for approval as an approved WTMP under the EPBC Act is provided in Table 10.

Table 9 Summary of review of Milestones from 2016-2020 Wildlife Trade Management Program

Milestone	Program Reference	Agency	Timeline	Status 2020	Issues	Recommended Action
Ensure the harvest ceiling is set in accordance with the Plan	3.1.2 Harvest review	DLRM, Wildlife Use	Annually	Compliant	Harvest set on modelling that is now peer reviewed and in press	Carry forward to new plan
Investigate and take appropriate action on all suspected local impacts on the population	3.1.2 Harvest review	DLRM, Wildlife Use	Ongoing	Compliant	No significant local impacts detected during life of plan. Occasional records of anthropogenic croc kills have been investigated but difficult to attribute source	Carry forward to new plan
Exempt manufactured items from the provisions of the <i>TPWC Act</i>	3.1.4 Permits and compliance	DLRM, Wildlife Use	Completed with gazettal of the NT Management Program	Finalised	Manufactured items which do not require a product label will not require an import/export permit for movement into/out of the Northern Territory	No change required. Product label and exemption classes working well.



Milestone	Program Reference	Agency	Timeline	Status 2020	Issues	Recommended Action
Investigate amendment of the <i>TPWC Act</i> to allow for the commercial licencing of crocodile farms	3.1.4 Permits and compliance	DLRM, Wildlife Use	Commence	Incomplete	Preliminary investigation. Advice was to include with overall review of the Act which is in the pipeline	Address when TPWC Act is reviewed
Ensure that the annual commercial harvest of Saltwater Crocodiles does not exceed the approved ceiling	3.1.4 Permits and compliance	DLRM, Wildlife Use	Annually	Compliant	Permitted take below the ceiling and actual take below the permitted amount	Carry forward to new plan
Assess applications and issue permits under the <i>TPWC Act</i>	3.1.4 Permits and compliance	DLRM, Wildlife Use	Ongoing	Compliant	Permits assessed and prepared by DENR with oversight and transmission via Parks and Wildlife Permits system	Carry forward to new plan. Review operational requirements at next MPSC review

Milestone	Program Reference	Agency	Timeline	Status 2020	Issues	Recommended Action
Monitor and audit harvest applications, approvals, returns, and investigate to resolve any discrepancies.	3.1.4 Permits and compliance	DLRM, Wildlife Use PWCNT, Wildlife Ops	Ongoing	Compliant	Integrated with annual reporting process. Some discrepancies with Live crocodile harvest from operators not submitting nil returns annually usually due to staff turnover	Carry forward to new plan. Review operational requirements at next MPSC review.
Ensure all permit applications have correct landholder approval.	3.1.4 Permits and compliance	DLRM, Wildlife Use	Ongoing	Compliant	Landholder sign-off or implemented Land Use Agreement or Park tender process required prior to processing. Issue of getting head office sign-off from pastoral companies has been raised by property managers.	Carry forward to new plan. No plans to change requirement from landholder approval to property manager at this stage.

Milestone	Program Reference	Agency	Timeline	Status 2020	Issues	Recommended Action
Conduct random checks on eggs and farm stock numbers	3.1.4 Permits and compliance	DLRM, Wildlife Use PWCNT, Wildlife Ops	Ongoing	Compliant	High levels of compliance in record keeping across the WTMP operating period. No audits could be performed in 2020 due to Covid-19 restrictions	Carry forward to new plan
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	3.1.4 Permits and compliance	DLRM, Wildlife Use PWCNT, Wildlife Ops	Ongoing	Compliant	Some issues re reporting timelines. All permit returns now submitted to Parks and Wildlife Permits section for clarity.	Carry forward to new plan. Review operational requirements at next MPSC review.
Address any permit breaches through warning letters, caution notices, infringement notices, permit cancellation or prosecution.	3.1.4 Permits and compliance	DLRM, Wildlife Use PWCNT, Wildlife Ops	Ongoing	Compliant	Most breeches recorded related to live (problem) crocodile take. No significant impact on legal and sustainability of wildlife trade component	Carry forward to new plan

Milestone	Program Reference	Agency	Timeline	Status 2020	Issues	Recommended Action
Continue the population survey program as described in this Plan	3.1.5 Monitoring	DLRM, Wildlife Use	Annually	Compliant	Environmental constraints (e.g. smoke) and (in one case) access issues have meant not all planned rivers could always be surveyed but overall program working well	Carry forward to new plan. Review operational requirements at next MPSC review.
Analyse and assess the results of the survey program and implement any management recommendations	3.1.5 Monitoring	DLRM, Wildlife Use	Annually	This report	Core program should be maintained. Some new technologies (environment DNA, drones etc.) on horizon but not mature enough for broad scale adoption.	Carry forward to new plan. Review operational requirements at next MPSC review. Continue to collaborate with Qld and WA re broader crocodile monitoring issues
Ensure the requirements of the Code of Practice are a condition on all permits and that a copy of the Code is distributed to all new permit holders	3.1.6 Animal welfare	DLRM, Wildlife Use	Ongoing	Compliant	No new operators in recent times with overall number of farms reducing over time.	Carry forward to new plan

Milestone	Program Reference	Agency	Timeline	Status 2020	Issues	Recommended Action
Ensure all successful permit applicants are competent to comply with the relevant animal welfare standards	3.1.6 Animal welfare	DLRM, Wildlife Use	Ongoing	Compliant.	DPIR have held several briefings with CFA NT re the implications of revision of Animal Welfare Act. No changes to the code of practice required.	Carry forward to new plan
Investigate and take appropriate action on any suspected breaches of the <i>Animal Welfare Act</i>	3.1.6 Animal welfare	DPIF, Animal Welfare	Ongoing as needs	No suspected breaches reported or detected	Farm production drivers are aligned with maintaining very high standards of animal welfare. Exit programs for farm closure worth consideration.	Carry forward to new plan. Review operational requirements at next MPSC review.
Annually audit the progress of the Plan against each of the performance indicators and adjust management practices as necessary	3.1.7 Reporting	DLRM, Wildlife Use	Annually	Compliant	Reported in annual monitoring reports.	Carry forward to new plan

Milestone	Program Reference	Agency	Timeline	Status 2020	Issues	Recommended Action
Submit annual reports to the Australian Government and provide a summary on the Northern Territory Government website	3.1.7 Reporting	DLRM, Wildlife Use	Annually	Compliant	Some delays in delivery related to resourcing levels and issues re different timelines of component parts (croc capture returns, egg harvesting season, crocodile monitoring program etc.)	Carry forward to new plan. Review operational requirements at next MPSC review.

Coding Used:

- 1. Sustainable (no over harvest)
- 2. Legal (in CITES/EPBC Act context)
- 3. Both
- 4. Neither

Table 10 Assessment of the current WTMP against the EPBC Act requirements

Requirement per section 303FO	Response
<p>1. The plan is consistent with the objects of Part 13A of the EPBC Act.:</p> <p>(a) to ensure that Australia complies with its obligations under CITES and the Biodiversity Convention</p> <p>(b) to protect wildlife that may be adversely affected by trade</p> <p>(c) to promote the conservation of biodiversity in Australia and other countries</p> <p>(d) to ensure that any commercial utilisation of Australian native wildlife for the purposes of export is managed in an ecologically sustainable way</p> <p>(e) to promote the humane treatment of wildlife</p> <p>(f) to ensure ethical conduct during any research associated with the utilisation of wildlife</p> <p>(g) to ensure that the precautionary principle is taken into account in making decisions relating to the utilisation of wildlife.</p>	<p>(a) NT Wildlife Program is seen as an example of a global success story by CITES e.g. <a href="#">CITES Secretary-General's opening remarks at the high-level event at UN Headquarters to celebrate World Wildlife Day</a></p> <p>(b) Species has continued to flourish in NT under many years of trade</p> <p>(c) Several examples of this program being used to promote biodiversity conservation</p> <p>(d) All take is within sustainable limits and promotes protection of habitats as well as a healthy wild population of saltwater crocodiles</p> <p>(e) All take and downstream processing within a code of practice for humane use</p> <p>(f) Not directly relevant but all R&amp;D approved is in keeping with NT MPSC</p> <p>(g) Harvest limits etc., set conservatively in an adaptive management framework (i.e. remedial action can be taken if evidence of unsustainable impacts on population)</p>
<p>2. There has been an assessment of the environmental impact of the activities covered by the plan, including (but not limited to) an assessment of:</p>	<p>Long standing plan which was based on impact assessment. Sub points a) to d) revisited in this report (see Table 2)</p>

Requirement per section 303FO	Response
<ul style="list-style-type: none"> <li>a. the status of the species to which the plan relates in the wild</li> <li>b. the extent of the habitat of the species to which the plan relates</li> <li>c. the threats to the species to which the plan relates</li> <li>d. the impacts of the activities covered by the plan on the habitat or relevant ecosystems.</li> </ul>	
<p>3. The plan includes management controls directed towards ensuring that the impacts of the activities covered by the plan on:</p> <ul style="list-style-type: none"> <li>a. a taxon to which the plan relates</li> <li>b. any taxa that may be affected by activities covered by the plan</li> <li>c. any relevant ecosystem (for example, impacts on habitat or biodiversity) are ecologically sustainable.</li> </ul>	<ul style="list-style-type: none"> <li>(a) No evidence of incidental take or impact on, for example, freshwater crocodile.</li> <li>(b) See Management actions</li> <li>(c) Use promotes maintenance of most critical nesting habitat by providing a direct return to landholder</li> </ul>
<p>4. The activities covered by the plan will not be detrimental to:</p> <ul style="list-style-type: none"> <li>a. the survival of a taxon to which the plan relates</li> <li>b. the conservation status of a taxon to which the plan relates</li> <li>c. any relevant ecosystem (for example, detriment to habitat or biodiversity).</li> </ul>	<p>See Table 2 for assessment against each of this sub points</p>



Requirement per section 303FO	Response
<p>5. The plan includes measures to:</p> <ul style="list-style-type: none"> <li>a. mitigate and/or minimise the environmental impact of the activities covered by the plan</li> <li>b. monitor the environmental impact of the activities covered by the plan</li> <li>c. respond to changes in the environmental impact of the activities covered by the plan</li> </ul>	<ul style="list-style-type: none"> <li>a) Impact on populations and habitat mitigated by sustainable use framework and</li> <li>b) Monitoring in place to validate population impacts and environmental health (e.g. continued nesting success demonstrates habitat protection)</li> <li>c) To date no change has been warranted based on monitoring. Separate performance indicators proposed in draft WTMP</li> </ul>

## **Additional review recommendations**

Review of the combined management actions and performance measures suggested that the combined “Milestones in the 2015-2020 plan did not explicitly establish performance levels (other than by lack of achievement). It was decided to therefore establish a separate Performance Indicator for each Management Action in line with the recently approved [Queensland WTMP](#).

Further, there was seen to be value in separating out the broader management of crocodiles in the NT under the MPSC from the WTMP and making the new plan on a more targeted document along the lines of the Queensland WTMP.

## **Requirement of EPBC Act relating to WTMP**

Section 303FO of the EPBC Act states that the Commonwealth Minister responsible for the Environment may declare a WTMP only if satisfied specific requirements. As part of the review a brief evaluation of the WTMP (including any implications for any future plan) is provided in Table 10. It should be noted that this plan and previous iterations were deemed to be compliant with the Act and no additional information has come to light to suggest any conflicts. However, it is worth re-assessing the plan in the context of the development of the next iteration. On the basis of this assessment the WTMP continues to meet the *EPBC Act* requirements as an approved WTMP.

## NT REVIEW OUTCOME

The overall review process concluded that:

- (a) Operation of WTMP was successful against the key aims – conservation of species and efficacious management of the industry; and
- (b) best approach is extension of existing WTMP, including maintaining key wild take thresholds, with some minor to amendments to Milestones/Actions.

Drafting of a new plan has been undertaken in light of this outcome and ongoing consultations. Several issues (Table 9) were identified that would be best addressed via a comprehensive review of the NT MPSC to update management information etc. based on recent research and streamlined reporting.

## REFERENCES

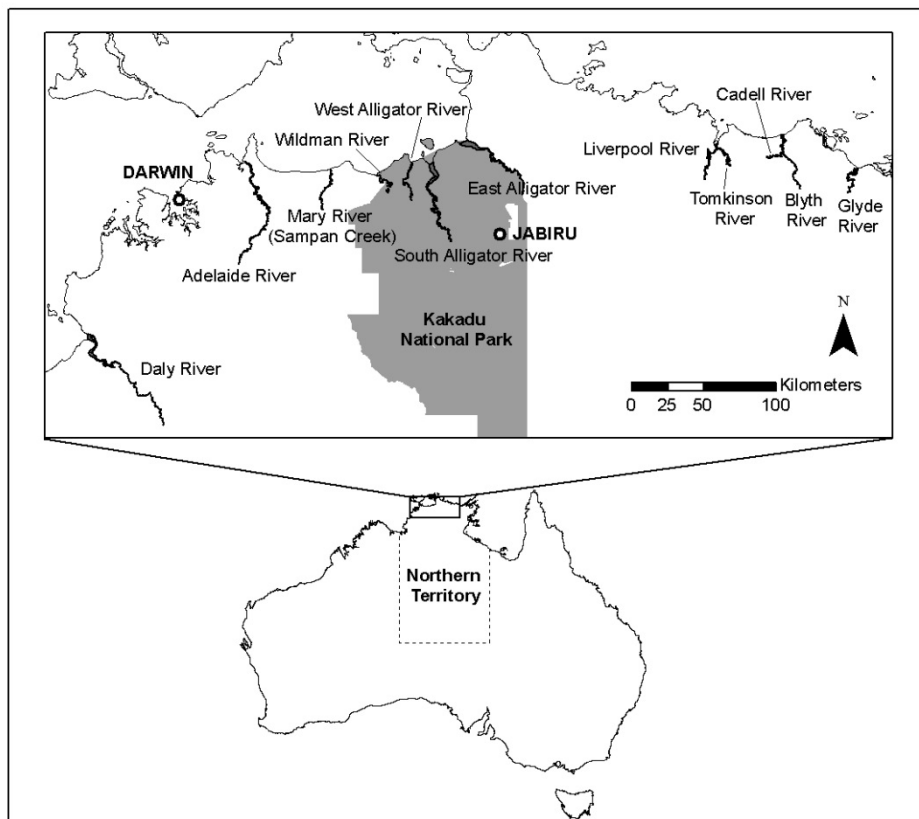
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# APPENDIX 1. MONITORING SURVEYS OF SALTWATER CROCODILE POPULATIONS IN THE TIDAL RIVERS OF THE NORTHERN TERRITORY: 2019 MONITORING DATA

## INTRODUCTION

Populations of *Crocodylus porosus* have been monitored since the species was protected (1971) in the Northern Territory (NT). The population monitoring program was initiated by Messel *et al.* (1981) and taken over by Wildlife Management International Pty Ltd during the 1980-90s (Webb *et al.* 2000). Since 1998, Department of the Environment and Natural Resources (DENR) has been conducting surveys in the selected rivers outside the Kakadu National Park (KNP) in the NT (Fukuda *et al.* 2011). The rivers in the KNP have been surveyed by Parks Australia on regular basis (Lindner 2004). This section reports on the results of these surveys (Figure 1) from the earliest (1975) to the latest (2019).



**Figure 1.** Rivers regularly surveyed to monitor *C. porosus* populations in the NT.

## METHODS

The NT's standardised crocodile surveys followed the procedures described in details by Messel *et al.* (1981), Bayliss *et al.* (1986), and Fukuda *et al.* (2013b). The first year of the standardised surveys varies between the monitored rivers (Table 1). Surveys were conducted between June and October (dry season) when the water level and temperature were low. Fixed sections of the mainstream of each river were surveyed at night by boat at a low speed (10-20 km/h). Surveys were restricted to low tide when mud banks were exposed and crocodiles were more visible at the water's edge. The water surface, banks and fringing vegetation were systematically scanned with a spotlight and crocodiles were located by their distinctive, reflective eye-shines. Each crocodile was approached as close as possible to estimate the total length (TL) in 0.3-m (1 ft) intervals and to confirm species (freshwater crocodiles, *C. johnstoni*, overlap with *C. porosus* in some rivers). TL was estimated from the 1:7 ratio (head length:TL) as described by Fukuda *et al.* (2013a). If the head of a crocodile was submerged and no estimate was possible, it was recorded as 'eyes only' (EO).

Surveyed distances to estimate crocodile densities were measured along the mid-line of streams in kilometres to the nearest 0.01 km, originally using survey maps (Messel *et al.* 1982) but in later years standardised to more accurate distances measured with a Geographic Information System (GIS). Because the start and finish points of survey have been fixed for each river, results were considered directly comparable from year to year (Fukuda *et al.* 2013b).

Abundance density of crocodiles sighted during survey was estimated by dividing the total number of non-hatchlings (TL <0.6 m) by the distance surveyed. Biomass density was also estimated by 1) converting the TL to biomass (kg) using the equations provided by Webb and Messel (1978) and 2) dividing the total biomass of non-hatchlings by the distance surveyed. These density indexed were plotted with previous results to assess the trend of population dynamics for each river. The trend was determined by fitting a linear, exponential, and logistic growth models to the historical densities (see Fukuda *et al.* 2011 for details).

**Table 1.** Summary of the standardised crocodile surveys in the monitored rivers in the NT between 2015 and 2019.

River monitored	Frequency	Agency responsible	First surveyed	2015	2016	2017	2018	2019	Number of years surveyed
<b>Adelaide</b>	Annual	DNER	1977	Done	Done	Done	Done	Done	36
<b>Blyth</b>	Biennial	DNER	1975		Done		Done		35
<b>Cadell</b>	Biennial	DNER	1975		Done		Done		34
<b>Daly</b>	Biennial	DNER	1978		Done		Done		26
<b>East Alligator</b>	Annual	Parks Australia	1977		Done	Done	Done	Done	32
<b>Glyde</b>	Biennial	DNER	1975		Done		*a		14
<b>Liverpool</b>	Biennial	DNER	1976		Done		Done		32
<b>Mary</b>	Biennial	DNER	1984	Done		Done		Done	23
<b>McArthur</b>	Irregular	DNER	1979					Done	4 <sup>*b</sup>
<b>Roper</b>	Irregular	DNER	2000			Done			3 <sup>*b</sup>
<b>South Alligator</b>	Annual	Parks Australia	1977	Done	Done	Done		Done	26
<b>Tomkinson</b>	Biennial	DNER	1976		Done		Done		32
<b>Victoria</b>	Irregular	DNER	1987			Done			7 <sup>*b</sup>
<b>West Alligator</b>	Annual	Parks Australia	1977		Done			*c	22
<b>Wildman</b>	Annual	Parks Australia	1978			Done		*c	23

\*a Survey was scheduled but cancelled as the traditional owner denied access to their river.

\*b Surveyed by different methods (e.g. helicopter) on many other years.

\*c The whole sections were not surveyed.



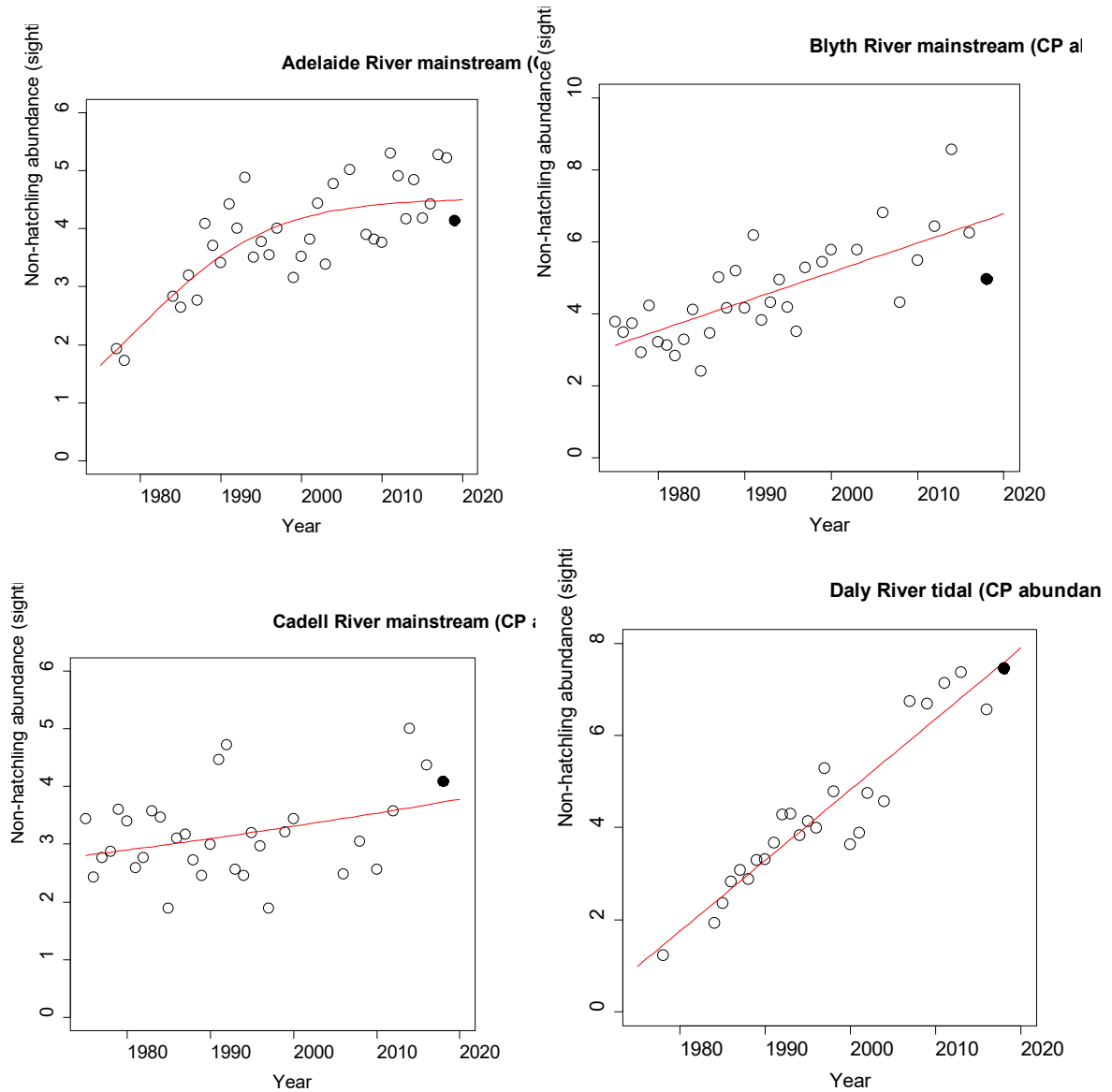
DENR monitors eight rivers (Adelaide, Blyth, Cadell, Daly, Glyde, Liverpool, Mary, and Tomkinson Rivers) on regular basis (Table 1). Each of these river is surveyed biennially except for the Adelaide River, which is monitored annually. Parks Australia surveys four rivers (East Alligator, South Alligator, West Alligator, and Wildman Rivers) in the KNP mostly annually.

In addition to the eight rivers regularly surveyed, DENAR surveyed the Roper River and Victoria River in 2017 and the McArthur River in 2019. The Roper and Victoria Rivers had not been surveyed since 2001 and 2002, respectively. The McArthur River had not been surveyed, using the standardised spotlight survey method, since 1986. Although these rivers do not require reporting under the Management Program (Saalfeld et al. 2016), their results are included in this report. The trend of these populations could not be identified due to their insufficient sample sizes.

## RESULTS

### *Abundance density*

Most of the monitored rivers showed increasing (linear or exponential) or stable (logistic) populations (Figures 2 and Tables 1). The Adelaide, East Alligator, Liverpool, Mary, South Alligator, West Alligator, and Wildman Rivers showed signs of reaching or having reached an asymptote. The Blyth, Cadell, Daly, Glyde, and Tomkinson Rivers appeared to be still increasing.



**Figure 2.** Abundance density (number of non-hatchlings sighted per kilometre of river surveyed) for each of the monitored rivers in the NT. Closed symbol is the latest survey. Red line is the trend predicted by the best supported model (see Table 2).

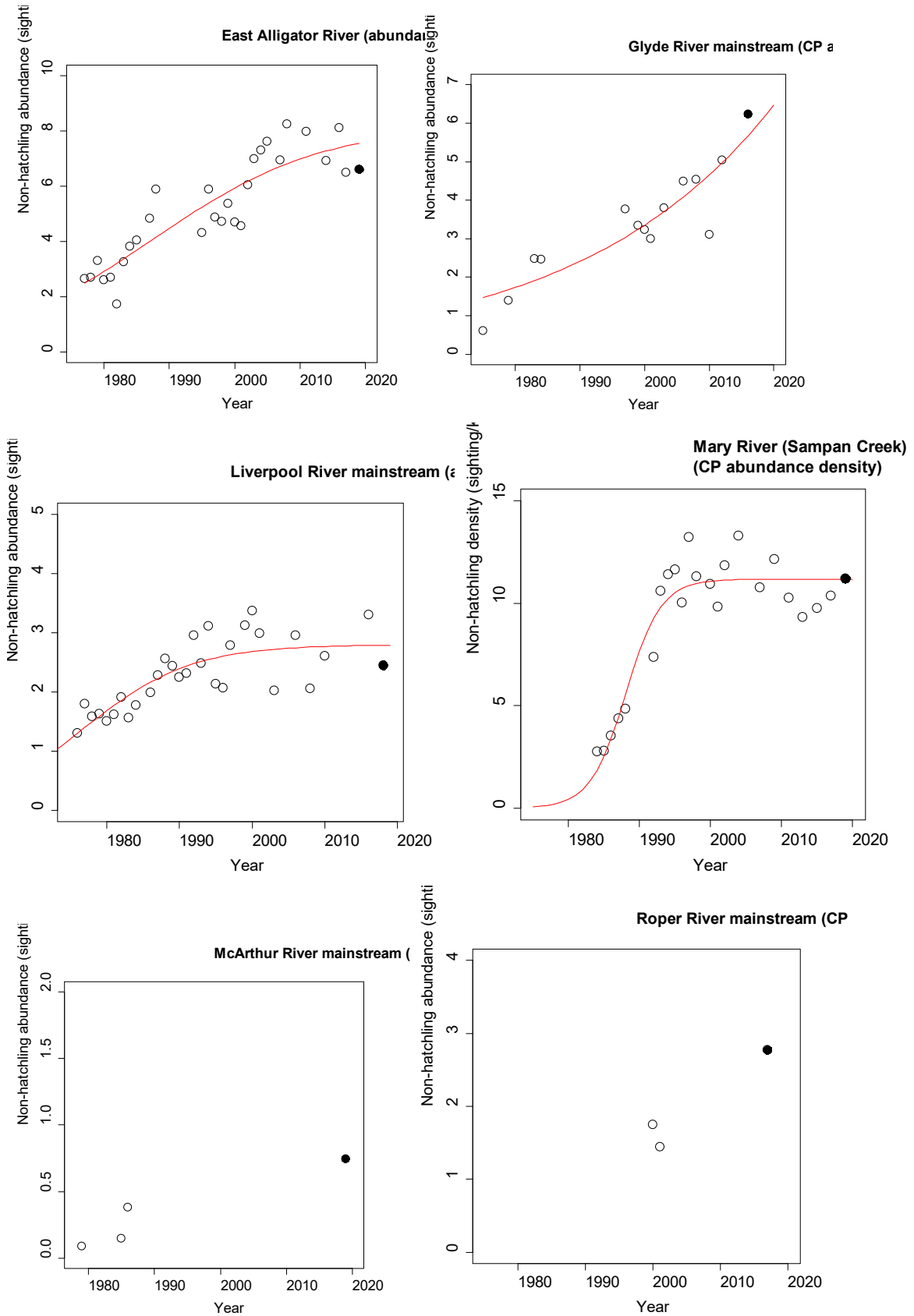


Figure 2 cont.

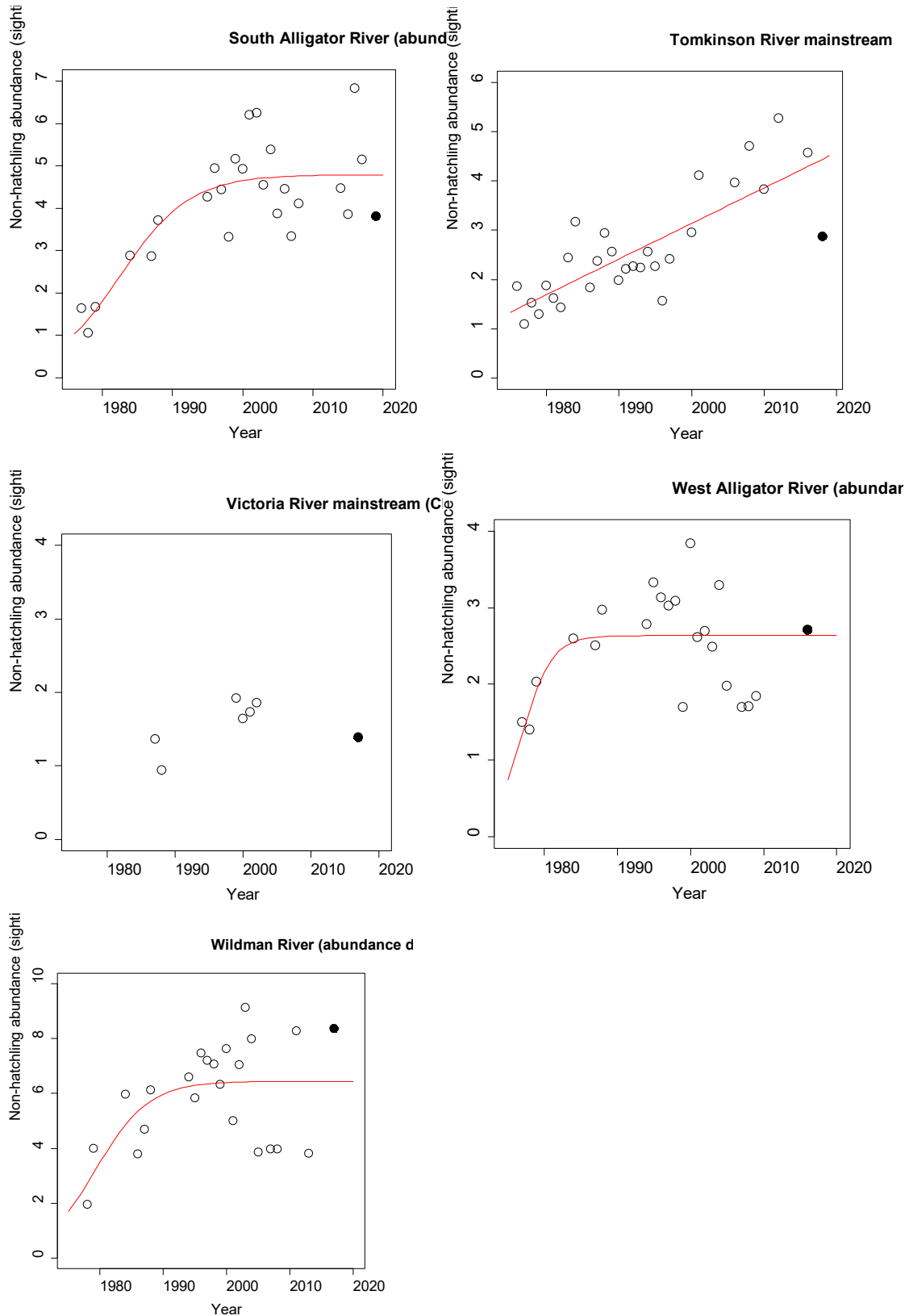


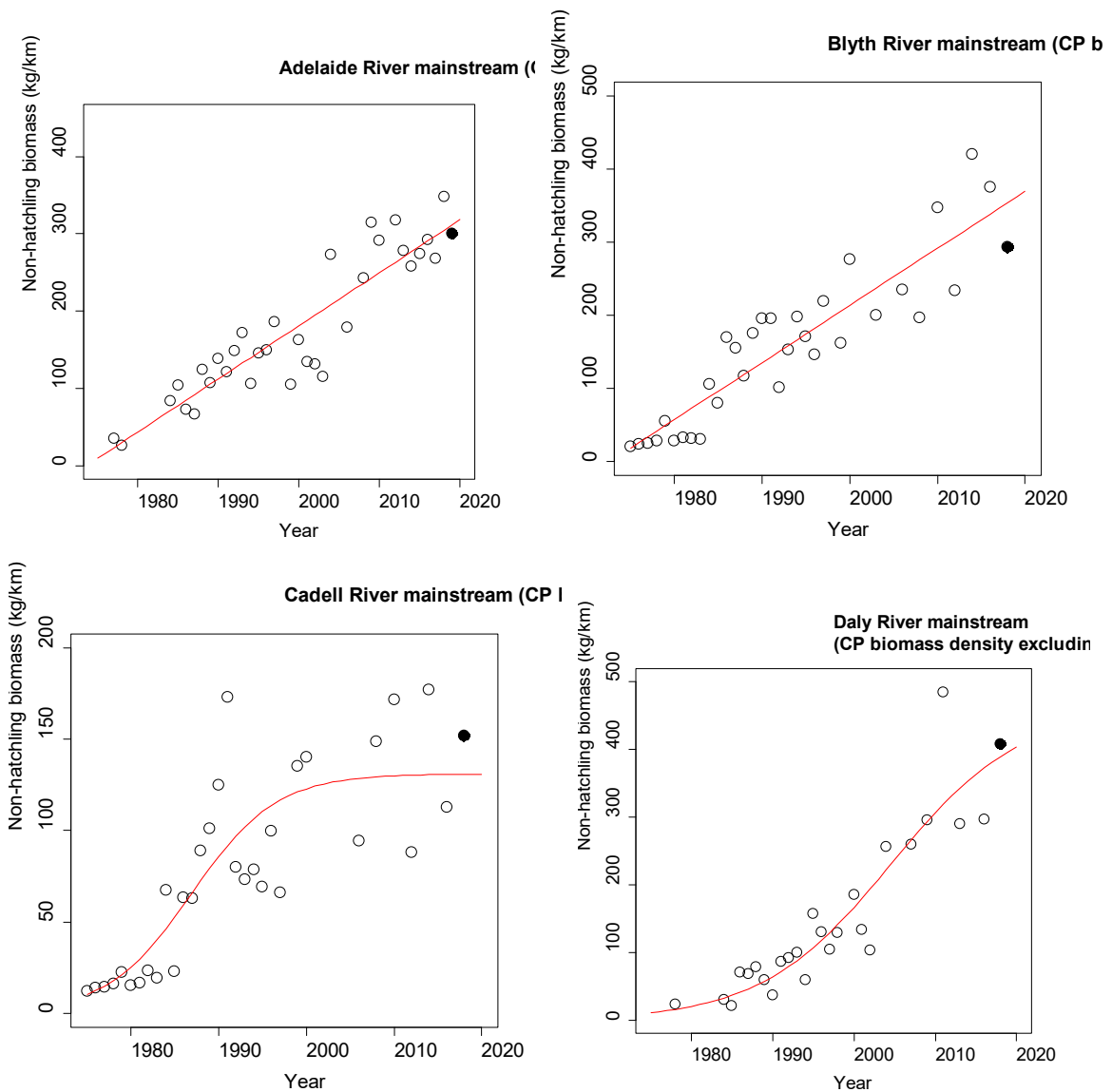
Figure 2 cont.

**Table 2.** Model selection statistics for the models fitted to the abundance density (number of non-hatchlings sighted per kilometre of river surveyed) for each of the monitored rivers in the NT.  $N$  = number of years surveyed,  $AICc$  = Akaike Information Criteria corrected for small sample size,  $\Delta_i$  = difference in  $AICc$  with the best supported model, and  $w_i$  = Akaike Weight.

River	Year ( $N$ )	Model	$AICc$	$\Delta_i$	$w_i$
Adelaide River	1977-2019 (35)	Logistic	62.40	0.00	78.25
		Exponentia	67.69	5.29	5.56
		Linear	65.55	3.15	16.18
Blyth River	1975-2018 (33)	Logistic	91.99	2.11	17.02
		Exponentia	90.60	0.72	34.10
		Linear	89.88	0.00	48.88
Cadell River	1975-2018 (32)	Logistic	-	-	-
		Exponentia	65.69	0.00	53.24
		Linear	65.95	0.26	46.76
Daly River	1978-2018 (26)	Logistic	51.10	3.72	13.11
		Exponentia	54.12	6.73	2.90
		Linear	47.38	0.00	84.00
East Alligator River	1977-2019 (29)	Logistic	79.91	0.00	53.87
		Exponentia	86.00	6.09	2.57
		Linear	80.34	0.43	43.56
Glyde River	1975-2016 (14)	Logistic	--	--	--
		Exponentia	30.71	0.00	51.87
		Linear	30.86	0.15	48.13
Liverpool River	1976-2018 (30)	Logistic	30.61	0.00	95.79
		Exponentia	39.81	9.20	0.96
		Linear	37.38	6.77	3.25
Mary River (Sampan Creek)	1984-2019 (23)	Logistic	78.02	0.00	>99.9
		Exponentia	114.4	36.4	<0.01
		Linear	111.8	33.8	<0.01
South Alligator River	1977-2019 (25)	Logistic	69.36	0.00	97.88
		Exponentia	80.21	10.8	0.43
		Linear	77.49	8.12	1.69
Tomkinson River	1976-2018 (29)	Logistic	62.60	1.84	21.01
		Exponentia	62.16	1.40	26.18
		Linear	60.76	0.00	52.81
West Alligator River	1977-2016 (22)	Logistic	44.49	0.00	76.88
		Exponentia	48.32	3.83	11.30
		Linear	48.23	3.75	11.82
Wildman River	1978-2017 (23)	Logistic	92.73	0.00	55.40
		Exponentia	94.79	2.06	19.78
		Linear	94.33	1.61	24.82

**Biomass density**

As in the abundance density, the monitored rivers showed increasing (linear or exponential) or stable (logistic) populations (Figures 3 and Tables 3). The Cadell, Daly, East Alligator, Glyde, Mary, South Alligator, Tomkinson, and West Alligator showed signs of reaching or having reached an asymptote. The Adelaide, Blyth, Liverpool, and Wildman Rivers appeared to be still increasing.



**Figure 3.** Biomass density (kilogram of non-hatchlings sighted per kilometre of river surveyed) for each of the monitored rivers in the NT. Closed symbol is the latest survey. Red line is the trend predicted by the best supported model (see Table 3).

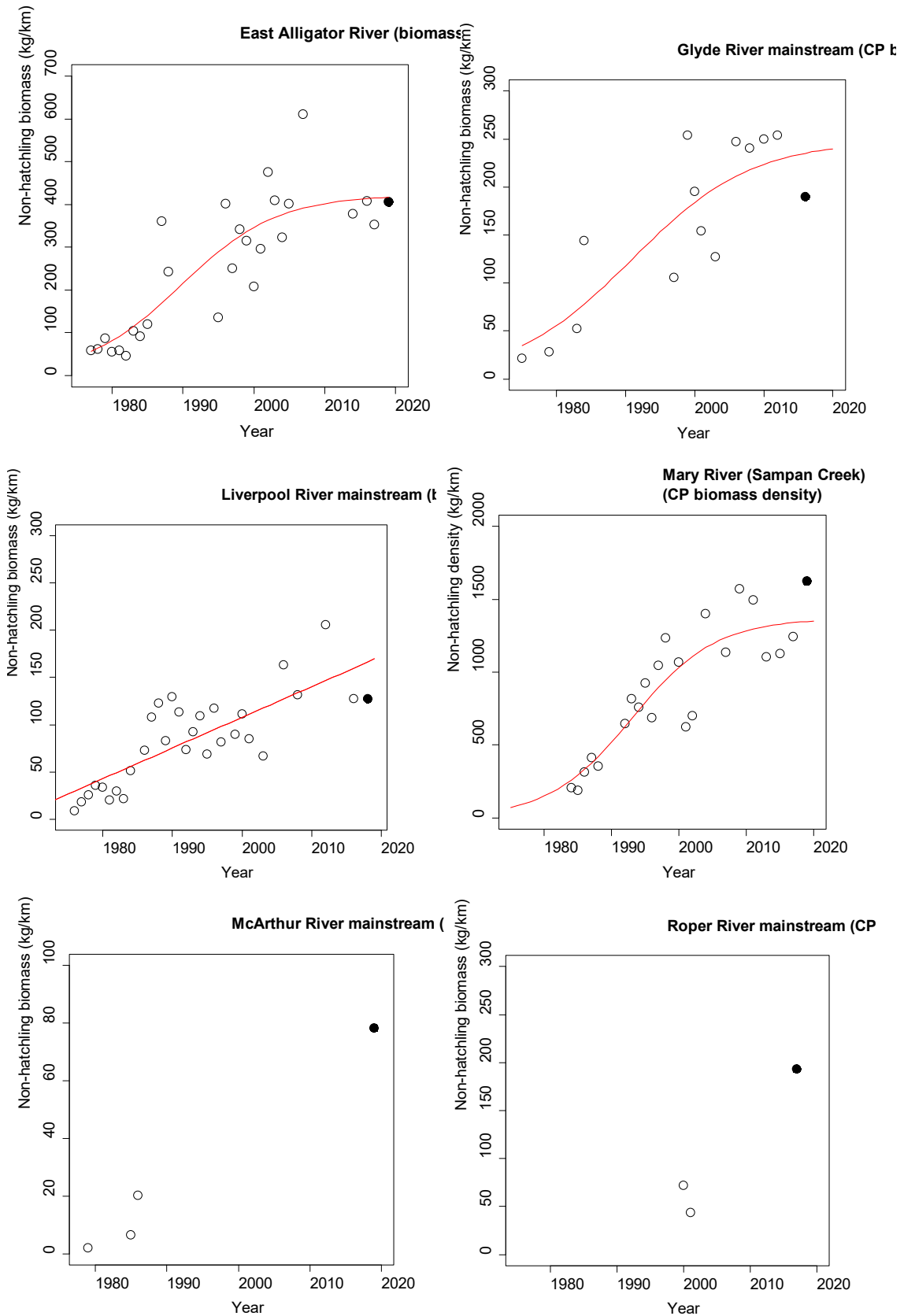


Figure 3 cont.

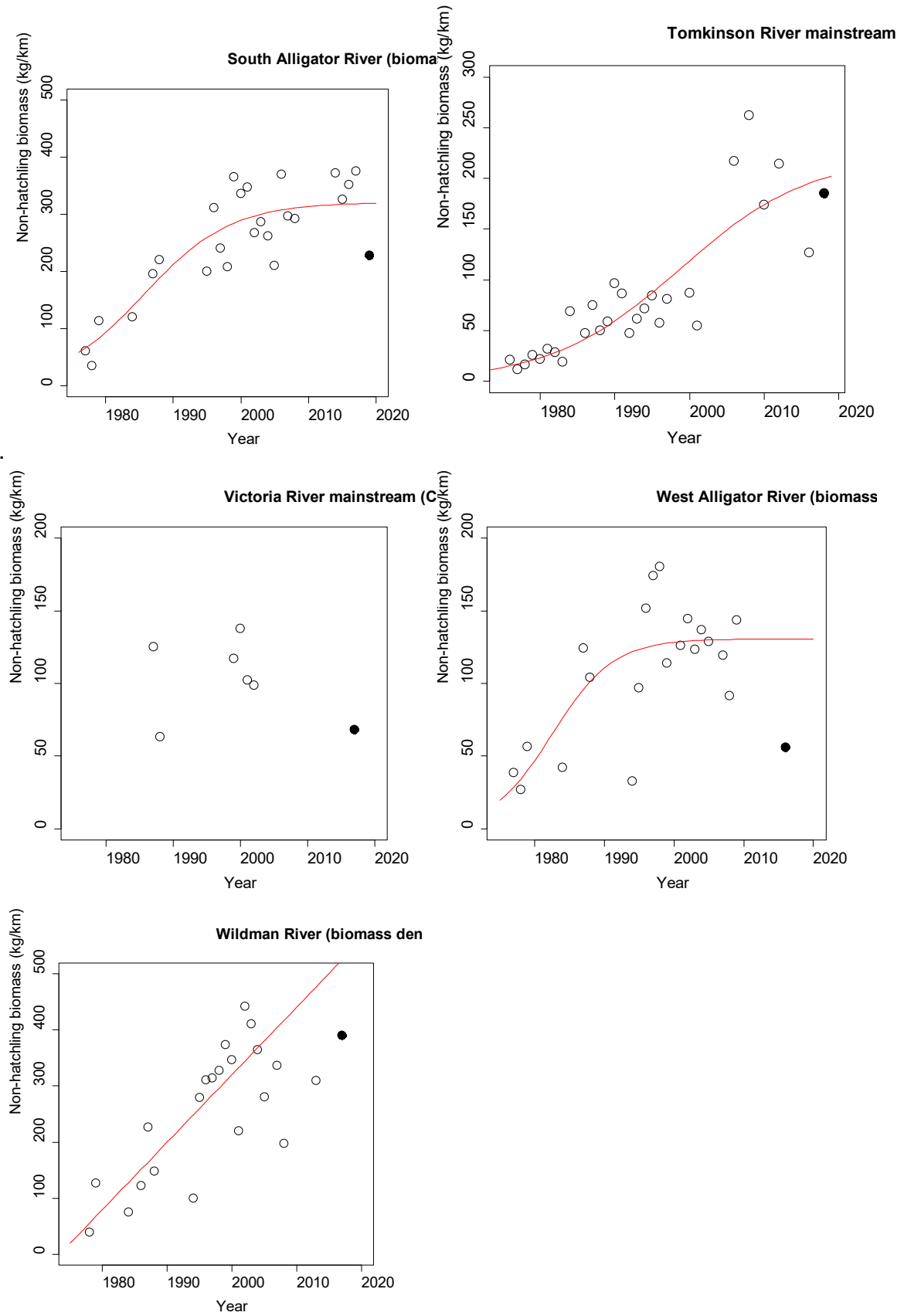


Figure 3 cont.



**Table 3.** Model selection statistics for the models fitted to the biomass density (kilogram of non-hatchlings sighted per kilometre of river surveyed) for each of the monitored rivers in the NT.  $N$  = number of years surveyed,  $AICc$  = Akaike Information Criteria corrected for small sample size,  $\Delta_i$  = difference in  $AICc$  with the best supported model, and  $w_i$  = Akaike Weight.

River	Year (N)	Model	AICc	$\Delta_i$	$w_i$
Adelaide River	1977-2019 (35)	Logistic	347.20	1.49	24.82
		Exponential	347.36	1.64	22.98
		Linear	345.72	0.00	52.20
Blyth River	1975-2018 (33)	Logistic	353.84	5.53	<0.01
		Exponential	358.70	10.39	<0.01
		Linear	348.31	0.00	>0.99
Cadell River	1975-2018 (32)	Logistic	312.08	0.00	82.48
		Exponential	-	-	-
		Linear	315.18	3.10	17.52
Daly River	1978-2018 (26)	Logistic	280.65	0.00	75.86
		Exponential	284.33	3.68	12.05
		Linear	284.32	3.67	12.09
East Alligator River	1977-2015 (25)	Logistic	321.20	0.00	81.71
		Exponential	331.58	10.38	0.46
		Linear	324.25	3.04	17.83
Glyde River	1975-2016 (14)	Logistic	153.75	2.43	0.23
		Exponential	--	--	--
		Linear	151.32	0.00	0.77
Liverpool River	1976-2018 (30)	Logistic	291.70	0.66	40.60
		Exponential	297.02	5.98	2.84
		Linear	291.04	0.00	56.56
Mary River (Sampan Creek)	1984-2019 (23)	Logistic	307.14	0.00	87.45
		Exponential	317.06	9.93	0.61
		Linear	311.12	3.98	11.94
South Alligator River	1977-2019 (25)	Logistic	272.53	0.00	94.82
		Exponential	283.88	11.35	0.33
		Linear	278.47	5.94	4.86
Tomkinson River	1976-2018 (29)	Logistic	292.35	0.00	52.43
		Exponential	296.94	4.59	5.27
		Linear	292.78	0.43	42.29
West Alligator River	1976-2016 (22)	Logistic	230.48	0.00	79.88
		Exponential	235.43	4.94	6.75
		Linear	234.06	3.58	13.37
Wildman River	1976-2017 (23)	Logistic	303.82	2.38	16.23
		Exponential	302.57	1.13	30.34
		Linear	301.43	0.00	53.43

## DISCUSSION

Some rivers that supported the logistic pattern in the abundance or biomass density seem to have reached an asymptote which is considered the carrying capacity of each population. The level of maximum carrying capacity is different among the populations, depending on the quality of each river as suitable habitat (Fukuda *et al.* 2007; Fukuda and Cuff 2013). Saturated population typically shows fluctuation around an asymptote rather than staying at equilibrium (Caughley 1977). This is evident in the crocodile densities in recent years. Mary River is a good example of the populations that are considered fully recovered in terms of both abundance and biomass from the uncontrolled hunting (1945-1971) (Figures 2 and 3).

Other rivers showed ongoing increase in the abundance density. Like the maximum carrying capacity, the rate of increase considerably varies between the populations, depending on the limited resources such as breeding habitats (Fukuda *et al.* 2007; Fukuda and Cuff 2013). Some rivers such as the Cadell, McArthur, Roper, and Victoria Rivers had an increase much slower than others (Figure 2). Given that these rivers were not harvested heavily before protection (1971) and the current harvest intensity for eggs is very low (DENR unpublished data 2019), it may be reflecting the natural attributes of the population rather than recovery from previous hunting. These populations are likely to stay stable rather than increasing or decreasing dramatically. In contrast, rivers with quality habitats such as the Daly and Glyde Rivers show high rates of increase without reaching an asymptote (Figure 2). However, this is interpreted as indication that the population is still approaching a stable state at levels thought to be close to those before the hunting.

In the case of biomass density (Figure 3), continuous increase indicates that individual crocodiles are getting larger even in rivers where the number of crocodiles has reached a ceiling (eg. the Adelaide River). This is consistent with the ongoing maturing of a population of a large, slow growing species recovering from substantial, unregulated harvest (Messel *et al.* 1981; Russ and Alcala 1996; Russ and Alcala 2004). It should be noted that biomass density could fluctuate drastically because of the presence or absence of a very large individual as their large mass can heavily affect the total biomass of crocodiles sighted (eg. 5.1-m crocodile can weigh over 500 kg). Given that there is no commercial harvest allowed in the West Alligator River, the decline in 2017 would be an example of this sensitivity (Figure 3).

Overall, the monitored populations showed different patterns of increase in the number and biomass of crocodiles, depending on the availability of quality habitats within each river, rather than the impact of the current, regulated harvest. The different rates of increase and carrying capacities, in response to the environmental quality, will determine the population size and the size structure at maturation. Survey results to date suggest that some rivers (eg. Mary River, East, South, and West Alligator Rivers) seem to have reached a ceiling in both the number and biomass of crocodiles. Although considered approaching close to an asymptote, other rivers are still increasing at different rates in the abundance, biomass, or both.

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## APPENDIX 2. PRODUCTION STATISTICS FROM CROCODILE FARMS (2017-20187)

*C. porosus* stock and production on farms in the Northern Territory for 2016/2017 are summarised in Table 11.

**Table 11:** *C. porosus* held on farms in the Northern Territory in 2016/2017. Total acquired includes farm bred hatchlings, ranched hatchlings and purchases/imports from other farms. Total lost includes crocodiles processed, sales/exports to other farms, escapes and mortality.

Farm	Stock held 1/02/2016	Farm- bred hatchlings	Total acquired	Crocodiles processed	Total lost	Stock held 31/01/2017
A	14,972	0	8,681	5,289	1,165	17,199
B	2,315	50	2,311	1983	454	2,239
C	21,394	356	19,972	4048	13,393	24,281
D	5,150	160	7,111	7406	185	4,830
E	3,260		3082	752	627	4,963
F	47,857	3,524	12,015	0	22,712	40,684
G	70				11	59
H	6,454				0	6,000
I	0		648		15	633
J	189		175	164	58	142
K	0				0	0
<b>Totals</b>	101,661	4,090	53,995	19,642	38,620	101,030

### APPENDIX 3. 2018/19 REPORTING AGAINST ANNUAL MILESTONE MATRIX

Milestone	Program Reference	2018/19	Status for 2018/19 Monitoring report
Ensure the harvest ceiling is set in accordance with the Plan.	3.1.2 Harvest review.	Annually	Done. Compliant. Standard part of permit assessment process.
Investigate and take appropriate action on all suspected local impacts on the population.	3.1.2 Harvest review.	Ongoing	Done. Compliant. No reported or identified local impacts.
Exempt manufactured items from the provisions of the <i>TPWC Act</i> .	3.1.4 Permits and compliance.	Complete	
Investigate amendment of the <i>TPWC Act</i> to allow for the commercial licencing of crocodile farms.	3.1.4 Permits and compliance.	Commence	Identified as part of review of <i>TPWC Act</i> , review ongoing.
Ensure that the annual commercial harvest of Saltwater Crocodiles does not exceed the approved ceiling.	3.1.4 Permits and compliance.	Annually	Done. Compliant. Standard part of permit assessment process.

Milestone	Program Reference	2018/19	Status for 2018/19 Monitoring report
Assess applications and issue permits under the <i>TPWC Act</i> .	3.1.4 Permits and compliance.	Ongoing	All permits applications were assessed. Eggs were allocated across the harvest regions as per the WTMP. 2019 represented a major renewal of multi-year permits for 2019/20 forward.
Monitor and audit harvest applications, approvals and returns and investigate and resolve any discrepancies.	3.1.4 Permits and compliance.	Ongoing	Compliant across all categories.
Ensure all permit applications have correct landholder approval.	3.1.4 Permits and compliance.	Ongoing	Compliant. Standardised assessment process.
Conduct random checks on eggs and farm stock numbers.	3.1.4 Permits and compliance.	Ongoing	Compliant; Checks of 3 farms in 2019 by DNRE Wildlife Use.
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	3.1.4 Permits and compliance.	Ongoing	Compliant; No reported breeches.

Milestone	Program Reference	2018/19	Status for 2018/19 Monitoring report
Address any permit breaches through warning letters, caution notices, infringement notices, permit cancellation or prosecution.	3.1.4 Permits and compliance.	Ongoing	Compliant. All reported matters investigated and either ongoing or resolved.
Continue the population survey program as described in this Plan.	3.1.5 Monitoring	Annually	Compliant. 2019 surveys undertaken and completed by end September 2019, data analysed and reported.
Analyse and assess the results of the survey program and implement any management recommendations.	3.1.5 Monitoring	Annually	2019 survey data analysed and reported. No significant deviation from long-term population trends identified.
Ensure the requirements of the Code of Practice are a condition on all permits and that a copy of the Code is distributed to all new permit holders	3.1.6 Animal welfare	Ongoing	Compliant. Standard permit condition for all harvest and problem crocodile permits.
Ensure all successful permit applicants are competent to comply with the relevant animal welfare standards.	3.1.6 Animal welfare	Ongoing	All permit applicants, nominees and authorised persons must provide evidence of competence with application. Subject to review by authorising officer.
Investigate and take appropriate action on any suspected breaches of the <i>Animal Welfare Act</i> .	3.1.6 Animal welfare	Ongoing as needs	No reported animal welfare matters requiring action by DIPR Animal Welfare Officers.



Milestone	Program Reference	2018/19	Status for 2018/19 Monitoring report
Annually audit the progress of the Plan against each of the performance indicators and adjust management practices as necessary.	3.1.7 Reporting	Annually	Compliant. Additional review done as part of WTMP renewal.
Submit annual reports to the Australian Government and provide a summary on the Northern Territory Government website.	3.1.7 Reporting	December 2018	Non-compliant. Annual report not submitted till September 2020. Workloads, Covid-19 impacts plus requirement to review and refresh WTMP all contributed to delays.