

# **NT SALTWATER CROCODILE (*Crocodylus porosus*) WILDLIFE TRADE MANAGEMENT PLAN: 2017-2018 Monitoring Report**

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## Summary

The Wildlife Trade Management Plan for the Saltwater Crocodile (*Crocodylus porosus*) in the Northern Territory of Australia, 2016 – 2020, requires annual reporting on the implementation of the Wildlife Trade Management Plan. This monitoring report reviews the performance in 2017/2018 period with data for the preceding years included within the report.

In 2017-18, revenue from the NT's crocodile industry rose 2.8% to \$23.7 million. The industry economic value has been stable in recent years averaging over \$20 million pa and is an important source of employment and resources for regional communities.

Northern Territory Department of Environment and Natural Resources (DENR) conducted spotlight surveys in 3 out of 8 monitoring rivers (3 scheduled) in 2018. Parks Australia North surveyed 3 of 4 monitoring rivers in Kakadu National Park in August / October / November 2018. The results of the surveys were consistent with recent trends showing either stable (believed to have reached an asymptote) or increases in numbers and continual increase in biomass (more larger crocodiles observed). Monitoring will continue in 2019 as per the current Management Program.

A total of 335 problem crocodiles were removed from the wild in 2017/2018 by DTSC Wildlife Operations staff for public safety and to protect stock in pastoral areas, of which 77% were males and 82% were caught in the Darwin Harbour. The number taken is the highest for a number of years but it is not yet clear whether this part of the natural variability or a longer-term upward trend.

DTSC continues to promote community awareness for safety and participation through CROCWISE campaign programs using a variety of media. Wildlife Operations staff within DTSC completed 102 Be Crocwise activities including school presentations in remote communities, United States military presentations and community presentations at public events that were attended by 17,500 people in 2017/2018.

Under the ceiling of 90,000 viable eggs, 77,000 viable eggs were allocated to harvest, but only 44,940 viable eggs were collected in 2017/2018. All indications are that current harvest of eggs is well within sustainable levels.

Under the harvest ceiling of 1,200 non-hatchling crocodiles provided in the Wildlife Trade Plan, 39 live crocodiles were reported as harvested in 2017/2018. The majority of reported live harvested crocodiles were adult animals and strongly biased to male crocodiles (81.1%). The average body size of the harvested animals was about 2.40 metres for females and 3.53 metres for males.

The total number of crocodiles harvested is known to be an underestimate due to a number of harvest permits being multiyear 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 was well below the 1,200 threshold identified in the WTMP.

10 crocodile farms operated in 2017/2018 in the Northern Territory with a further farm being inactive. Farm production data of 10 farms for the period 1 February 2017 to 31 January 2018 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 Northern Territory went to Queensland.

Permit compliance and animal welfare was closely monitored and inspected by DENR, DTSC and the Northern Territory Department of Primary Industry and Resources (DIPR). No significant permit compliance or animal welfare matters were reported in 2016/2017. A small number of minor permit compliance matters were dealt with by warning letter and two harvested crocodiles were surrendered by the catcher as they were above the annual permit limit for the harvest area.

## 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 of the sustainable use and conservation of the Saltwater Crocodile (*Crocodylus porosus*) in this jurisdiction. The WTMP was approved by the Minister for the Environment and Energy as an Approved Wildlife Trade Management Plan under Subsection 303FO(3) of the *Environment Protection and Biodiversity Conservation Act 1999* on 21 December 2015.

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 governance and program support is reported annually to the Australian Government Department of Environment and Energy (DEE). This monitoring report reviews the implementation and performance of the WTMP in 2017/2018.

The WTMP seeks to manage the Saltwater Crocodile for the benefit of Territorians while ensuring the long-term conservation of the species and its habitats in the Northern Territory: In achieving this aim two general principles are applied:

1. Management and regulatory decisions should be evidence-based, supported by high-quality scientific data and robust monitoring;
2. The treatment of saltwater crocodiles must be humane and in accordance with the requirements of Animal Welfare legislation, and adhere to The Code of Practice on the Humane Treatment of Wild and Farmed Australian Crocodiles.

The reporting requirements are outlined in Section 3.1.7 of the WTMP. The status of each milestone as defined as annual actions and performance measures (Section 3.4) in the WTMP is summarised in Appendix 1.

## POPULATION MONITORING

The results of the population surveys are provided in Appendix 2 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.

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.

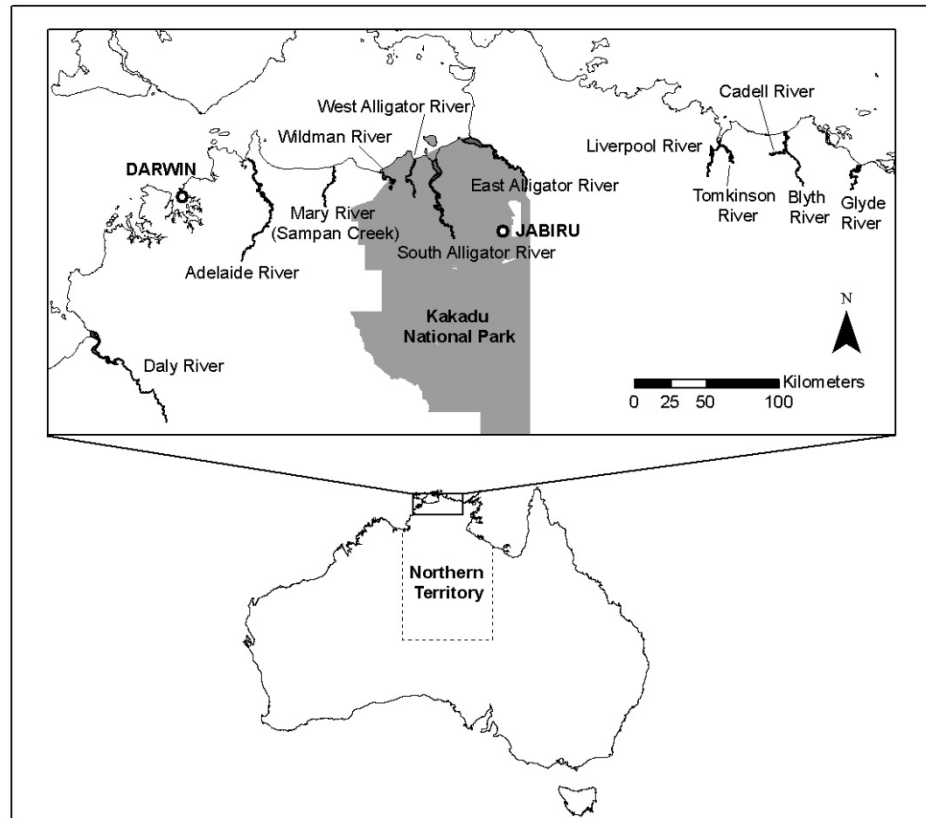


Figure 1 Rivers surveyed to monitor *C. porosus* populations in the Northern Territory.

## General trends

Results from modelling of monitoring program 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). Consistent with previous monitoring reports, the analyses of the most recent surveys indicate that the rate of increase of crocodile populations in many rivers is slowing or approaching an asymptote. Most of the monitored rivers have shown large increases since protection and some have stabilised at an asymptote in recent years. Analysis of each individual river is provided in Appendix 2 including an update of the relevant rivers surveyed in the 2018 period. 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 of any of important determinants of population processes (recruitment, dispersal, adult survivorship etc.).

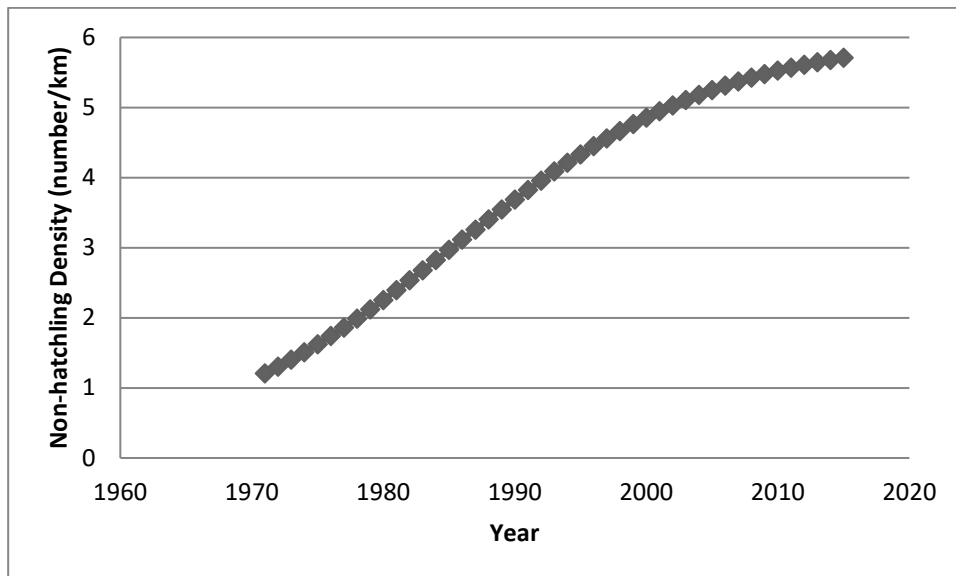


Figure 2 Modelled abundance density of non-hatchling (>0.6 m, including eyes-only) of *C. porosus* calculated from standardised spotlight surveys in 12 tidal rivers since 1975.

## Size Structure

Results indicate that the size structure of the crocodile population appears to be shifting from smaller crocodiles to a higher proportion of larger crocodiles with an associated large increase in biomass in recent years (Appendix 2). This is consistent with the ongoing maturing of a population of a large, slow growing species recovering from substantial unregulated harvest. Analysis of each individual river is provided in Appendix 2.

As previously reported the recent monitoring data indicate a shift in the size structure of the crocodile population from smaller to larger crocodiles compared with immediately post-protection and through the 1980s, 1990s and early 2000s (Figure 3). 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.

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 2017/2018 and at this juncture no requirement for management intervention. A more detailed review of the changes in population structure, incorporating 2019 survey data is planned in the lead up to the next five year review of the MPSC.

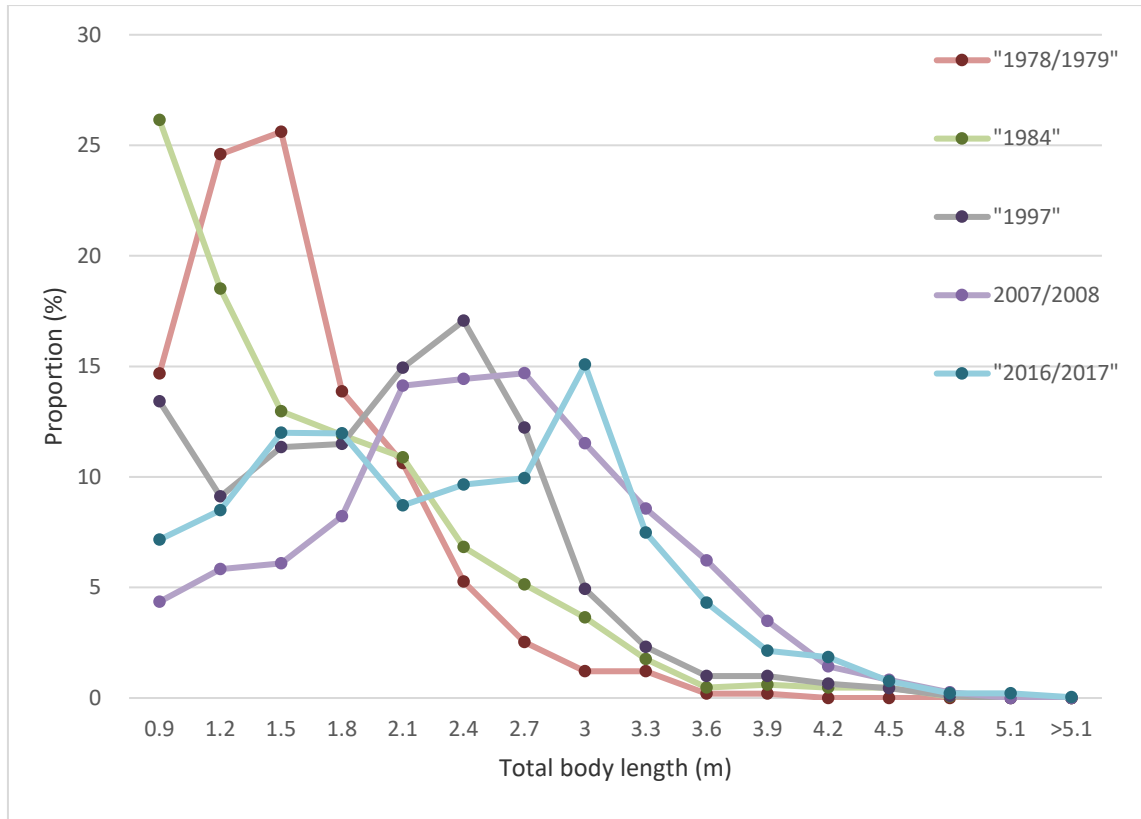


Figure 3 Changes in proportion (%) of saltwater crocodiles at each size class from 0.3 - >5.1 m (1 - >17 ft) in 12 monitored rivers combined in the Northern Territory, Australia between 1978 and 2016/2017.

## PROBLEM CROCODILES

Problem crocodiles are defined broadly as those individuals that occur within settled areas or areas of recreational use, where public safety is a prime consideration; and 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. These areas are intensively managed through an active trapping and surveillance program by DTSC Wildlife Operations staff to maintain a very low crocodile density. DTSC also responds to reports of problem crocodiles on a case by case basis. Darwin Harbour and Katherine River have detailed management strategies with defined zones and specific management actions to remove crocodiles.

### Removal of Problem Crocodiles by PWC

The Northern Territory Government removes problem crocodiles from specific problem crocodile management zones in the Northern Territory: 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 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 335 problem crocodiles was removed between July 2017 and June 2018 (Table 1, Figure 5). This represents the highest recorded number of removals; however, whether this is part of a longer term increasing trend or reflection of recent year to year variation is not yet clear. Other factors such as catching effort and improved targeting of priority areas also needs to be taken into account.

Four fifths of these animals were removed from Darwin Harbour, a further 52 removed from the greater Darwin area and a few animals from the Katherine and Borroloola area and other communities.

Problem crocodiles removed by DTSC staff are made available to Northern Territory crocodile farms through a tender process with the vast majority (>95%) sold under this arrangement.

*Table 1 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 2017/2018.*

<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%

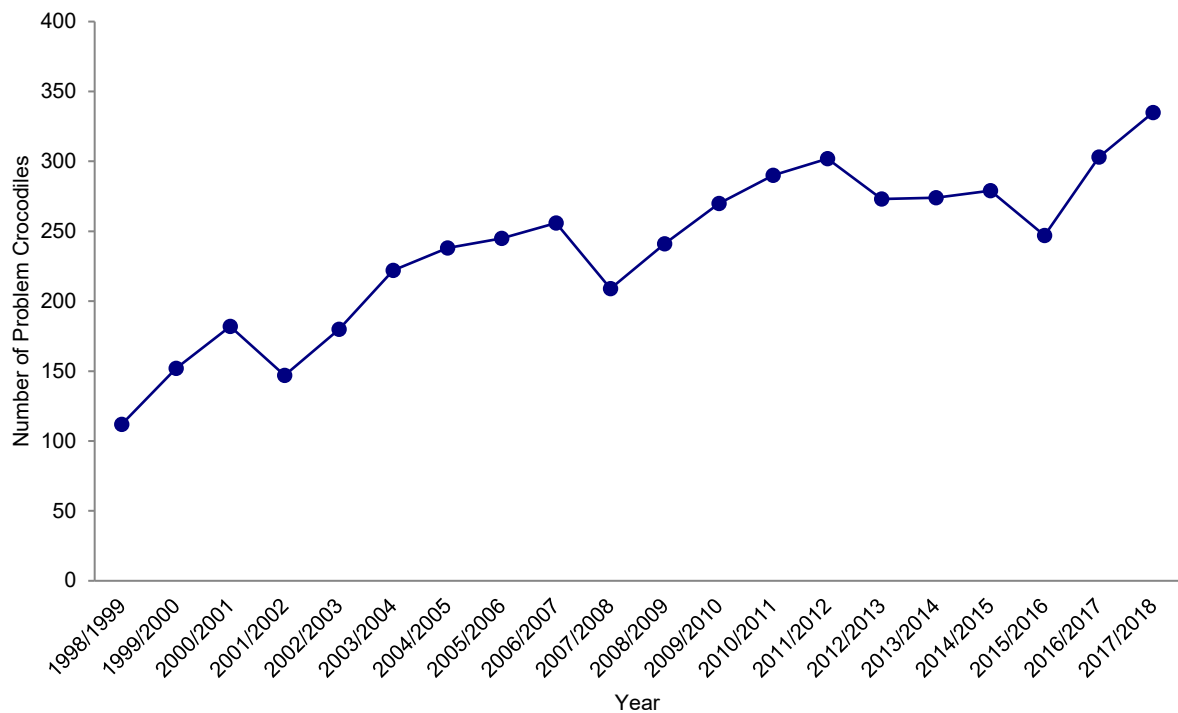


Figure 4 Changes in the numbers of problem *C. porosus* removed by DTSC staff in 1998/1999 – 2017/2018.

## Community Awareness and Participation

The Northern Territory Government promotes crocodile awareness among residents and visitors by disseminating educational information through the CROCWISE strategy. Public awareness campaigns continues 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, and park ranger talks are avenues to further disseminate messages in a face-to-face setting. DTSC staff also visits local schools and run competitions to deliver the educational program to teachers and children. Signs are placed at popular water entry points to reduce risks associated with crocodiles. 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. Wildlife Operations staff within DTSC completed 102 Be Crocwise activities including school presentations in remote communities, United States military presentations and community presentations at public events that were attended by 17,500 people in 2017/2018.

## 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 those in the WTMP.

The number of eggs permitted to be harvested has been maintained below the harvest ceiling in all years (Table 2). As in previous years, the harvest in 2017/2018 was lower than the number of eggs permitted and this was consistent across all permits; however, the larger operators took generally between 75 to 95% of their allotted quota per permit. Egg collection permits in 2017/2018 were predominantly under five year permits covering 2014/2015 to 2018/2019 and issued for current harvest allocation quantities. The individual allocations were amended to higher quantities in a couple of harvest areas as requested by landholders/harvesters (net increase of 7,000) but were within the established harvest ceiling and did not result in a significant increase in eggs harvested.

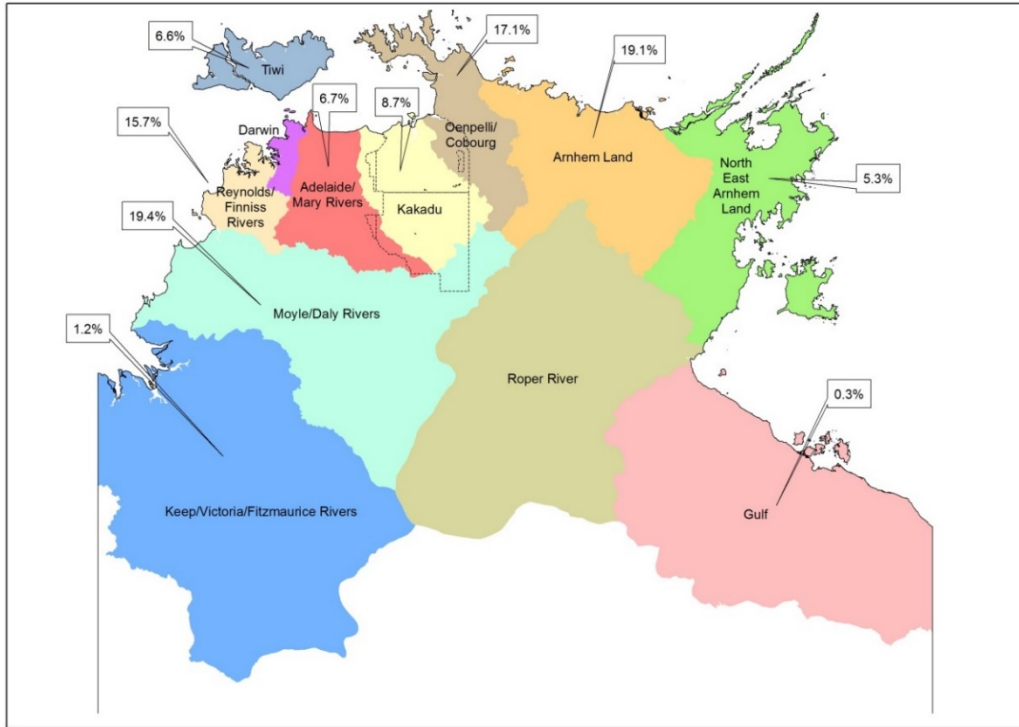
The number of eggs permitted and collected varies between the different regional catchments (Figure 5), depending on a number of factors as outlined in Appendix 1 of the WTMP. The proportion allocated across catchments has been kept broadly similar across the life of the WTMP with some minor modifications based on the additional allocations discussed above. However, the actual numbers taken per region vary from year to year depending on a range of factors (including rainfall driven nesting patterns) changing the relative proportions (Figure 5) but will be below the regional cap in an absolute sense.

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

*Table 2 The number of eggs of C. porosus 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.*

Season	Harvest Ceiling	Eggs permitted	Eggs harvested
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

a)



b)

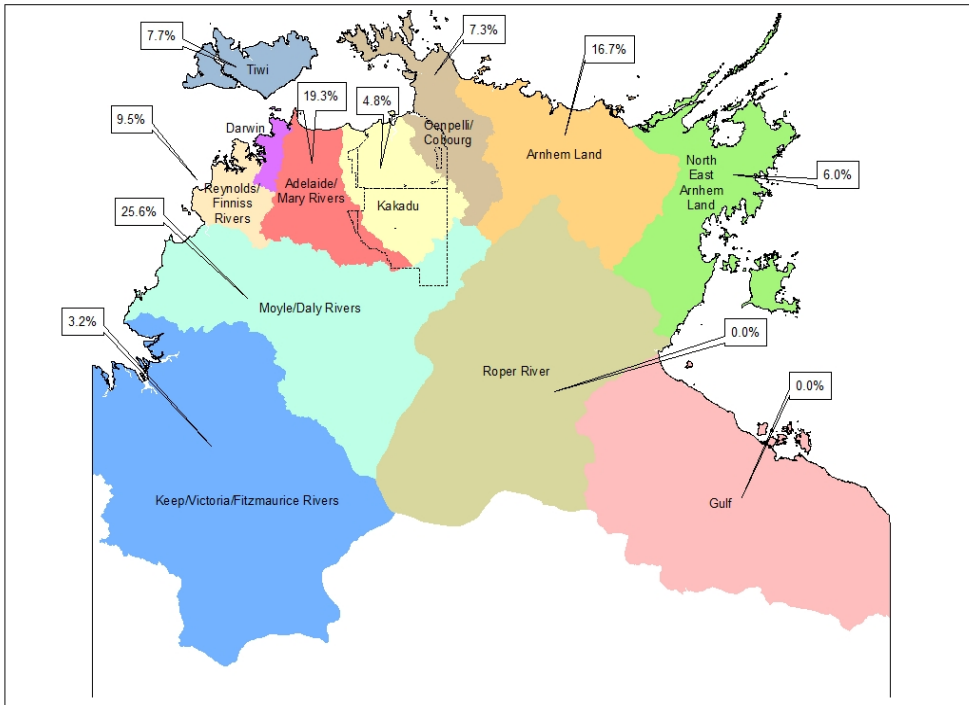


Figure 5 Proportion of *C. porosus* egg harvest per regional catchments in a) 2013/2014 through 2016/2017 and b) 2017/2018, relative to the total NT number of eggs harvested. Note that the boundary of Kakadu regional catchment is different from Kakadu National Park (KNP).

## 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 staff (reported separately in Table 1). 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 a allowed take of 163 adult animals.

A total of 39 non-hatchling *C. porosus* were harvested from the wild in 2017/2018 (Table 3). Variation in the sex ratio of harvested adults is influenced by the harvest purpose; skin and meat harvest, female breeding stock for farms or problem crocodile removal. In 2017/2018 the sex ratio was strongly biased towards males (92.3% (Table 4)), and when coupled with the large average size of harvested males (3.94 m; Table 5), indicates that animals were harvested were predominantly problem animals. Crocodiles were harvested from pastoral properties and aboriginal land. It is not known how many of these animals were harvested as true “problem” crocodiles by private operators because it is often difficult to determine whether the primary aim of the harvest is for public safety and livestock protection or commercial gain for farming. However, discussions with Landholders and Aboriginal Ranger Groups support the idea that most of this harvest relates to strategies to mitigate risk to human safety and/ or minimise livestock losses.

The trend of increasing average size of males most likely reflects both the increasing proportion of larger males in the population and harvest being focused on problem animals or large wild skins. The decrease in average size of harvested females in 2017/2018 probably reflects a focus on sourcing breeding stock for farms in this reporting period.

The number of crocodiles harvested in 2017/2018 as presented in Table 3 is known to be an underestimate of the actual harvest in the 12 month period reported. Nevertheless, the total regulated harvest of live crocodiles from all sources is well below the established limit of 1,200.

*Table 3 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 and 2017/2018.*

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

*Table 4 Proportion of C. porosus harvested for commercial use in 2012/2013, 2013/2014, 2014/2015, 2016/2017 and 2017/2018 that were male.*

Year	Male
2012/2013	0.655
2013/2014	0.735
2014/2015	0.856
2015/0216	0.764
2016/2017	0.811
2017/2018	0.923

*Table 5 Average body size of C. porosus (non-hatchling) for each sex harvested for commercial use in 2012/2013, 2013/2014, 2014/2015, 2015/2016, 2016/2017 and 2017/2018. Small juveniles whose sex was unknown are not included in the figures.*

Year	Female	Male
2012/2013	2.13 m	3.11 m
2013/2014	2.12 m	3.22 m
2014/2015	2.16 m	3.70 m
2015/0216	2.12 m	3.51 m
2016/2017	2.40 m	3.53 m
2017/2018	1.65 m	3.94 m

## 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 required 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. Taken all monitoring data into account along with reported size of the egg and live harvest it is apparent that the existing thresholds are appropriate to ensure no ongoing overharvest.

## FARM PRODUCTION

Ten crocodile farms operated in the Northern Territory in 2017/2018 (Table 6). Time periods used were as for 2016/2018 report (Feb to Jan) reflecting change in reporting period implemented in 2013/14 to be more in line with farm operational cycles. Production data for the period 1 February 2017 to 31 January 2018 are reported here. To better reflect actual numbers of animals held and provide a more realistic estimate of numbers of mortalities, stock held includes only live (hatched crocodiles).

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.

Details of the stock held on each farm for the period 1 February 2017 to 31 January 2018 are provided in Appendix 3.

Table 6 The number of crocodile farms operating in the Northern Territory, showing details of *C. porosus* stock held (2013/2014 to 2017/2018).

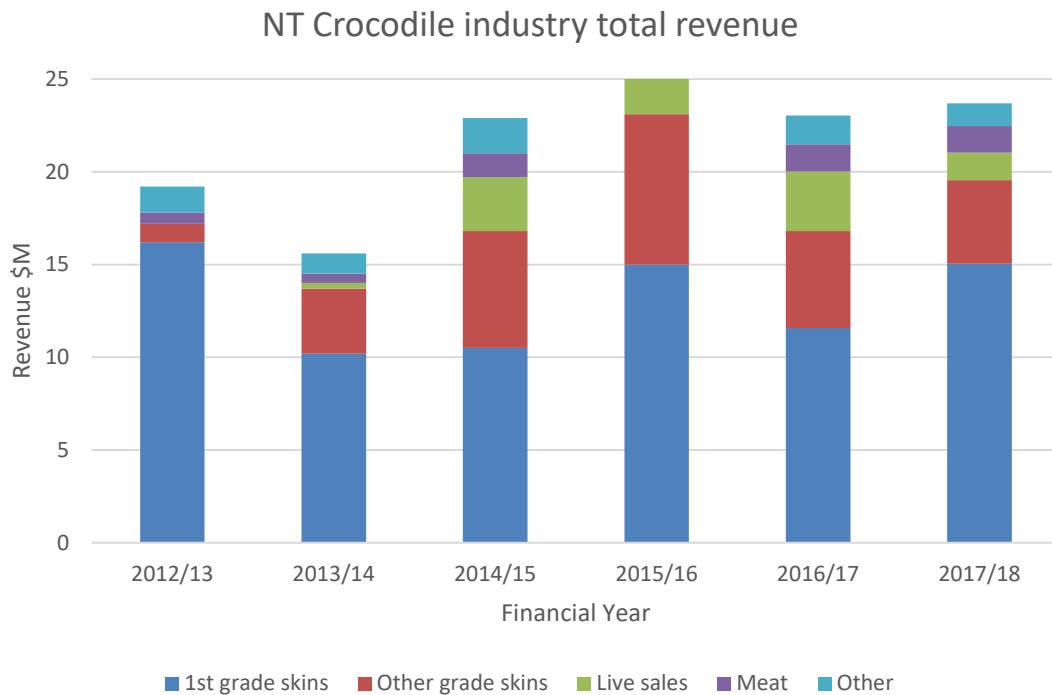
Year	No. of farms	Stock held 1 February	Farm-bred hatchlings	Total acquired	Crocodiles processed	Total Losses (Transfers/ Mortalities/ Unaccounted)	Stock held 31 January
2013/2014	8	114,550	7,497	50,665	17,689	46,572	118,656
2014/2015*	8	118,656	6,877	61,347	14,061	49,632	122,915
2015/0216	9	130,431	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	50,535	7,727	101,030

\* 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

Trends in industry economic return (as measured by reported farm revenue) have been steady at just over \$20 M per annum in recent years (Figure 6). In 2017-18, revenue from the NT's crocodile industry rose 2.8% to \$23.7 million. Stricter grading standards were introduced in 2016-17, 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 2017/18 (Converted into skins or live sales including sales of hatchlings/juveniles to interstate farms). This was down from 42,681 in 2016/17 due to a reduction in lower grade skins and less transfers to interstate farms. Note, the numbers do not compare directly with the Crocodiles processed reported in Table 6 due to different reporting periods.



*Figure 6 Trends in NT Crocodile Industry economic returns (revenue in \$ M) over years 2013/14 to 2017/18. Data are from industry return data to NT Department of Treasury and Finance.*

## PERMITS & COMPLIANCE

The following is a summary of permits and compliance for the 2017/18 egg harvest season:

- A total of 20 individual permits to collect crocodile eggs were in operation.
- For 2017/2018 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 collect the necessary data as specified in the WTMP. The forms were provided both electronically and in hardcopy with each permit as permit conditions.
- There were 6 audits of farm incubators and no field audits of collected nests during the 2017/2018 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 2017/2018 egg collection season from Traditional Owners, property owners or the public.
- Crocodile egg collection permit holders were required to submit final returns for the 2017/2018 crocodile egg collection season (December - May) by 31 July 2017. No warning letters or infringement notices were issued for non-compliance of late submission of returns.
- For the 2017/2018 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 were a high number of instances this season in harvesters needing to postpone planned collection in response to changed weather conditions. No warning letters or infringement notices were required to be 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.
- There was one reported breach (self-reported) of a problem crocodile taking above the annual permit allocation for live crocodiles for a given area. The matter was investigated jointly by DTSC and DENR and concluded with a warning to the permit holder and surrendering of the 2 crocodiles (skulls and prepared skins) that were above the permit quantity.
- Two other reported instances of suspect behaviour by a crocodile harvester/s were investigated by DTSC but no evidence was found to support any formal breach notification.
- There was regular interaction with all other relevant jurisdictions.

## 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.

## ACKNOWLEDGMENTS

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.

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## APPENDIX 1. ANNUAL MILESTONE MATRIX FOR 2016-2020 WTMP

Milestone	Program Reference	2017/18	Status for 2017/18 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.
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.
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 6 farms in 2018 by DNRE Wildlife Use and DTSC Wildlife Ops Staff.
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; One reported (inadvertent) breach of non-compliance by crocodile harvest permit holder (2 Crocodiles taken about permitted amount for collection period. Product surrendered and harvester reprimanded.

Milestone	Program Reference	2017/18	Status for 2017/18 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. 2017 surveys undertaken and completed by end September 2017, data analysed and reported.
Analyse and assess the results of the survey program and implement any management recommendations.	3.1.5 Monitoring	Annually	2017 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.
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.
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 January 2020.

## APPENDIX 2. MONITORING METHODS & RESULTS - SPOTLIGHT SURVEYS

Since 1975 spotlight surveys have followed the standardised procedures described by Messel *et al.* (1981), Bayliss (1987) and Fukuda *et al.* (2013a). Surveys are mostly conducted during the dry season, between June and October, when water levels are low. Specific sections of river, including both the mainstream and accessible side creeks are traversed at night by boat. Surveys are restricted to either side of low tide, when mud banks are exposed and crocodiles are most visible. The water surface, banks and fringing vegetation are scanned with a spotlight and crocodiles are located by their distinctive reflective eye shine. They are approached as close as possible to estimate their TL in 0.3 m (1 ft) intervals (see Fukuda *et al.* 2013b for method) and to confirm species (freshwater crocodiles, *C. johnstoni* overlap with *C. porosus* in some range). If no size estimate is possible they are recorded as “eyes only”. Given that “eyes only” animals tend to be large animals (Webb and Messel 1979, Webb *et al.* 1989), they are all regarded as non-hatchlings.

Distances surveyed were measured along the mid-line of streams in kilometres to the nearest 0.1 km, originally using survey maps (Messel *et al.* 1982) but in later years standardised to more accurate distances measured with a Geographic Information System (Fukuda *et al.* 2013a). The start and finish points have been permanently fixed since the early years, such that mean densities are considered directly comparable from year to year.

DENR monitors eight rivers with mid-high levels of harvesting on a regular basis (Table 8). Each of these rivers is surveyed biennially (every two years) except for the Adelaide River (which is monitored annually). These regularly monitored rivers are required to be reported under the current Management Program. In 2018, DENR surveyed the Adelaide, Daly and Arnhem Land Rivers. The Glyde River was not surveyed because the traditional owner did not allow access to the river. On the top of the regularly monitored rivers, DENR monitors rivers with low density of crocodiles on an irregular basis. In 2017, DENR surveyed the Roper River and Victoria River that had not been surveyed since 2001. Although these irregularly monitored rivers are not required to be reported under the Management Program, the results of brief analysis (population model fitting is not possible for these rivers) are included in this report.

Parks Australia surveys four rivers in Kakadu National Park (KNP) semi-annually (Table 8). DENR analyses and reports the results of the KNP surveys in the monitoring reports whenever their data become available to DENR. DENR is committed to assisting KNP on future surveys and with data analysis.

**Table 8** Monitoring rivers for *C. Porosus* surveyed by DENR and Parks Australia in 2014-2018.

Agent	Region	River	2014	2015	2016	2017	2018
DENR	Darwin	Adelaide	Done	Done	Done	Done	Done
		Daly			Done	Done	Done
		Mary		Done		Done	
	Arnhem Land	Blyth	Done		Done		Done
		Cadell	Done		Done		Done
		Glyde			Done		
		Liverpool			Done		Done
		Tomkinson			Done		Done
	Other	Roper				Done	
		Victoria				Done	
Parks Australia	Kakadu	East Alligator	Data available		Data available	Data available	
		South Alligator	Data available	Data available	Data available	Data available	
		West Alligator			Data available		
		Wildman				Data available	

## Analysis of non-hatchling density in individual rivers

For this analysis only survey data from the mainstems of the rivers (rather than side creeks) were used, because visibility biases increase with narrowing stream width (Webb *et al.* 1989) and the availability of the side creeks is not consistent between the surveyed years (Fukuda *et al.* 2011). Hatchlings (<0.6 m TL) were excluded from the analysis due to high variance in both annual nest abundance and hatching success (Messel *et al.* 1981, Fukuda and Saalfeld 2014).

No corrections for visibility bias (Webb *et al.* 1984, 1989; Bayliss *et al.* 1986; Bayliss 1987) were applied, and so abundance is expressed as relative rather than absolute density: the number (or biomass) of non-hatchling *C. porosus* sighted, rather than the number present, divided by the midstream length of river surveyed (km). Biomass of crocodiles is calculated using equations provided by Webb and Messel (1978).

Observer bias in the number of crocodiles sighted within a spotlight survey appears slight (Webb *et al.* 1989), but observer bias in the estimated size of crocodiles sighted can be more variable (Choquenot and Webb 1987, Webb *et al.* 1989). To minimise the observer bias, observers with sufficient experience (usually >10 years) estimate the TL of each crocodile sighted. Neither sources of error are considered further here.

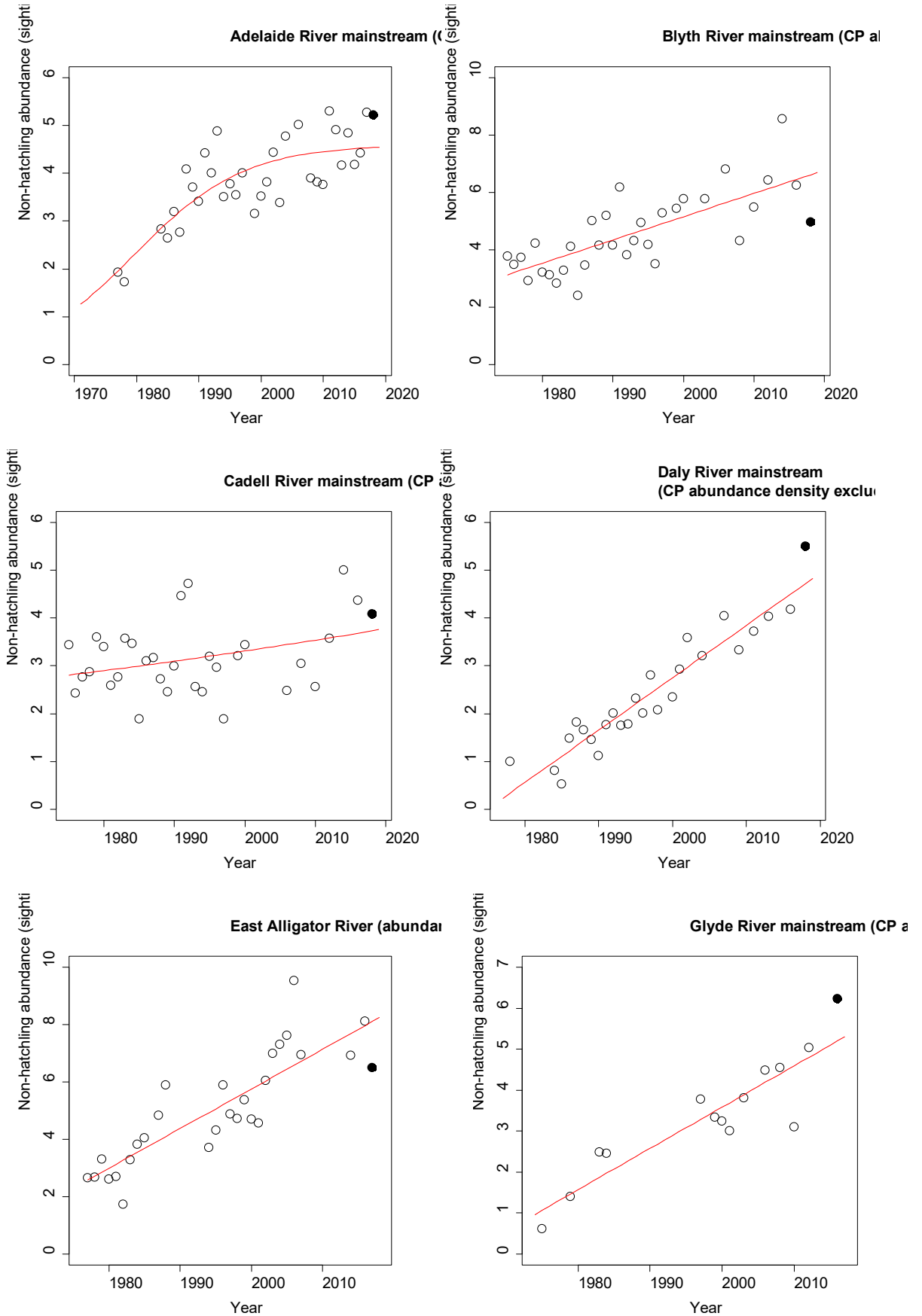
Estimated density is plotted for the surveyed years since the standardised monitoring program began in each river. Three candidate regression models (linear, exponential and logistic) are fitted to both the abundance and biomass to approximate the population growth pattern in each river (Tables 9 and 10), with the line of best fit plotted for each river (Figures 6 and 7). The fit of each model was assessed using information theoretic procedures, following Burnham and Anderson (2002).

## Results: Non-hatchling density

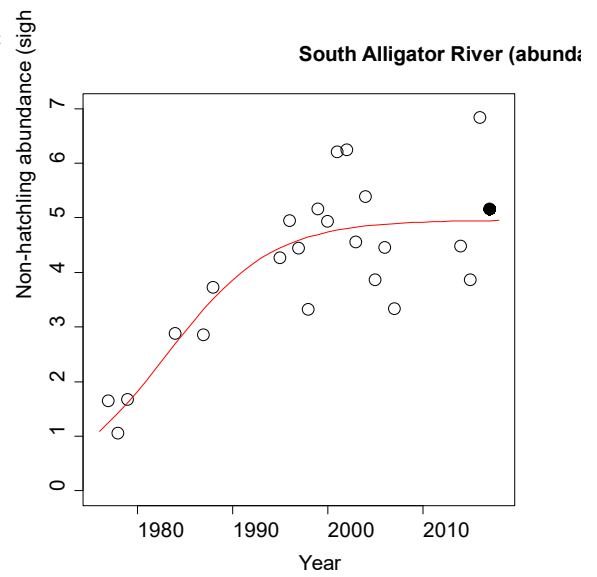
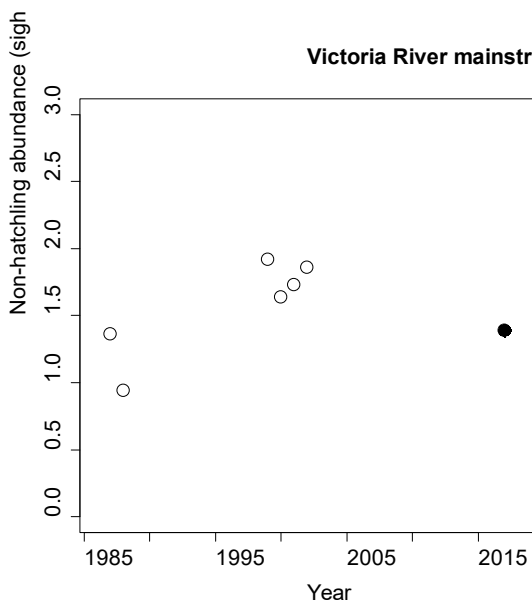
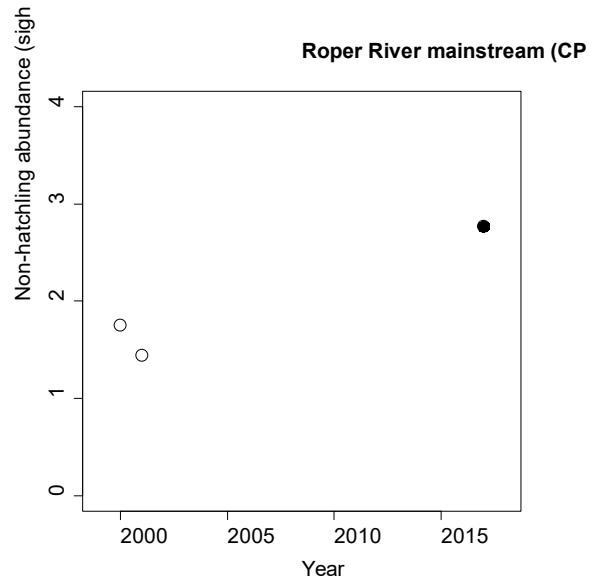
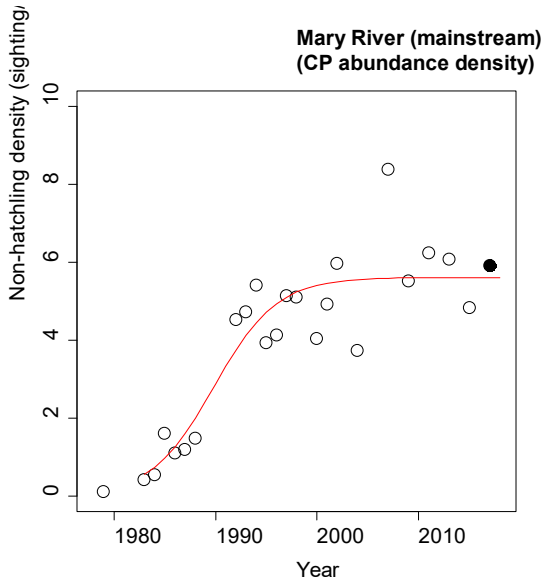
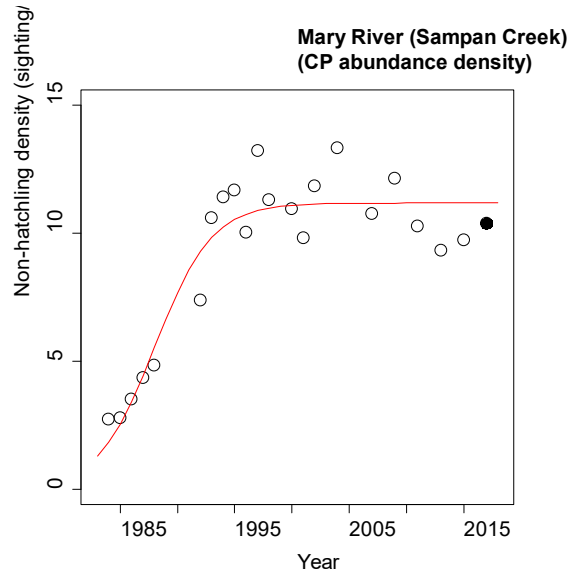
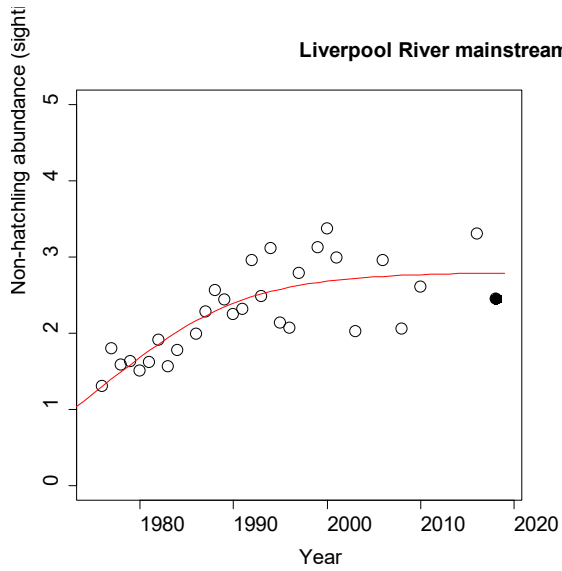
All the monitored rivers showed increasing (linear or exponential) or stable (logistic) populations (Figure 6 & Table 9). The Adelaide, Liverpool, Mary, South Alligator, West Alligator, and Wildman Rivers showed signs of reaching or having reached an asymptote by 2018. The Blyth, Daly, East Alligator, Glyde, and Tomkinson Rivers appeared to be still increasing. Results for the Cadell, Roper, and Victoria Rivers show stable or slightly increasing population levels since protection. Given that these rivers were not harvested heavily before protection for crocodile skins and the current harvest intensity for eggs is very low (Saalfeld *et al.* 2016, DENR unpublished data 2013), it is likely reflecting the natural size of the populations rather than

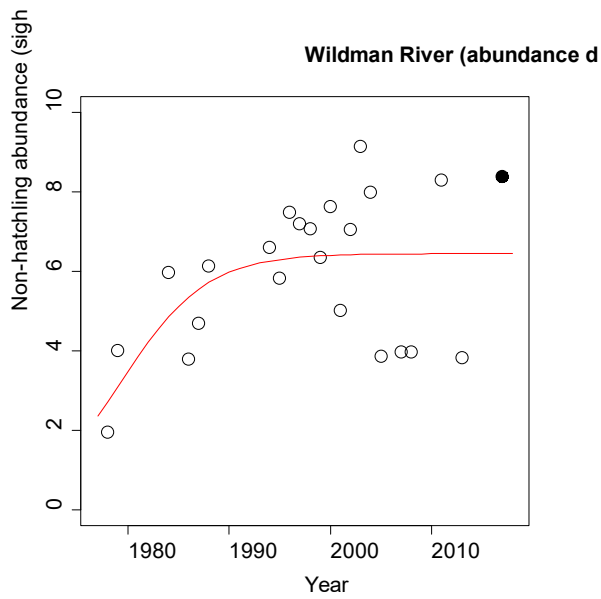
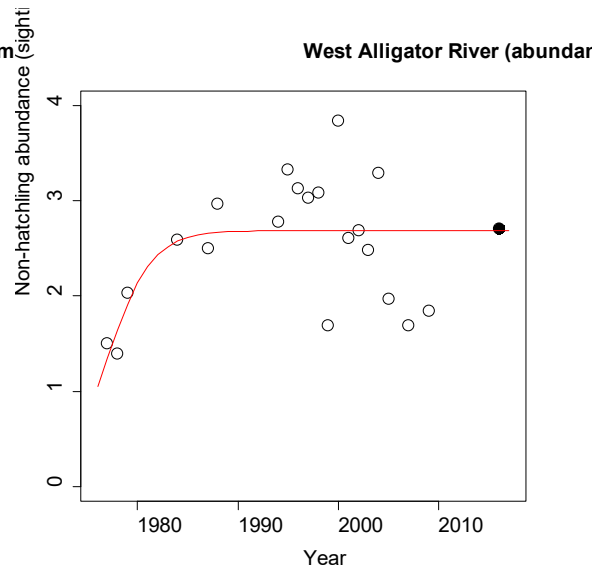
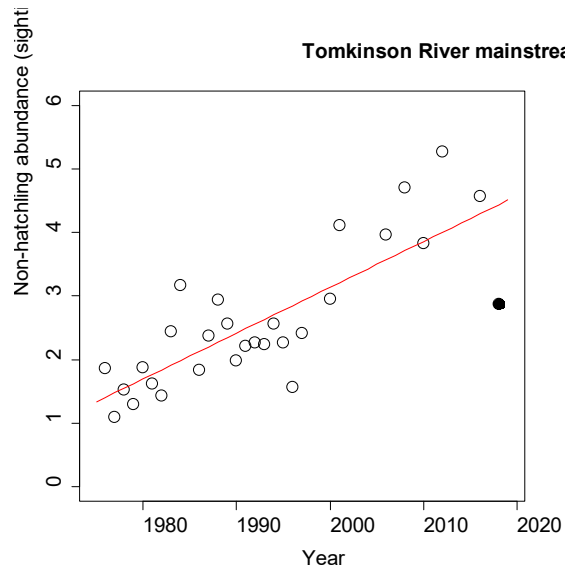
recovery from previous harvest. A few rivers showed a slight decline in the latest year or small fluctuation in the recent years (eg. Blyth, East Alligator, Liverpool Rivers). These are most likely a combination of environmental variability and survey artefact rather than an actual decline. Overall, survey results indicate that the crocodile populations in the monitored rivers are slowly increasing to a stable state at levels thought to be close to those from the uncontrolled hunting era (1945-1970). There is no sign that any of the monitored populations is likely to increase or decrease dramatically.

**Figure 6** Abundance density (sighting/km) of non-hatchling *C. porosus*. Data are up to 2016, 2017 or 2018 (see Table 8). Closed symbol is the latest survey.









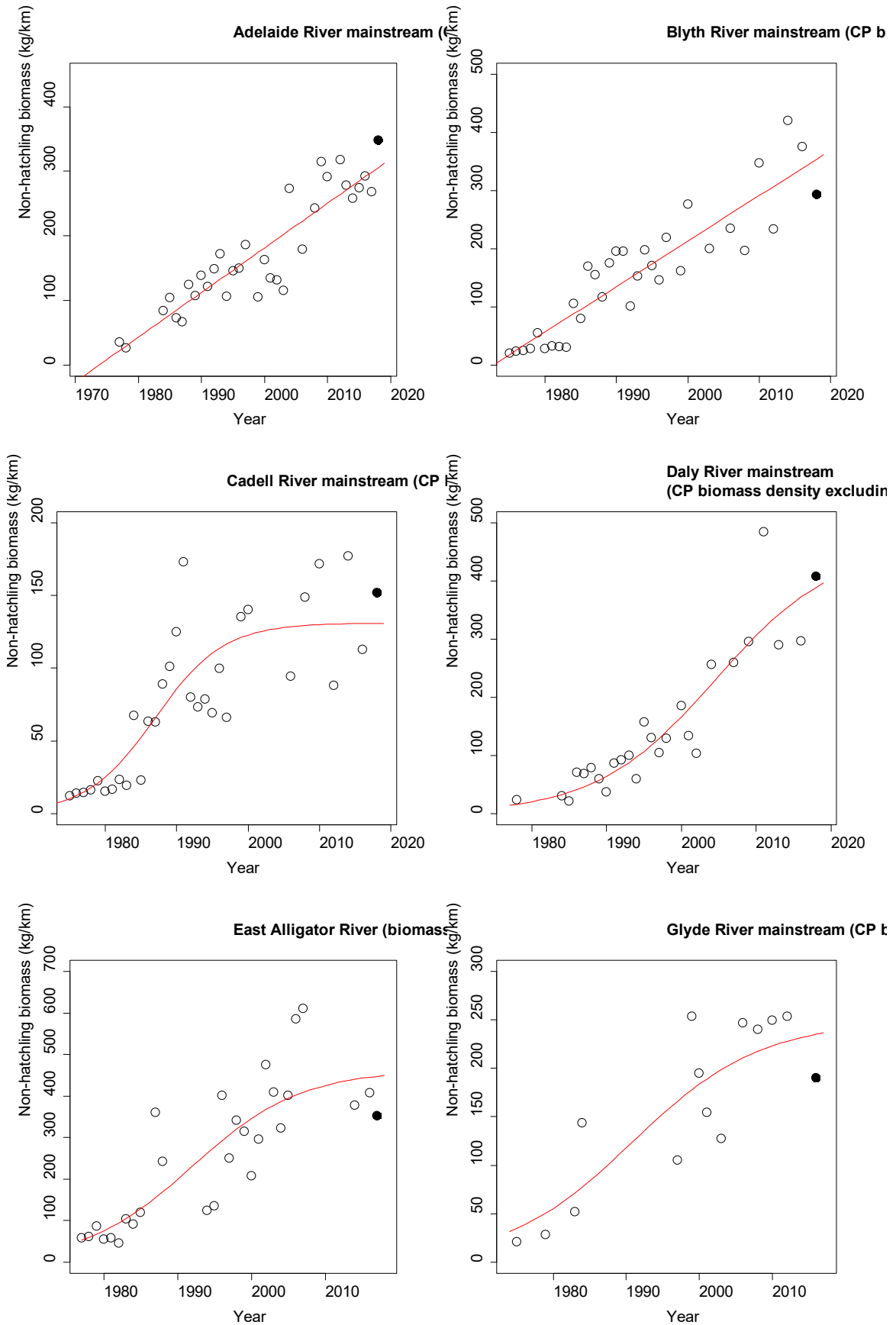
**Table 9:** Results of model selection fitted to the abundance density of non-hatchling *C. porosus*. N = number of years surveyed, AICc = Akaike information criterion corrected for a small sample size,  $\Delta_i$  = difference in AICc,  $w_i$  = Akaike weight in % (-- not converged).

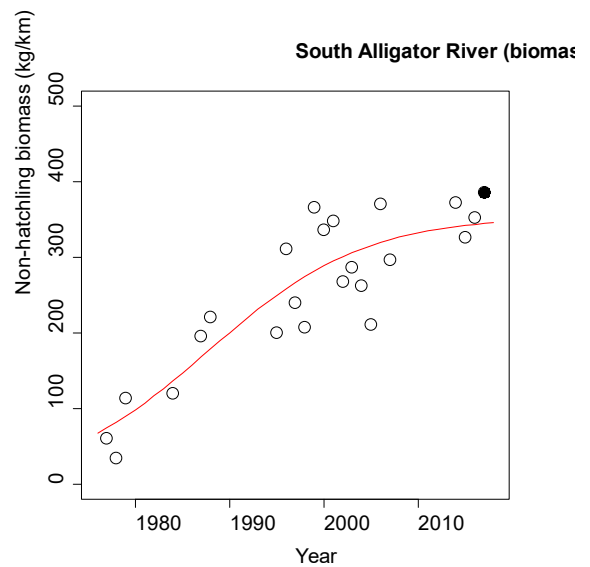
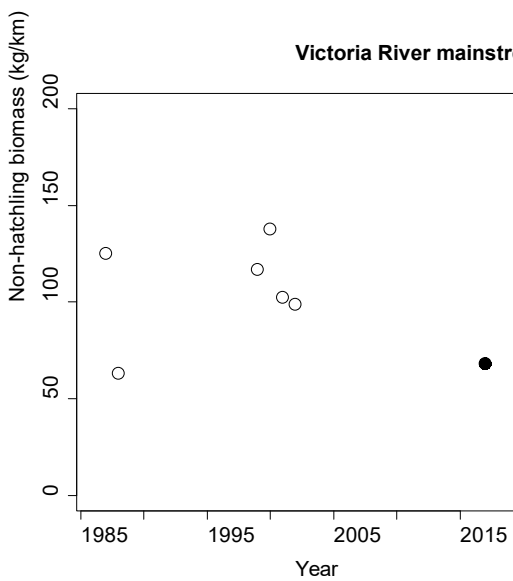
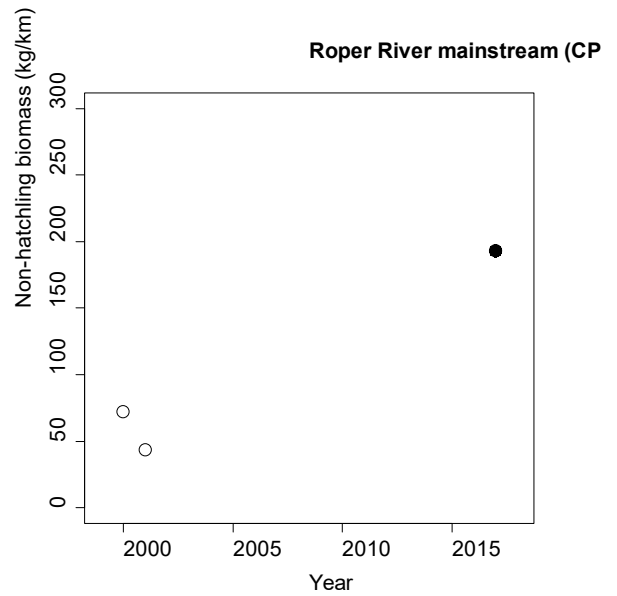
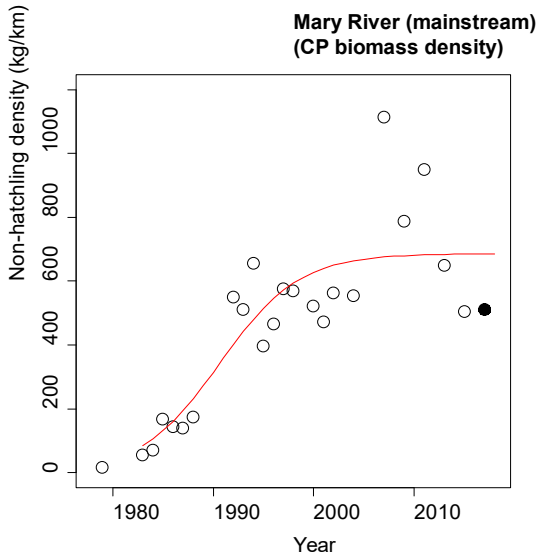
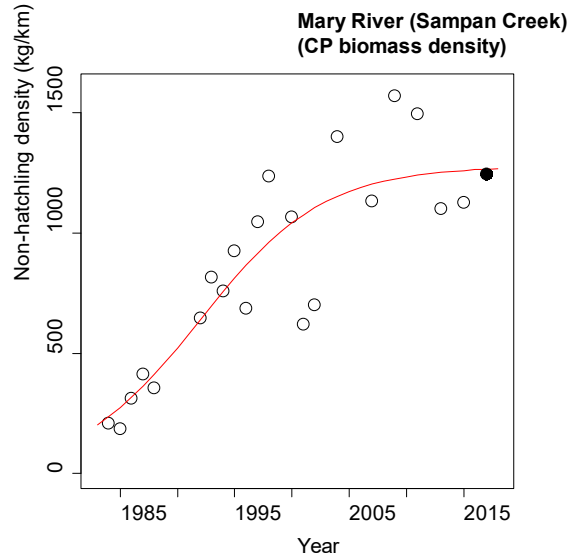
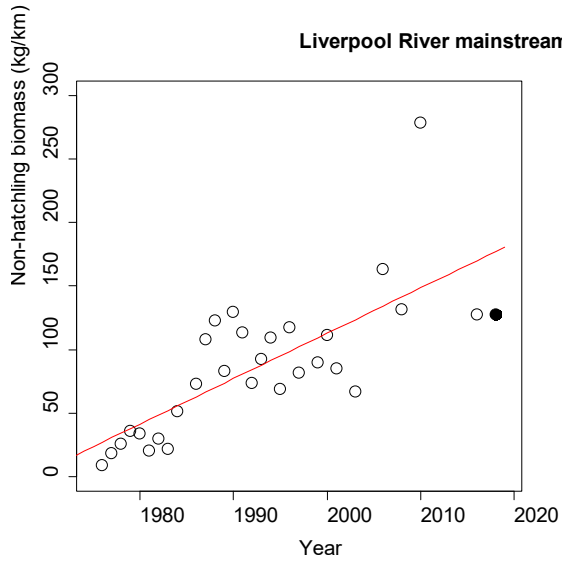
River	Year (N)	Model	AICc	$\Delta_i$	$w_i$
Adelaide River	1977-2018 (34)	Logistic	61.33	0.00	58.98
		Exponential	64.66	3.33	11.14
		Linear	62.69	1.36	29.89
Blyth River	1975-2018 (33)	Logistic	91.99	2.11	17.02
		Exponential	90.60	0.72	34.10
		Linear	89.88	0.00	48.88
Cadell River	1975-2018 (32)	Logistic	-	-	-
		Exponential	65.69	0.00	53.24
		Linear	65.95	0.26	46.76
Daly River	1978-2018 (26)	Logistic	29.38	0.53	43.42
		Exponential	54.12	25.27	0.00
		Linear	28.85	0.00	53.58
East Alligator River	1977-2017 (28)	Logistic	85.77	1.45	32.58
		Exponential	284.28	199.97	0.26
		Linear	84.32	0.00	67.42
Glyde River	1975-2018 (15)	Logistic	340.87	310.01	0.00
		Exponential	284.90	254.04	0.00
		Linear	30.86	0.00	100
Liverpool River	1976-2018 (30)	Logistic	30.61	0.00	95.79
		Exponential	39.81	9.20	0.96
		Linear	37.38	6.77	3.25
Mary River (Sampan Creek)	1984-2017 (22)	Logistic	75.99	0.00	1.00
		Exponential	110.26	34.27	0.00
		Linear	107.51	31.52	0.00
Mary River (mainstream)	1984-2017 (22)	Logistic	69.56	0.00	99.80
		Exponential	90.06	20.50	0.00
		Linear	81.95	12.39	0.20
South Alligator River	1977-2017 (23)	Logistic	64.16	0.00	92.19
		Exponential	72.65	8.48	1.33
		Linear	69.47	5.31	6.48
Tomkinson River	1976-2018 (30)	Logistic	62.60	1.84	21.01
		Exponential	62.16	1.40	26.18
		Linear	60.76	0.00	52.81
West Alligator River	1977-2016 (21)	Logistic	40.95	0.00	80.71
		Exponential	45.29	4.34	9.21
		Linear	45.11	4.16	10.08
Wildman River	1978-2017 (23)	Logistic	92.73	0.00	55.40
		Exponential	94.79	2.06	19.78
		Linear	94.33	1.61	24.82

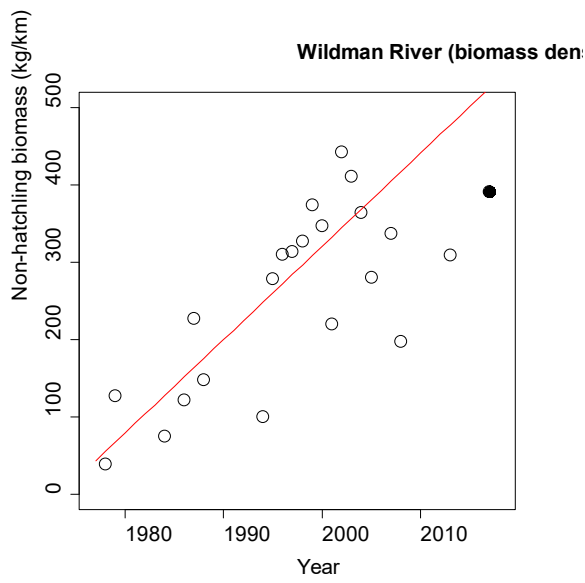
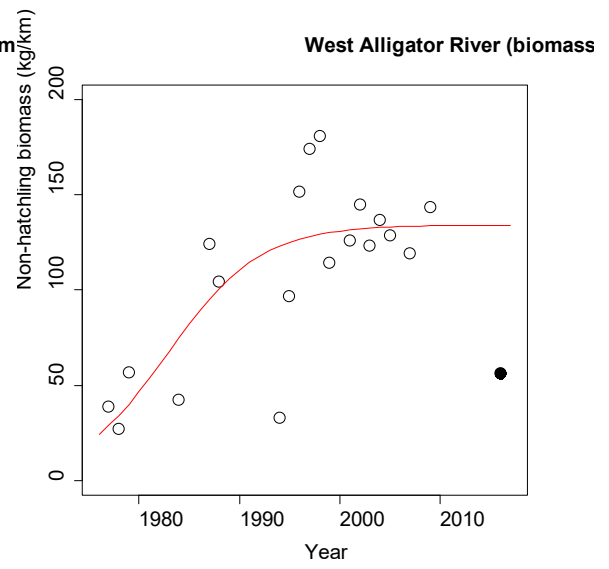
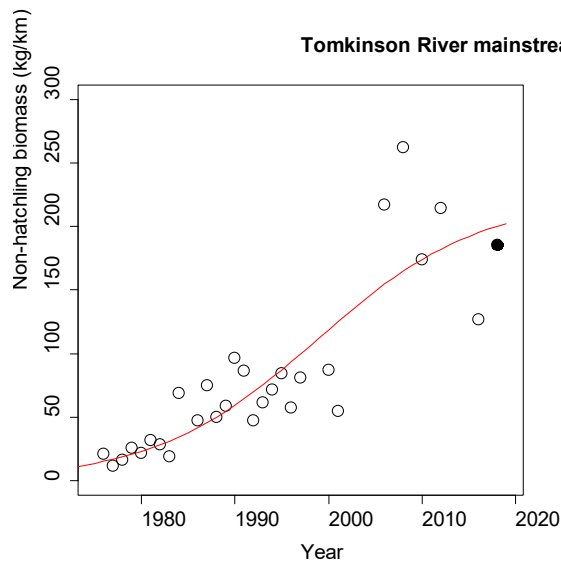
**Results: Non-hatchling biomass**

Like the abundance density, the biomass density continued to increase in some rivers while it indicated approaching an asymptote in other rivers (Figure 7 & Table 10). This suggests that individual animals are getting larger in the populations still growing in terms of biomass even if the number of crocodiles has reached a ceiling. This is consistent with the ongoing maturing of a population of a large, slow growing species recovering from substantial unregulated harvest. Maturity in biomass is expected 10-20 years after the abundance has long reached saturation in the number. The Mary River (both the mainstream and Sampan Creek) is a good example for such matured population. Other rivers are expected to follow this trend at different points, depending on their environmental carrying capacities.

**Figure 7** Biomass density (kg/km) of non-hatchling *C. porosus*. Data are up to 2016, 2017 or 2018 (see Table 8). Closed symbol is the latest survey.







**Table 10:** Results of model selection fitted to the biomass density of non-hatchling *C. porosus*. N = number of years surveyed, AICc = Akaike information criterion corrected for a small sample size,  $\Delta_i$  = difference in AICc,  $w_i$  = Akaike weight in % (-- not converged).

River	Year (N)	Model	AICc	$\Delta_i$	$w_i$
Adelaide River	1977-2018 (34)	Logistic	337.84	1.26	22.79
		Exponential	337.01	0.43	34.46
		Linear	336.58	0	42.74
Blyth River	1975-2018 (33)	Logistic	353.84	5.53	5.91
		Exponential	358.70	10.39	0.52
		Linear	348.31	0.0	93.58
Cadell River	1975-2018 (32)	Logistic	312.08	0.0	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	1977-2017 (28)	Logistic	339.47	55.19	0.00
		Exponential	284.28	0.00	100
		Linear	340.62	56.35	0.00
Glyde River	1975-2016 (14)	Logistic	153.75	2.43	22.91
		Exponential	284.90	133.58	0.00
		Linear	151.32	0.00	77.09
Liverpool River	1976-2018 (30)	Logistic	306.98	1.74	29.52
		Exponential	-	-	-
		Linear	305.24	0.00	70.48
Mary River (Sampan Creek)	1984-2017 (22)	Logistic	292.15	0.00	95.57
		Exponential	304.17	12.01	0.24
		Linear	298.41	6.25	4.19
Mary River (mainstream)	1984-2017 (22)	Logistic	304.21	0.00	99.03
		Exponential	319.89	15.68	0.04
		Linear	313.54	9.33	0.93
South Alligator River	1977-2017 (23)	Logistic	248.65	0.00	62.02
		Exponential	256.11	7.47	1.48
		Linear	249.71	1.06	36.49
Tomkinson River	1976-2018 (30)	Logistic	292.35	0.00	52.43
		Exponential	296.94	4.59	5.27
		Linear	292.78	0.43	42.29
West Alligator River	1977-2016 (21)	Logistic	220.33	175.03	0.00
		Exponential	45.29	0.00	100
		Linear	223.57	178.28	0.00
Wildman River	1978-2017 (23)	Logistic	303.82	2.38	0.30
		Exponential	302.57	1.13	0.57
		Linear	301.43	0.00	99.13



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### APPENDIX 3. Production statistics from crocodile farms (2017-2018).

*C. porosus* stock and production on farms in the Northern Territory for 2017/2018 are summarised in Table 11. Farm H was in the process of moving out of production in late 2018 and transferring stock to another farm. This will be reflected in the 2018/2019 report. Farm K is not currently operating; however, the permit is still maintained as the operator is investigating a new site.

Stock held reflects live crocodiles only and does not include eggs until successfully hatched.

**Table 11:** *C. porosus* held on farms in the Northern Territory in 2017/2018. Total acquired includes farm bred hatchlings, ranched hatchlings and purchases/imports from other farms. Total lost includes transfer to other farms, unaccounted for losses and (predominantly) mortality.

Farm	Stock held 1/02/2017	Farm-bred hatchlings	Total acquired	Crocodiles processed	Total losses	Stock held 31/01/2018
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					20,000
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	19,855	2,857	40,684
G	70				11	59
H	6,454					6,000
I	0		648		15	633
J	171		160	119	11	196
K	0					0
<b>Totals</b>	101,661	4,090	53,995	50,535	7,727	101,030