

**NT SALTWATER
CROCODILE**
(Crocodylus porosus)
**WILDLIFE TRADE
MANAGEMENT PLAN:**
2015-2016 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 2015/2016 (financial year). Data for 2015/2016 and the preceding four years are included throughout the report.

Northern Territory Department of Environment and Natural Resources (DENR) conducted spotlight surveys in 7 out of 8 monitoring rivers (6 scheduled) in 2016. One river, the Daly River, was surveyed out of sequence due to scheduled survey in 2015 not occurring due to water levels being too low to allow access. The results showed that the population of non-hatchling *C. porosus* in most rivers continued to increase or remain stable. The Adelaide River continues to show stable population abundance with increasing biomass; indicating a stable mature population. The remaining monitored rivers all show either stable abundance with increasing biomass (Mary) or increasing abundance and biomass (Daly, Liverpool, Tomkinson, Blyth, Cadel and Glyde Rivers). The apparent trend of very slight decline in the Cadell River is no longer evident with the inclusion of the latest monitoring data. Given that the harvest intensity of eggs in the catchment is low and the river was not heavily hunted for crocodiles before protection, it is not likely that the previously observed decline was caused by the harvest. These rivers, particularly the Adelaide River which is both intensively harvested and the closest river to the Greater Darwin Problem Crocodile Management Zone, will be monitored more intensively if monitoring indicates any harvest impact.

Parks Australia North surveyed 2 of 4 monitoring rivers in Kakadu National Park in November 2015; the South Alligator and East Alligator Rivers. The South Alligator, West Alligator and Wildman Rivers showed possible declines in the years up to 2008; however recent surveys of the South Alligator Rivers supports a stable population, rather than declining, and increasing biomass. The East Alligator River showed both increasing abundance and biomass.

Survey results also indicated that the size of individual animals (estimated from size structure and biomass) has been increasing in most rivers, reflecting the continued maturity of the population still recovering from the unregulated hunting in the period 1945 to 1971.

A total of 247 problem crocodiles were removed in 2015/2016 by Parks and Wildlife Commission (PWC) staff for public safety and to protect stock in pastoral areas, of which 74% were males and 74% were caught in the Darwin Harbour.

PWC continues to promote community awareness for safety and participation through CROCWISE campaign programs using a variety of media. PWC delivered local schools with educational programs.

Under the ceiling of 70,000 live eggs, 70,000 eggs were allocated to harvest, but only 47,194 live eggs were collected in 2015/2016.

DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

Under the ceilings of 500 hatchlings, 400 juveniles and 500 adults provided in the Management Program, 0 hatchlings, 0 juveniles and 121 adults were harvested in 2015/2016. The adults harvested were strongly biased to male (76.4%). The average body size of the harvested animals was about 2.1 metres for females and 3.5 metres for males. The total number of crocodiles harvested 121 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 is not yet available.

Nine crocodile farms operated in 2015/2016 in the Northern Territory. Farm production data for the period 1 February 2015 to 31 January 2016 is reported here. Farm production reporting is limited to stock held, total acquisitions and total disposals. Most live crocodiles exported from the Northern Territory went to Queensland.

Permit compliance and animal welfare was closely monitored and inspected by DENR, PWC and the Northern Territory Department of Primary Industry and Resources (DIPR). No significant permit compliance or animal welfare matters were reported in 2015/2016. A small number of minor permit compliance matters were dealt with by warning letter..

INTRODUCTION

The Northern Territory Department of Environment and Natural Resources (DENR), Parks and Wildlife Commission (PWC) 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). The annual revision is reported to the Australian Government Department of Environment and Energy (DEE). This monitoring report reviews the implementation and performance of the WTMP in 2015/2016.

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.

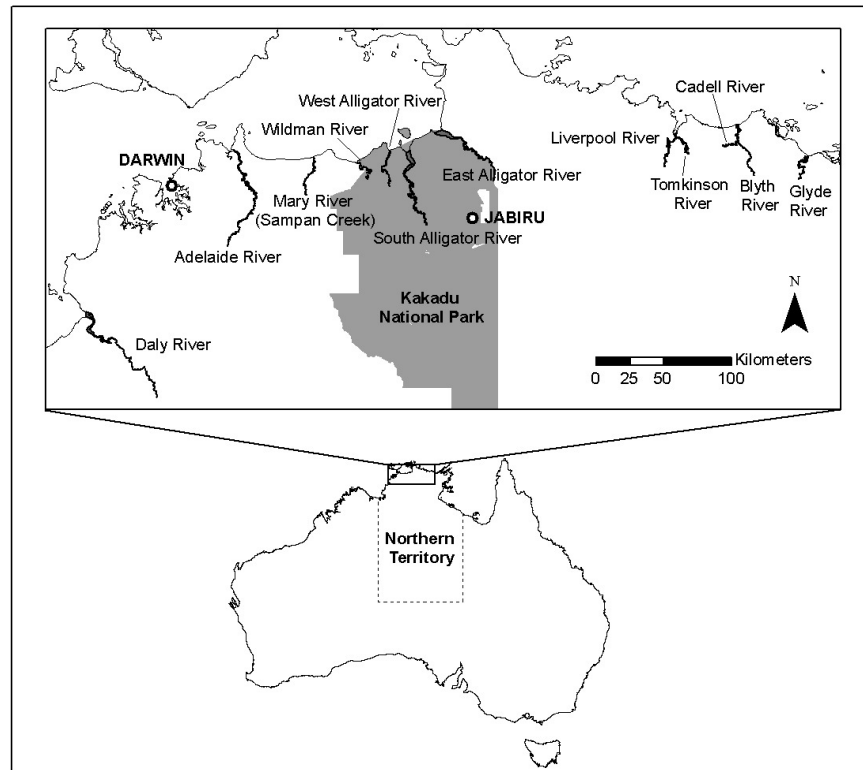
The WTMP seeks to manage the Saltwater Crocodile for the benefit of Territorians while ensuring the long-term conservation of the species and its habitats in the Northern Territory: In achieving this aim two general principles are applied:

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.
- 3.

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. The results of the population surveys and farm stock reporting are provided in Appendix 2 and 3, respectively.

POPULATION MONITORING

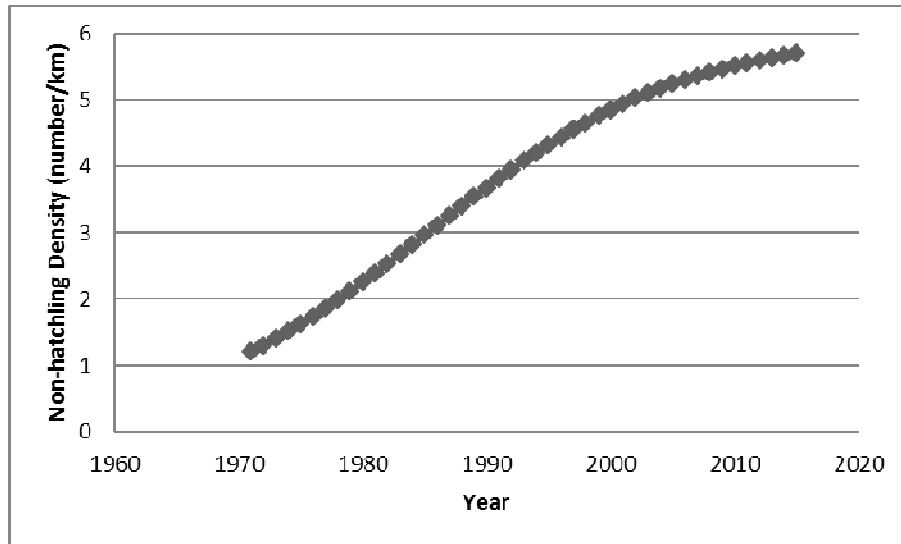
Populations of *C. porosus* have been monitored in the Northern Territory since the species was declared protected in 1971 through a range of varied monitoring projects undertaken by the University of Sydney, Parks Australia North (Kakadu National Park), Wildlife Management International (WMI), DENR and individual PWC 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. Data from the Kakadu rivers up to 2007 and 2014 and 2015 only are available to DENR at this time. Surveys have been carried out in these rivers between 2007 and 2014, however processing and analysis constraints by Kakadu National Park Service have resulted in this data for the period 2008 to 2013 being unavailable for this report. Future availability of this data is not known at this time.

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). Analyses of recent monitoring surveys suggest that the rate of increase of crocodile populations in a majority of rivers is slowing or approaching an asymptote. Most of the monitored rivers show large increases since protection and some have stabilised at an asymptote in recent years. Analysis of each individual river is provided in Appendix 2. There is no evidence that the harvesting program has had a detrimental impact on crocodile population in the NT.

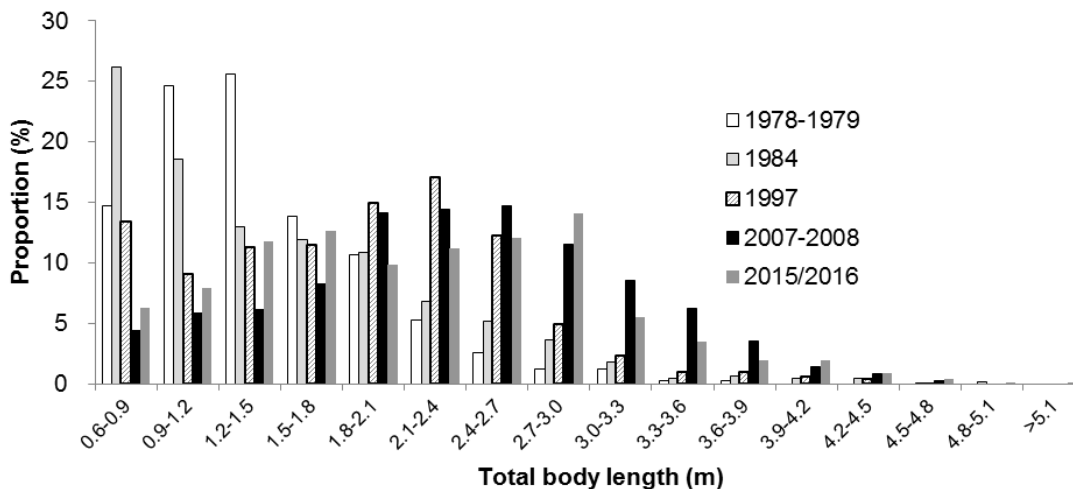
Figure 2 Modelled abundance density of non-hatchling (>0.6 m, including eyes-only) of *C. porosus* calculated from standardised spotlight surveys in 12 tidal rivers since 1975.



Size Structure

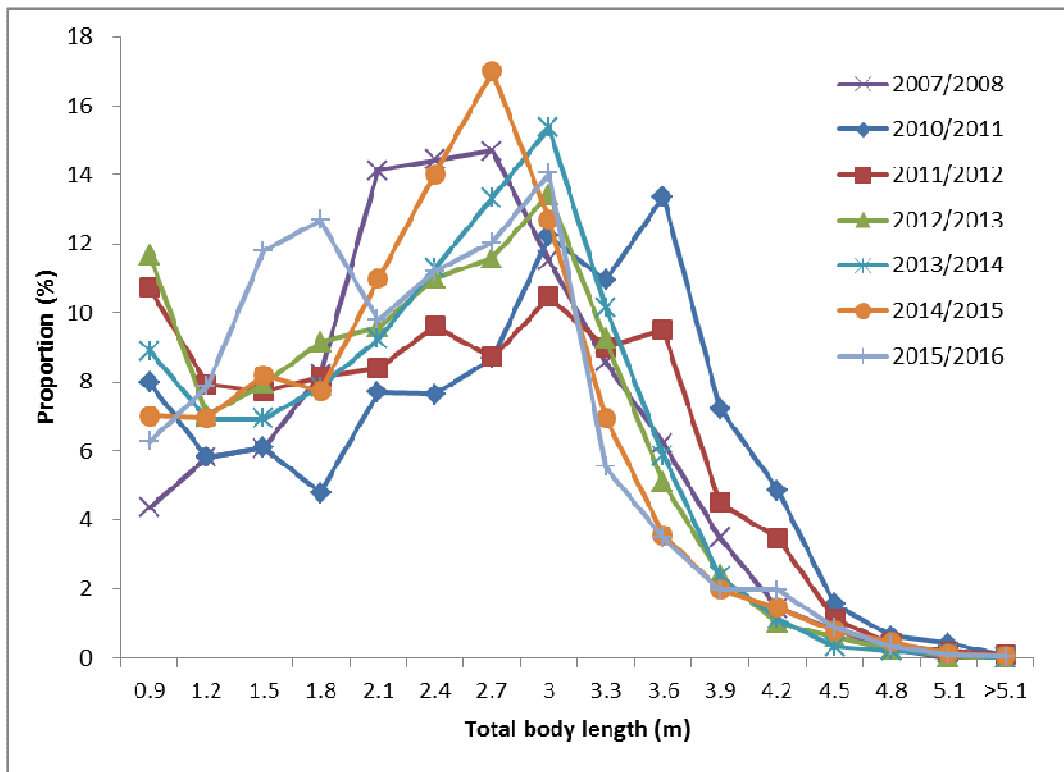
Results indicate that the size structure of the crocodile population appears to be shifting from smaller crocodiles to a higher proportion of larger crocodiles (Figure 3) with an associated large increase in biomass in recent years (Appendix 2). This is consistent with the ongoing maturing of a population of a large, slow growing species recovering from substantial unregulated harvest. Analysis of each individual river is provided in Appendix 2.

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 in 1978/79 (10 rivers in 1978 and 1 river in 1979; no data available for Mary River), 1984, 1997, 2007/08 (6 rivers in 2007 and 6 rivers in 2008) and 10 monitored rivers combined in 2015/16 (4 rivers in 2015 and 7 rivers in 2016).



Monitoring data for the last five years indicates that while there has been 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, there does appear to be a decline in the proportion of crocodiles in the 3 to 4 metre size range in the population in recent years (Figure 4). This apparent decline is not thought to be detrimental at the population level; it is primarily in the size classes representing young males and may be a result of changes in size structure associated with a population approaching carrying capacity. Corresponding to this decline is an increase in the proportion of crocodiles in the 1 to 3 metre size range and in 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). Young, sexually active males (3 to 4 metre) could be expected to be driven out of this habitat by dominate breeding males. This will be subject to ongoing monitoring and if the decline continues management intervention may be warranted. There is little or no change in the 3 to 4 metre proportion of the population from 2014/2015 to 2015/2016 and at this juncture no requirement for management intervention.

Figure 4 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 2007/08 and 2015/16.



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 PWC staff to maintain a very low crocodile density. PWC 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 the Northern Territory Government

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 Borrooloola Crocodile Management Zone. In addition to the management zones, the Northern Territory Government removes problem crocodiles at other locations upon request. Removed problem crocodiles are sold to crocodile farms to be consumed 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).

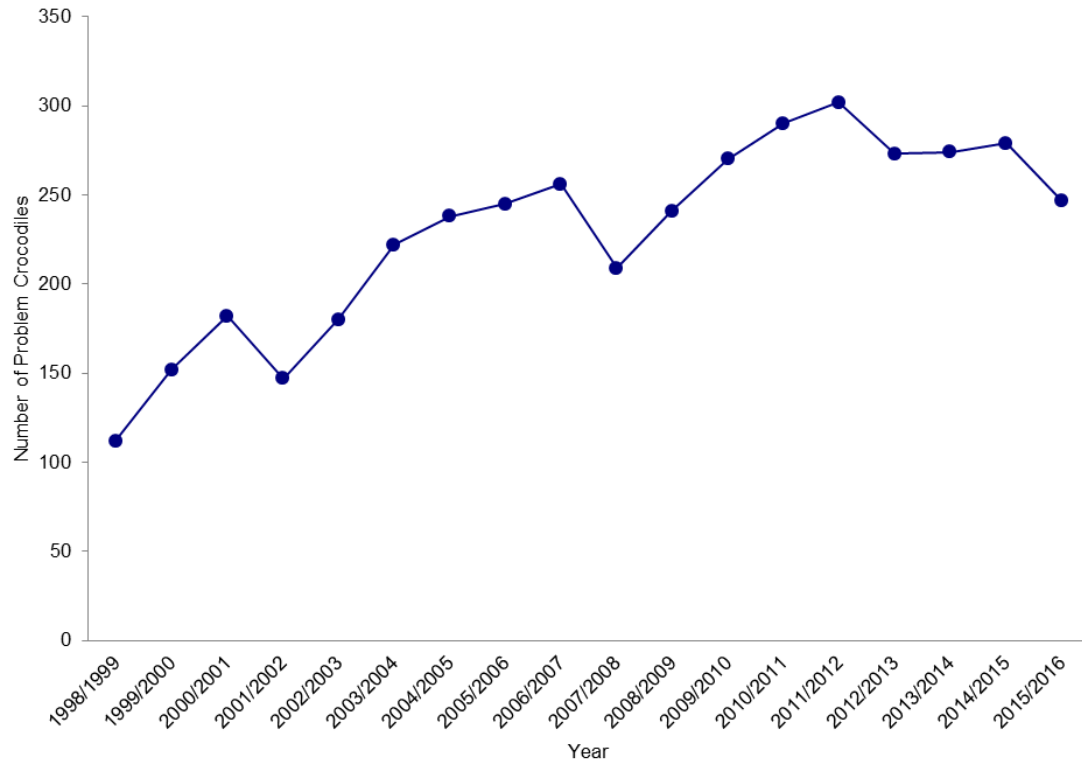
A total of 247 problem crocodiles were removed between July 2015 and June 2016 (Table 1, Figure 4). Whilst the vast majority of these animals were removed from Darwin Harbour, a number have been removed from the greater Darwin area and a few animals from the Katherine and Borrooloola area and other communities.

Problem crocodiles removed by PWC staff are made available to Northern Territory crocodile farms through a tender process.

Table 1 Total number of *C. porosus* removed by PWC staff as problem crocodiles, sex ratio as proportion of males, the proportion of problem crocodiles caught in the Darwin Harbour in 2011/12, 2012/13, 2013/14, 2014/15 & 2015/16.

Year	Problem crocodiles	Males	Darwin Harbour
2011/12	302	79%	68%
2012/13	273	80%	71%
2013/14	274	81%	74%
2014/15	279	81%	71%
2015/16	247	74%	74%

Figure 4 Changes in the numbers of problem *C. porosus* removed by PWC staff in 1998/1999 – 2015/2016.



Community Awareness and Participation

The Northern Territory Government promotes crocodile awareness among residents and visitors by disseminating educational information through a CROCWISE plan. Public awareness campaign continues to be conducted regularly to minimise harmful interactions between people and crocodiles. The campaign uses a variety of the media including TV, DVD, papers 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. PWC staff also visits local schools to deliver the educational program to teachers and children. Signs at popular water entry points are placed to reduce risks with crocodiles. The Northern Territory Government also promote relevant legislation, policy and guidelines to the commercial crocodile industry and wider community via promotion of this management program, relevant fact sheets, and through the Northern Territory Government permit system.

HARVESTS FROM THE WILD

Eggs

Under the Management Program for the Saltwater Crocodile in the Northern Territory of Australia, 2014-2015 (Saalfeld *et al.* 2014), the quota was 70,000 live eggs in 2014/2015. The egg harvest quota in the 2016-2020 WTMP of 90,000 viable eggs applies to the 2016/2017 egg harvest season onwards.

The definition of “live”, “viable” and “total eggs” follows those in the WTMP 2016-2020 (Saalfeld *et al.* 2015).

The number of eggs harvested has been below the harvest ceiling in all years (Table 2). As in previous years, the harvest in 2015/2016 was lower than the number of eggs permitted due to a combination of factors, including the loss of nests due to flooding and infrastructure limitations on farms. Egg collection permits in 2015/2016 were in the main five year permits covering 2014/2015 to 2018/2019 and issued for current harvest allocation quantities each year for the next 5 years. The individual allocation can be amended to higher quantity where requested by landholders/harvesters. Single year permits were issued for areas not covered by 4 year permits.

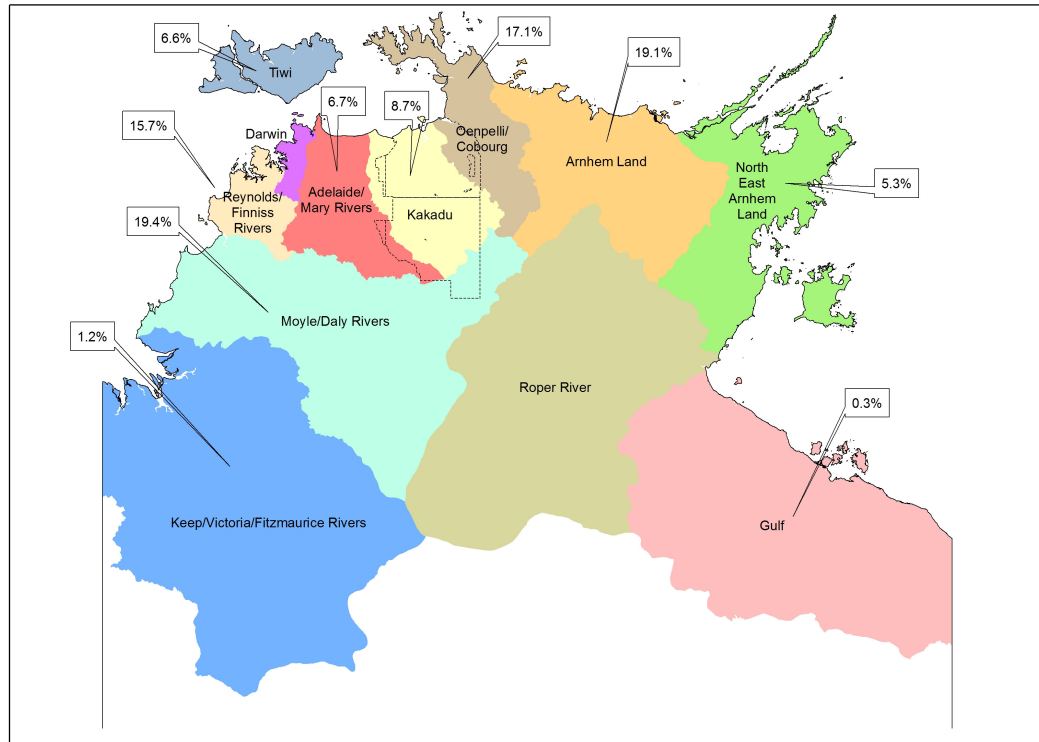
The number of eggs permitted and collected varies between the different regional catchments (Figure 5), depending on a number of factors as outlined in Appendix 1 of the WTMP. The base allocation proportion across catchments will remain at the 2013/2014 distribution for the life of the WTMP 2016-2020, but may be varied depending upon monitoring results and landholder/harvester requests for amendment of allocated harvest quantities.

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

Table 2 The number of eggs of *C. porosus* harvested for commercial use in 2011/12, 2012/13, 2013/14, 2014/15 & 2015/16.

Season	Harvest Ceiling	Eggs permitted	Eggs harvested
2011/12	60,000	52,500	42,171
2012/13	60,000	58,500	47,610
2013/14	70,000	60,750	51,238
2014/15	70,000	68,000	50,022
2015/16	70,000	70,000	47,194

Figure 5 Average proportion of *C. porosus* egg harvest in the regional catchments in 2013/2014 through 2018/2019, relative to the total NT allocation. Note that the boundary of Kakadu regional catchment is different from Kakadu National Park (KNP) and no eggs are harvested in 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 PWC staff (reported separately in Table 1 above).

A total of 121 non-hatchling *C. porosus* were harvested from the wild in 2015/2016 (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 2015/2016 the sex ration was strongly biased to males (76.4% (Table 4)), and when coupled with the large average size of harvested males (3.51 m (Table 5)), indicates that animals were being harvested either for breeding stock or were 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. The trend of increasing average size of males and static average size of females most likely reflects both increasing proportion of larger males in the population and harvest being focused on problem animals or large wild skins.

The number of crocodiles harvested in 2015/2016 as presented in Table 3 is known to be an underestimate of the actual harvest in the 12 month period reported. Harvest data is incomplete at this time due to three harvest permits being multiyear permits that have not yet expired and do not require annual reporting; consequently final return/harvest data is not yet available for these permits. These permits all expire in 2016/2017.

Table 3 The number of hatchlings, juveniles and adults (2011/12 to 2014/15) or non-hatchling (2015/16) of *C. porosus* harvested for commercial use in 2011/12, 2012/13, 2013/14, 2014/15 & 2015/16.

Year	Hatchlings	Juveniles	Adults / non-hatchling
2011/12	0	18	72
2012/13	0	16	59
2013/14	0	29	119
2014/15	0	0	61
2015/16	-	0	121

Table 4 Proportion of male *C. porosus* harvested for commercial use in 2010/11, 2011/12, 2012/13, 2013/14 and 2014/15.

Year	Male
2011/12	65.2%
2012/13	65.5%
2013/14	73.5%
2014/15	85.6%
2015/16	76.4%

Table 5 Average body size of *C. porosus* (non-hatchling) for each sex harvested for commercial use in 2011/12, 2012/13, 2013/14, 2014/15 & 2015/16. Small juveniles whose sex was unknown are not included in the figures.

Year	Female	Male
2011/12	2.15 m	2.83 m
2012/13	2.13 m	3.11 m
2013/14	2.12 m	3.22 m
2014/15	2.16 m	3.70 m
2015/16	2.12 m	3.51 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 end of the WTMP on 31 December 2020.

FARM PRODUCTION

Nine crocodile farms operated in the Northern Territory in 2015/2016 (Table 6). Due to change in farm reporting to annual reports on calendar year, commencing with the 2013/2014 monitoring report, farm production data for the period 1 February 2015 to 31 January 2016 is reported here.

In line with discussion at the annual Crocodile Managers Forum, 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.

The number of *C. porosus* (eggs, hatchlings, and juveniles/adults) exported to other States is provided (Table 7). Queensland had the highest number of live crocodiles exported from the Northern Territory. These animals were incubated and raised on Northern Territory farms and then exported to the other States.

Details of the stock held on each farm for the period 1 February 2015 to 31 January 2016 are provided in Appendix 3.

Table 6 The number of crocodile farms operating in the Northern Territory, *C. Porosus* stock held (2013/14 to 2015/16), eggs (2011/12)/hatchlings (2013/14 to 2015/16) produced from on farm breeding, total acquisitions (2013/14 to 2015/16), processed on farm (2011/12 to 2015/16) and total lost (2013/14 to 2015/16) as processed, sold, exported, escaped and mortality.

Year	No. of farms	Stock held 1 February	Farm-bred eggs/hatchlings	Total acquired	Crocodiles processed	Total lost	Stock held 31 January
2011/12	8	NA	12,000*/-	NA	25,435	NA	NA
2012/13	8	NA	NA	NA	8,667**	NA	NA
2013/14	8	114,550	7,497	50,665	17,689	46,572	118,656
2014/15***	8	118,656	6,877	61,347	14,061	49,632	122,915
2015/16	9	130,431	7,698	63,742	17,935	59,198	137,661

* estimate only based on reported number of farm nests

** data for 1 July 2012 to 31 December 2012 only

*** data for 7 of 8 farms only, data for 1 farm still under audit

Table 7 *C. porosus* (live eggs (E), hatchlings (H), and Juveniles/Adults (J/A)) exported to other States in 2011/12, 2012/13, 2013/14, 2014/15 & 2015/16.

State	2011/12			2012/13			2013/14			2014/15			2015/16		
	E	H	J/A	E	H	J/A	E	H	J/A	E	H	J/A	E	H	J/A
QLD	1,460	750	10,198	1,550	953	10,191	2,941	2,900	10,228	3,000	2,580	9,688	4,500	3,932	11,586
WA															
VIC					19			7			2			3	
SA															
NSW					1	1		2			4			6	

PERMITS & COMPLIANCE

The following is a summary of permits and compliance for the 2015/16 egg harvest season:

- A total of 19 individual permits to collect crocodile eggs were in operation.

- For 2015/2016 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 no audits of either farm incubators or field audits of collected nests during the 2015/2016 egg collection season. Past audit compliance has been extremely high and it was determined that audits would be undertaken on a random basis or as required on information received in the future. This approach was agreed by participants at the Crocodile Managers Forum held in Darwin in late 2014.
- There were nil reported substantive compliance issues for the 2015/2016 egg collection season.
- Crocodile egg collection permit holders were required to submit final returns for the 2015/2016 crocodile egg collection season (December - May) by 31 July 2016. Submission of final returns was fully compliant. In only one instance was the final return submitted late, due to computer issues. Non-compliance in submission of returns was dealt with through direct contact. No warning letters or infringement notices were issued as all returns were received.
- For the 2014/2015 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 for this system was of a high standard. Non-compliance was primarily in the form of late notification (either immediately prior or after actual collection) and in a number of instances was due to requirement for harvesters to respond immediately to changed weather conditions. Warning letters were issued where permit holders could not provide reasonable cause for non-compliance and there were no cases of multiple non-compliance. A total of 3 warning letters were issued to 3 harvesters.
- DENR provided information to the Department of the Environment, Wildlife Trade Regulation Branch, relating to crocodile products (skin and skull) taken under NT permit and presented for export out of Australia.
- PWCNT investigated 17 matters involving saltwater crocodiles. 12 matters involved reports of saltwater crocodile carcasses discovered in the wild. One matter is under ongoing investigation, four matters were resolved; two insufficient information to proceed and two by warning letter.
- One significant report involving the illegal (safari) take of crocodiles was ongoing from 2014/2015. This matter was resolved as insufficient information to proceed..
- There was regular interaction with all permit holders; crocodile egg and live crocodile harvest and crocodile farm, to discuss issues related to permitting, compliance and enforcement.
- 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*.

ACKNOWLEDGMENTS

Parks Australia North provided data on the East Alligator, South Alligator, West 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.

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APPENDIX 1. ANNUAL MILESTONE MATRIX FOR 2016-2020 WTMP

Milestone	Program Reference	2015/16	Status for 2014/15 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 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; no reported information of non-compliance by permit holders.
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 information of non-compliance by permit holders..

DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

Milestone	Program Reference	2015/16	Status for 2014/15 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. 2016 surveys undertaken and completed by end September 2016, data analysed and reported.
Analyse and assess the results of the survey program and implement any management recommendations.	3.1.5 Monitoring	Annually	2016 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	October 2016	Non-compliant. Annual report not submitted till 2017.

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 sidecreeks are traversed at night by boat. Surveys are restricted to either side of low tide, when mudbanks are exposed and crocodiles are mostly at the water's edge and not hidden amongst fringing vegetation. 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 1-foot (0.3 m) intervals and to confirm species (some freshwater crocodiles, *C. johnstoni*, extend down into the tidal parts of some rivers). 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 kilometers 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. Most of the available surveys had the same or similar start and finish points, such that mean densities are considered directly comparable from year to year.

DENR monitors 8 rivers and each river is surveyed biennially except for the Adelaide River (which is monitored annually) (Table 8). Parks Australia North surveys 4 rivers in KNP annually.

Data for the Wildman, West Alligator, South Alligator and East Alligator Rivers collected by Parks Australia North in Kakadu National Park was not available to DENR for 2008 through 2013. In 2014 and 2015 DENR assisted KNP with surveying the South Alligator and East Alligator Rivers and subsequently analysed and reported the survey results for these rivers. Results for these rivers are included in this report.

For the 2015/2016 monitoring surveys, the Daly Rivers was surveyed due to the inability to survey it in 2014/2015. In 2015 extremely low river levels restricted access to less than two thirds of the survey length during the standard survey period (June-October). The Daly was added to the 2016 survey plan to avoid a four year gap in data for this river which is subject to intensive harvest.

Table 8 Monitoring rivers for *C. Porosus* surveyed by DENR and Parks Australia North in 2011-2015.

Agent	Region	River	2012	2013	2014	2015	2016
NRETAS	Darwin	Adelaide	Done	Done	Done	Done	Done
		Daly	-	Done	-	-	Done
		Mary	-	Done	-	Done	-
	Arnhem Land	Blyth	Done	-	Done	-	Done
		Cadell	Done	-	Done	-	Done
		Glyde	Done	-	-	-	Done
		Liverpool	Done	-	-	-	Done
Tomkinson	Done	-	-	-	Done		
Parks Australia North	Kakadu	East Alligator	Unavailable	Unavailable	Done	Done	
		South Alligator	Unavailable	Unavailable	Done	Done	
		West Alligator	Unavailable	Unavailable	-	-	
		Wildman	Unavailable	Unavailable	-	-	

Analysis of non-hatchling density in individual rivers

For this analysis only survey data from the mainstems of the rivers (rather than sidecreeks) were used, because visibility biases increase with narrowing stream width (Webb *et al.* 1989). Some surveys in some years were excluded from analysis because they did not follow the standardised survey procedures and were surveyed during unfavourable conditions (eg wet seasons, high tides) or included only a small proportion of the standardised mainstream survey section. Following Messel *et al.* (1981), hatchlings (<0.6m) were excluded due to high variance in both annual nest abundance and hatching success.

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 of non-hatchling *C. porosus* sighted, rather than the number present, divided by the midstream length of river surveyed (km). 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 is more variable despite mean values being reasonably accurate (Choquenot and Webb 1987, Webb *et al.* 1989). Neither sources of error are considered further here.

Estimated density is plotted for all years since the standardised monitoring program began in each river. Three candidate regression models (linear, exponential and logistic) were then 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 (see Burnham and Anderson (2002) for detailed discussion on model selection).

Results: Non-hatchling density

Most of the monitoring rivers showed increasing (linear or exponential) or stable (logistic) populations (Figure 6 & Table 9). The Adelaide, Mary and South Alligator Rivers showed signs of reaching or having reached an asymptote. The Blyth, Daly, East Alligator, Glyde, Liverpool and Tomkinson Rivers seem to be still increasing. This is interpreted as indication that the crocodile population is approaching a stable state at levels thought to be close to those from the pre-unrestricted hunting era (1945-1971).

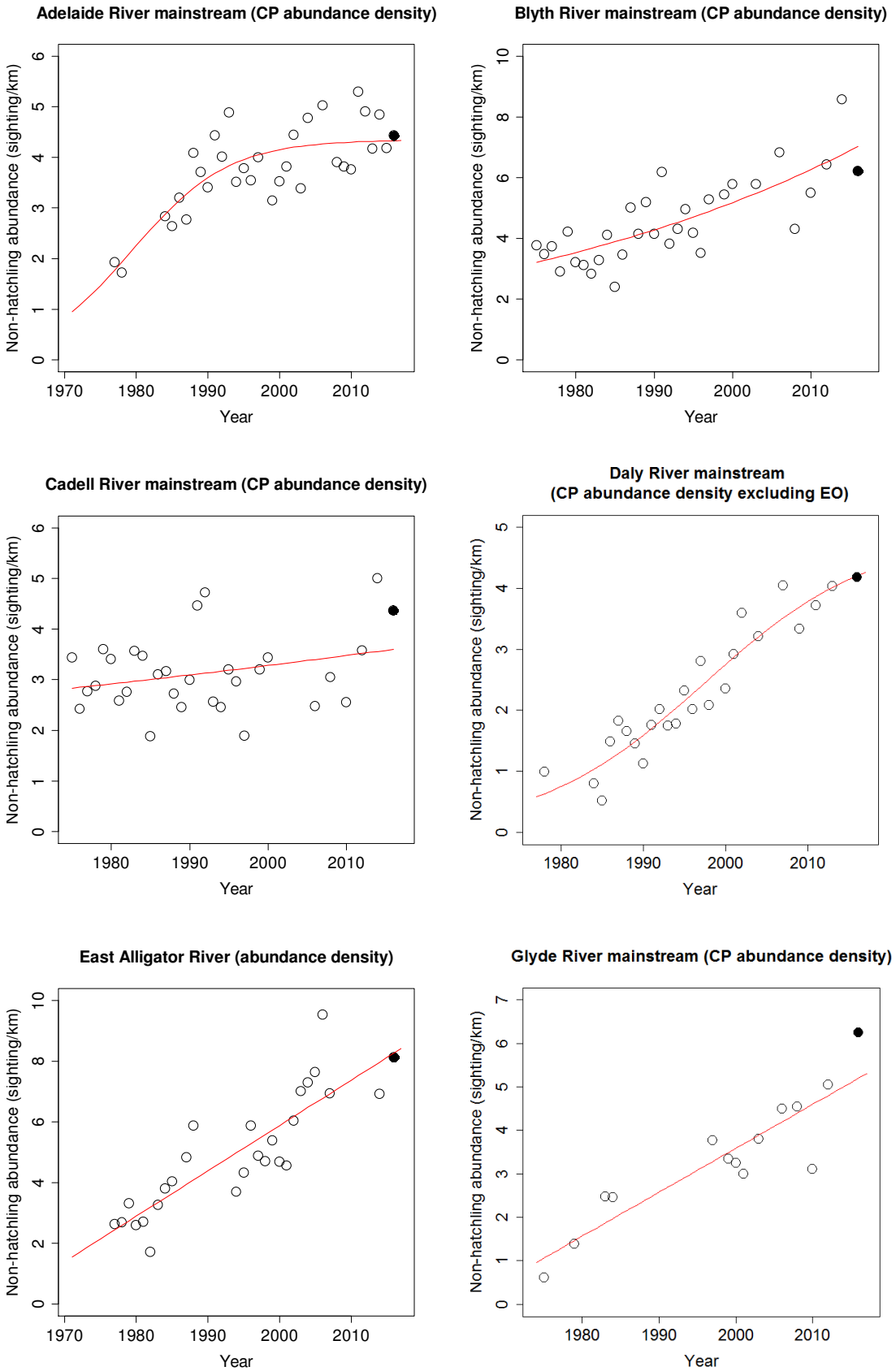
The Cadell River shows stable or very slightly increasing population levels since protection. Given that this river was not harvested heavily before protection for crocodile skins and the current harvest intensity for eggs is still low (DENR unpublished

data 2013), it may be showing the natural size of the population rather than recovery from the skin harvest. The population is likely to stay stable rather than decrease dramatically.

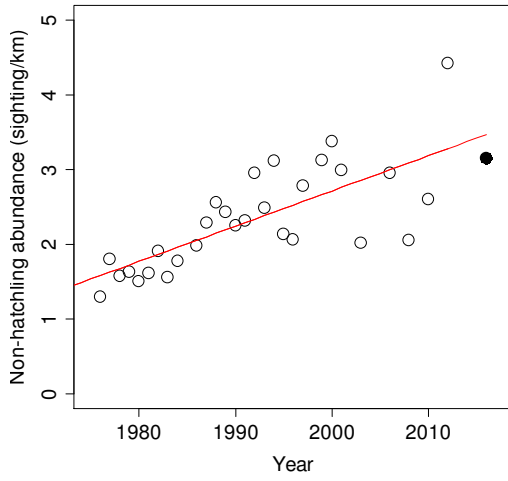
The Adelaide River, which showed possible slight decrease in the recent years after having reached an asymptote, is now thought to have reached a stable population level. The observed slight decline in population abundance is no longer apparent when the last four years of survey data is included in the analysis. The reported decline is thought to be a survey data artefact rather than an actual decline. This artefact is most likely a combination of environmental variability and survey error (precision). Concurrent with the stable population density in the Adelaide River is an ongoing shift in the size distribution of the population showing a proportional shift to larger animals, particularly in the two to three metre size range. In considering this population shift to larger animals the stable population abundance, rather than indicating a harvest impact is more reasonably interpreted as indicating a stabilising mature population. The Adelaide River is the only river that DENR surveys annually and the stable (asymptote) population state was confirmed by the 2015 and 2016 monitoring results.

Results for the South Alligator River also supported a stable population state, with both abundance (density) and biomass approaching the logistic model asymptote. The East Alligator still appears to be increasing strongly (based on the best fit model), however the most recent monitoring abundance and biomass estimates are less than recent prior results and this river could also be approaching a stable population state. Additional monitoring data is required and DENR has committed to assisting KNP on future surveys and providing data analysis.

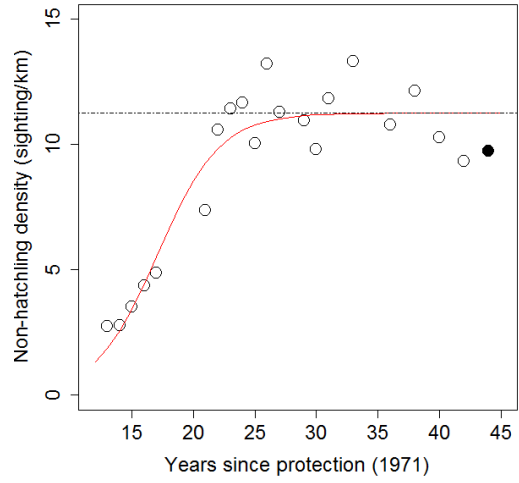
Figure 6 Abundance density (sighting/km) of non-hatchling *C. porosus*. Data are for 2016 for the Adelaide, Daly and Arnhem Land rivers and 2015 for the South Alligator River.



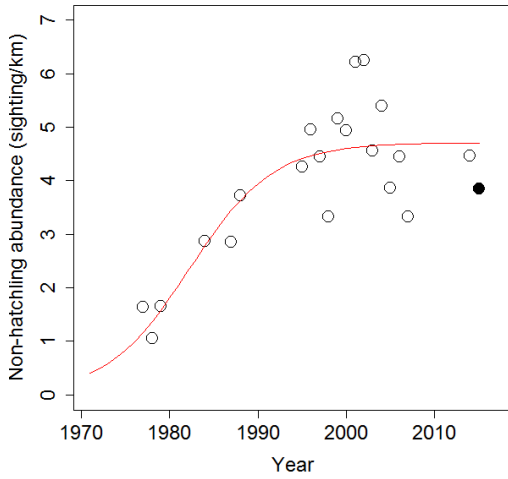
Liverpool River mainstream (abundance density)



Mary River (Sampan Creek) (CP abundance density)



South Alligator River (abundance density)



Tomkinson River mainstream (abundance density)

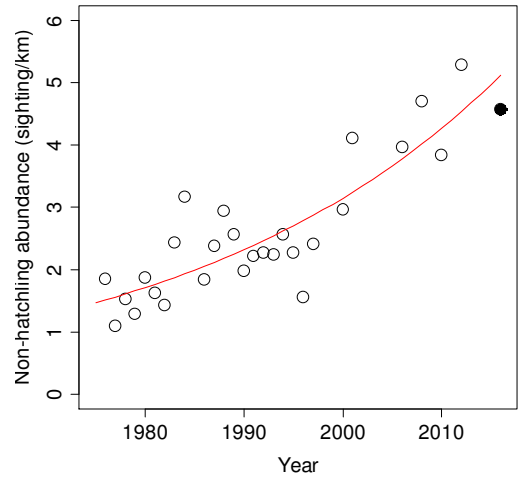


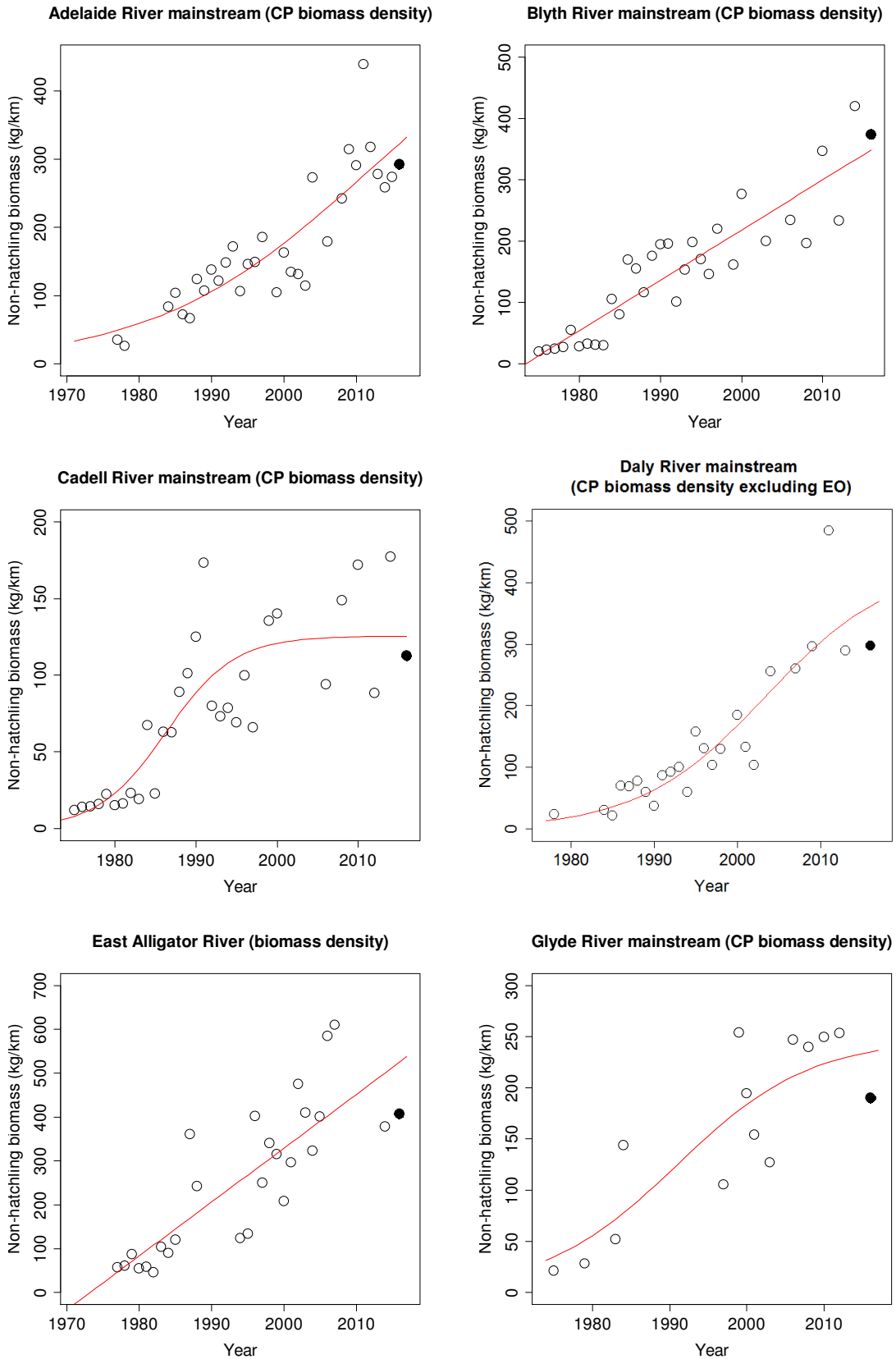
Table 9: Results of model selection fitted to the abundance density of non-hatchling *C. porosus*. N = number of years surveyed, AICc = Akaike information criterion corrected for a small sample size, Δ_i = difference in AICc, w_i = Akaike weight (-- not converged).

River	Year (N)	Model	AICc	Δ_i	w_i
Adelaide River	1977-2016 (32)	Logistic	55.46	0.00	0.93
		Exponential	-	-	-
		Linear	60.51	5.05	0.07
Blyth River	1975-2016 (32)	Logistic	85.86	2.44	0.15
		Exponential	83.42	0.00	0.49
		Linear	84.06	0.00	0.36
Cadell River	1975-2016 (31)	Logistic	--	--	--
		Exponential	64.24	0.00	0.52
		Linear	64.40	0.16	0.48
Daly River	1978-2016 (25)	Logistic	22.89	0.00	0.57
		Exponential	70.78	47.89	0.00
		Linear	23.41	0.54	0.43
East Alligator River	1977-2015 (25)	Logistic	81.62	2.26	0.24
		Exponential	--	--	--
		Linear	79.37	0.00	0.76
Glyde River	1975-2016 (14)	Logistic	328.56	297.70	1.00
		Exponential	--	--	--
		Linear	30.86	0.00	0.00
Liverpool River	1976-2016 (29)	Logistic	42.73	0.88	0.39
		Exponential	--	--	--
		Linear	41.85	0.00	0.61
Mary River (Sampan Creek)	1984-2015 (21)	Logistic	73.41	0.00	1.00
		Exponential	105.48	32.07	0.00
		Linear	102.37	28.96	0.00
South Alligator River	1977-2015(25)	Logistic	55.01	0.00	0.99
		Exponential	67.23	12.22	0.00
		Linear	64.18	9.17	0.01
Tomkinson River	1976-2016 (29)	Logistic	50.89	2.52	0.19
		Exponential	48.37	0.00	0.67
		Linear	51.52	3.16	0.14

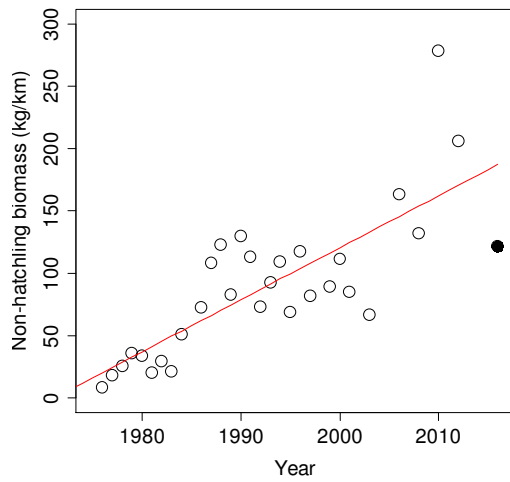
Results: Non-hatchling biomass

Unlike the abundance density, the biomass density continued to increase without reaching asymptote in most rivers (Figure 7 & Table 10). This indicates that individual animals are still getting larger even in rivers where 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.

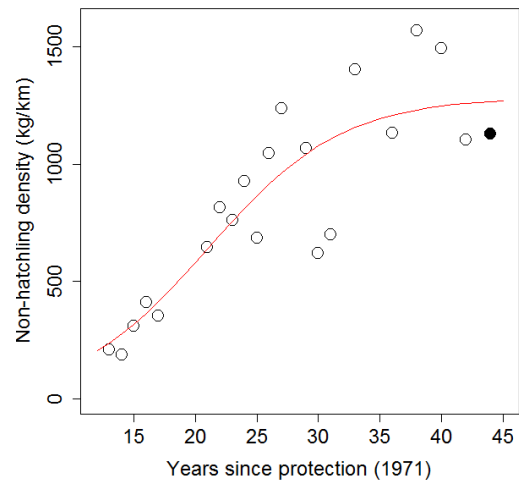
Figure 7 Biomass density (kg/km) of non-hatchling *C. porosus*. Data are for 2012 for Arnhem Land Rivers and 2013 for Adelaide, Daly and Mary Rivers.



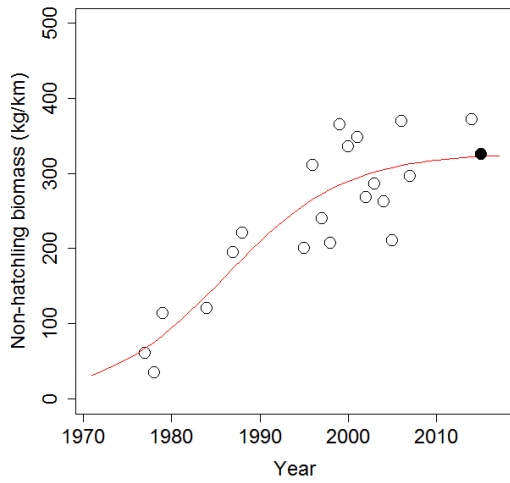
Liverpool River mainstream (biomass density)



Mary River (Sampan Creek) (CP biomass density)



South Alligator River (biomass density)



Tomkinson River mainstream (biomass density)

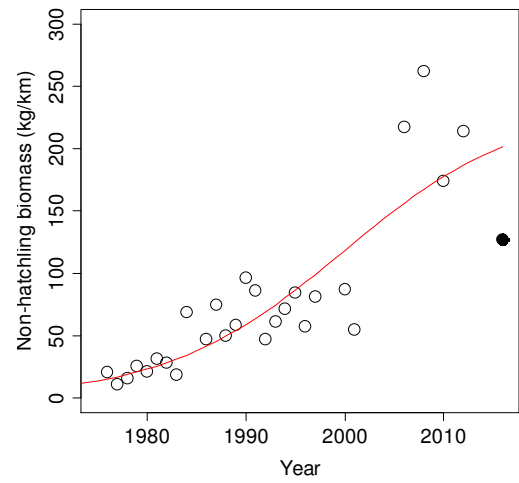


Table 10: Results of model selection fitted to the biomass density of non-hatchling *C. porosus*. N = number of years surveyed, AICc = Akaike information criterion corrected for a small sample size, Δ_i = difference in AICc, w_i = Akaike weight (-- not converged).

River	Year (N)	Model	AICc	Δ_i	w_i
Adelaide River	1977-2016 (32)	Logistic	343.87	0.86	0.39
		Exponential	-	-	-
		Linear	343.01	0.00	0.61
Blyth River	1975-2016 (32)	Logistic	343.42	6.81	0.03
		Exponential	344.19	7.57	0.02
		Linear	336.61	0.00	0.95
Cadell River	1975-2016 (31)	Logistic	302.89	0.00	0.84
		Exponential	--	--	--
		Linear	306.21	3.32	0.15
Daly River	1978-2016 (25)	Logistic	270.89	0.00	0.71
		Exponential	274.10	3.21	0.14
		Linear	274.00	3.07	0.15
East Alligator River	1977-2015 (25)	Logistic	327.20	0.66	0.42
		Exponential	--	--	--
		Linear	326.54	0.00	0.58
Glyde River	1975-2016 (14)	Logistic	153.75	2.43	0.23
		Exponential	--	--	--
		Linear	151.32	0.00	0.77
Liverpool River	1976-2016 (29)	Logistic	307.95	3.46	0.13
		Exponential	307.98	3.50	0.13
		Linear	304.48	0.00	0.74
Mary River (Sampan Creek)	1984-2015 (21)	Logistic	286.16	0.00	0.69
		Exponential	296.45	7.29	0.02
		Linear	290.92	1.76	0.29
South Alligator River	1977-2015(25)	Logistic	228.76	0.00	0.61
		Exponential	235.41	6.64	0.02
		Linear	229.80	1.04	0.37
Tomkinson River	1976-2016 (29)	Logistic	283.25	0.00	0.48
		Exponential	286.17	2.93	0.11
		Linear	283.60	0.35	0.41

APPENDIX 3. Production statistics from crocodile farms (2015-2016).

C. Porosus stock and production on farms in the Northern Territory for 2015/2016 are summarised in Table 11.

Table 11: *C. Porosus* held on farms in the Northern Territory in 2015/2016. 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 1/02/2015	Farm-bred hatchlings	Total acquired	Crocodiles processed	Total lost	Stock held 31/01/2016
A	19,850	0	7,165	5,851	10,856	16,159
B	5,771	0	3,419	0	4,317	4,873
C	23,175	402	15,671	116	14,327	24,805
D	4,994	70	11,560	0	10,895	5,659
E	1,082	0	1,895	0	616	2,361
F	67,988	6,819	20,735	10,116	14,106	74,617
G	55	0	16	0	5	66
H	7,516	407	3,014	1,852	4,076	6,454
I	0	0	267	0	0	267
Totals	130,431	7,698	63,742	17,935	59,198	137,661