

SALTWATER CROCODILE (*Crocodylus porosus*) MANAGEMENT PROGRAM:

2007-2009 Monitoring Report

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Summary

This report reviews the results of the Saltwater Crocodile (*Crocodylus porosus*) monitoring program from 2007 to 2009 (2007/08 to 2008/09 in financial year where appropriate) from the Northern Territory Department of Natural Resources, Environment, the Arts and Sport (NRETAS).

Spotlight surveys showed that the population of non-hatchling *C. porosus* continued to increase or remain stable between 2007 and 2009 in all 12 rivers monitored.

The results indicated that the average size of *C. porosus* (both length and as measured by biomass) has been increasing, probably reflecting the continued maturity of individual animals as the population recovers from the high levels of take in the period 1945 to 1971.

A total of 422 crocodiles were removed over the two years by NRETAS staff for public safety and to protect stock in pastoral areas. A further 326 animals were removed by private operators for similar reasons or were harvested for commercial gain.

Totals of 37,608 and 33,117 saltwater crocodile eggs were harvested in 2007/08 and 2008/09, respectively. The harvest in 2007/08 exceeded the annual quota of 25,000 eggs at the time. As a result, the systems and processes for managing the crocodile egg harvest were revised. This included fine-tuning the permit system and processes; upgrading databases and using a Geographic Information System (GIS) to manage crocodile harvest and population survey data. The improved processes ensured strict monitoring of harvest and the harvest in 2008/09 remained within the harvest ceiling (35,000 eggs).

Few hatchling, juvenile or adult crocodiles were harvested in 2007/08 and 2008/09. Harvests in all the years were significantly lower than the current quota of 500 juveniles and 600 adults per year.

The number of operating crocodile farms and the amount of skins and meat produced mostly remained steady between 2007/08 and 2008/09 with an average of 11,679 skins and 54,967 kilograms of meat processed each year.

INTRODUCTION

This Monitoring Report reviews the implementation of the Management Program for *Crocodylus porosus* in the Northern Territory, which fulfils the obligations for a wildlife trade management plan under the *Environmental Protection and Biodiversity Conservation Act 1999*. A sustainable crocodile ranching industry in the Northern Territory is reliant on meeting the obligations laid out by the management program.

There have been major changes in the management of crocodiles in the Northern Territory since the last Monitoring Report was submitted in early 2008. As a result of the issues highlighted in the report and concerns expressed by the Australian and Northern Territory governments and stakeholders, the Northern Territory Department of Natural Resources, Environment the Arts and Sport (NRETAS) has reviewed and upgraded its processes and systems relating to the sustainable use of crocodiles. As part of this process a commitment was made to the Department of Environment, Water, Heritage and the Arts (DEWHA) to:

- Develop a new Draft Management Program by June 2009
- Allocate no more than the agreed ceiling of eggs or animals
- Develop a GIS to aid allocation and monitoring of harvest

The egg harvest allocation system has been upgraded by improving databases and developing a GIS to store and analyse population and harvesting data as both a spatial database and decision support tool. This allows NRETAS to accurately track spatial and temporal patterns of egg harvest and to more closely link harvest data with population surveys and essential habitat. The ability to spatially analyse crocodile data with environmental layers has improved the decision-making processes for allocation of the harvest quota.

Other changes and improvements implemented include:

- An annual closing date for all egg harvest applications;
- A consistent end date for all permits and harvest returns;
- Stringent enforcement of the due date for returns and harvest limits; and
- Allocation of egg harvests on a regional or catchment (ecological habitat) basis with appropriate limits or quotas.

In addition DEWHA agreed to a request by the Territory to allow a harvest of up to 35,000 eggs for the 2008/09 harvest season.

Reporting requirements of the 2005-2010 management program (PWSNT 2005) relating to the sustainable use of *C. porosus* are outlined in:

- Section 6.2 Reporting (Wild harvests, crocodile farm stocks, and crocodile population monitoring);
- Section 5.2.4 Licensing, inspections and returns (permit returns by crocodile farms); and
- Section 5.1.3 Performance indicators.

A new Management Program (Leach *et al* 2009) has been developed since the last monitoring report, and approved by the Australian Government Minister for the Environment, Heritage and the Arts on 29 September 2009 (the program approval specifically excluded any safari hunting of crocodiles). More comprehensive milestones, performance indicators and reporting requirements are outlined in the 2009-2014 Program, Section 4 (Management practices and performance measures) and summarised in Appendix 4.

This Monitoring Report is consistent with the requirements of both programs although it largely follows the format of the 2009-2014 program. The 2009-2014 Program has four objectives:

1. To facilitate the sustainable use of Saltwater Crocodiles;
2. To promote community awareness and public safety;
3. To ensure the humane treatment of Saltwater Crocodiles; and
4. To monitor and report on the impact of the harvest of Saltwater Crocodiles.

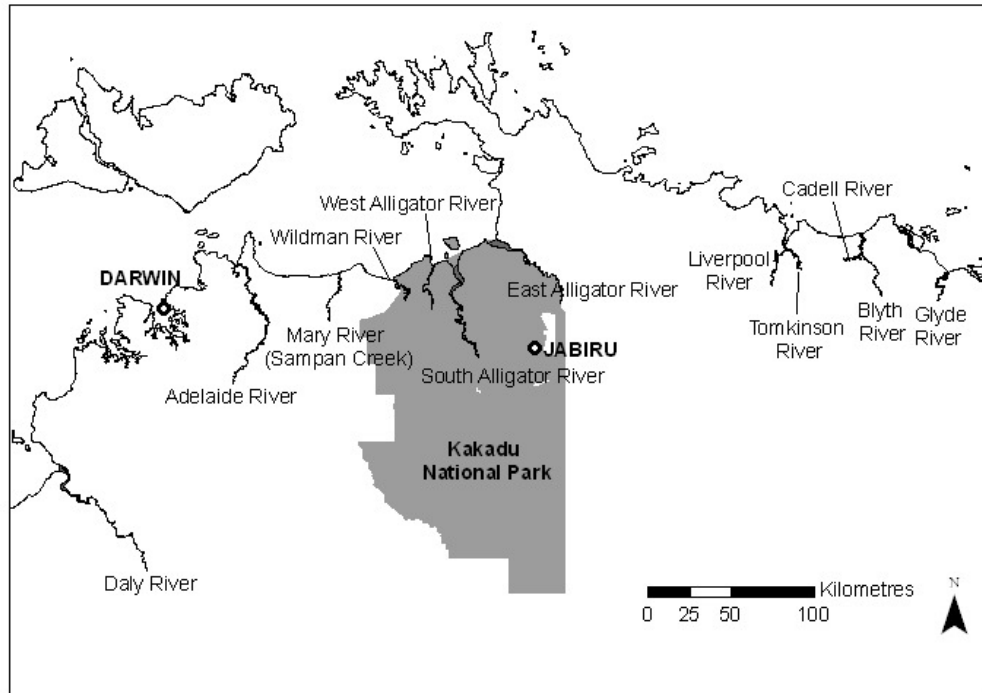
This report specifically addresses objective 4, with some consideration of the other three objectives. The status of each milestone as defined in the new Management Program is summarised in Appendix 1.

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), NRETAS and individual NRETAS parks. This report focuses on results the NRETAS monitoring program, supplemented by monitoring data from Parks Australia North. The standardised spotlight monitoring program started in 1975 and has continued since then in specific rivers where significant, regular harvesting occurs (Appendix 2).

Under the 2009-2014 Management Program, the NRETAS monitors the Daly River, Adelaide River, Mary River, Liverpool River, Tomkinson River, Blyth River, Cadell River and Glyde River on a biennial basis (Figure 1). 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.

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

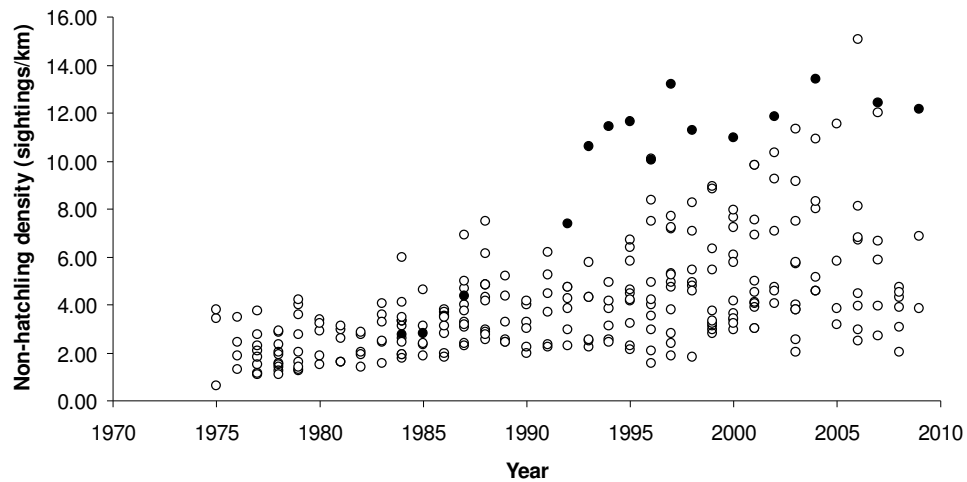


All the monitoring rivers have been surveyed at least once in the two years since the last Monitoring Report. For the rivers in Kakadu summarised data from the 2008 surveys are not yet available, and the 2009 surveys have just been undertaken, and hence these data are not included in this report.

General trends

Results from the monitoring program have shown that the population of wild non-hatchling *C. porosus* has largely increased since protection in 1971 and the introduction of farming in 1980 (Figure 2 and Appendix 2).

Figure 2 Density of non-hatchling (> 60 cm) including eyes-only) *C. porosus* calculated from standardised spotlight surveys in 12 tidal rivers since protection in 1971. Closed symbols are from the Mary River that is known to have particularly high densities and open symbols are from all other rivers.



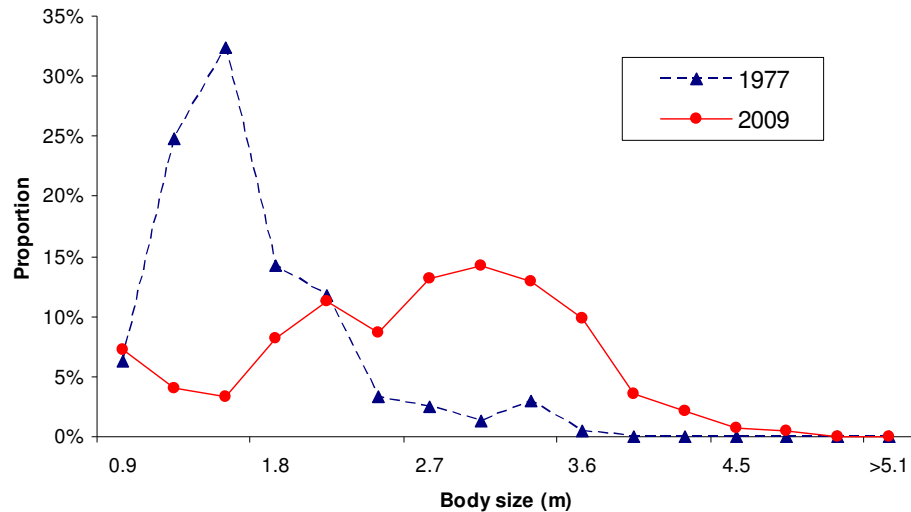
Analyses of recent surveys continue to suggest that the rate of increase of crocodile populations in some rivers is slowing or approaching equilibrium (Delaney *et al.* 2007; Fukuda *et al.* 2007; Leach *et al.* 2009). Crocodile populations in the Adelaide River, Mary River (Sampan Creek), Wildman River, West Alligator River, South Alligator River and Liverpool River may be reaching an equilibrium density, whilst populations in the Daly River, East Alligator River, Tomkinson River, Blyth River and Glyde River are still increasing (Appendix 2). No monitored river shows clear evidence of a population decrease; nor is there evidence that the harvesting program has had a detrimental impact on crocodile populations.

Size/Age Structure

The length of a crocodile gives an indication of its age and can be used to monitor relative changes in the population age structure. Current assessment indicates that the size/age structure of the crocodile population in each monitored river appears to be shifting from smaller crocodiles to a higher proportion of larger crocodiles (Figure 3) with an associated increase in biomass (Appendix 2). Whilst a number of the monitored rivers appear asymptotic for crocodile biomass, in six of the rivers biomass continues to increase even when the numbers of crocodiles appears to have stabilised 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.

Figure 3 Change in *C. porosus* population size structure in the Adelaide River in 1977 (n=238) and 2009 (n=416).

Adelaide River



Problem crocodiles

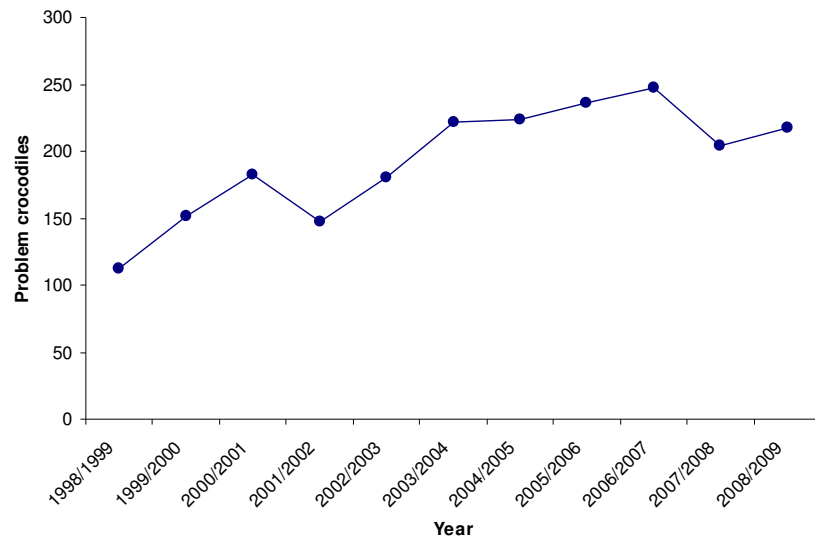
Problem crocodiles are defined broadly as those individuals that occur within settled areas or areas of recreational use, where public safety is a prime consideration; and those that attack stock in pastoral areas. In some areas, such as Darwin Harbour and the Katherine River near Katherine, any *C. porosus*, regardless of size, is classed as a problem animal. NRETAS staff set traps in these waters and regularly patrol them to remove any crocodiles found. NRETAS also responds to reports of problem crocodiles on a case by case basis.

The Management Program allows for problem crocodiles to be killed and used directly 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.

A total of 422 problem crocodiles were removed between July 2007 and June 2009 (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 area and other communities.

Table 1 Total number of *C. porosus* removed as problem crocodiles in 2007/2008 and 2008/2009.

Year	Problem crocodiles	Males
2007/08	204	78%
2008/09	218	64%

Figure 4 Changes in the numbers of *C. porosus* removed by NRETAS staff in recent years.

HARVESTS FROM THE WILD

Eggs

Under the 2005-2010 Management Program up to 25,000 eggs could be harvested from the wild each year; however a revised total of 35,000 eggs for the 2008/09 season was agreed to by the Northern Territory and Australian governments.

The number of eggs collected in the different areas varies, depending on contingencies such as the amount and timing of rainfall, cyclones, local flooding and individual nesting success.

NRETAS determines egg harvest permits on application, based on current knowledge of the number of crocodiles and nests in each of the individual areas. A change from one year permits to a mix of 1 to 3 year permits and changes in staff (as outlined in the 2007 Monitoring Report) resulted in the number of eggs harvested exceeding the egg quota in the 2007/08 season (Tables 2 and 3).

Table 2 The number of *C. porosus* (eggs) harvested for commercial use in 2007/08 and 2008/09.

Season	Harvest Ceiling	Total eggs harvested	Viable eggs (%)
2007/08	25,000	37,608	32,562 (87%)
2008/09	35,000	33,117	N/A*

* Insufficient viability data has been provided to date for the 2008/09 harvest season to calculate egg viability.

Table 3 The number of *C. porosus* (eggs) harvested for commercial use in 2007/08 and 2008/09 from the catchments of rivers monitored by NRETAS

River	2007/08	2008/09
Adelaide	6,322	5,385
Daly (including Moyle)	5,933	4,368
East Alligator	4,975	2,978
Mary	2,379	2,214
Wildman	242	201
Arnhem (Liverpool, Tomkinson, Blyth, Cadell, Glyde)	4,602	5,589
Total	24,453	20,735

The returns of permit holders are monitored to ensure that the stock taken under permit complies with the conditions of the permit (see Permits and Compliance section below).

Hatchlings, juveniles and adults

Under the 2005-2010 Management Program up to 500 hatchlings (total body length <0.6 m¹), 500 juveniles (total body length 0.6 - 2.1m) and 600 adult (total body length >2.1m) *C. porosus* can be directly harvested from the wild each year. This has been modified to 500 hatchlings, 400 juveniles and 500 adults in the 2009-2014 Management Program. These quotas do not include any problem crocodiles removed by NRETAS staff (which are reported separately in Table 1 above).

A small number of hatchling and juvenile *C. porosus* were directly harvested from the wild during this period (Table 4). A greater number of adults were harvested – largely as they were considered to be of concern to livestock – but this harvest was still well below the approved ceiling. Most of these crocodiles were harvested from pastoral properties and this adult take is extremely biased towards females (Table 5). The average size of these animals in males and females is provided in Table 6.

Table 4 The number of *C. porosus* (hatchlings, juveniles and adults) harvested for commercial use in 2007/08 and 2008/09.

Year	Hatchlings	Juveniles	Adults
2007/08	6	6	17
2008/09	138	32	128

Table 5 Sex ratio (percentage of females) of *C. porosus* harvested for commercial use in 2007/08 and 2008/09.

Year	Juveniles	Adults
2007/08	83.3%	64.7%
2008/09	N/A ²	96.0%

Table 6 Average body size of *C. porosus* (juveniles and adults combined) for each sex harvested for commercial use in 2007/08 and 2008/09.

¹ Note that the 2005-2010 Management Program defined hatchlings as <0.4m and juveniles as 0.4 – 2.2m, however in this report and in the new Management Program the conventional definitions of hatchlings as animals <0.6m (2 ft) and juveniles as 0.6 – 2.1m (7 ft); are used.

² Only 16 juveniles were able to be sexed as it is difficult to distinguish between the sexes in smaller (<1m) animals.

³ Data required to estimate on farm breeding not available until end of 2009 calendar year.

Year	Female	Male
2007/08	2.41 m	4.08 m
2008/09	2.50 m	3.54 m

FARM PRODUCTION

Six crocodile farms have consistently operated between 2007 – 2009. On average the farms produced 11,679 skins and 54,967 kilograms of meat each year (Table 7). Details of the stock held on each farm and products produced in 2007 - 2009 are provided in Appendix 3.

Table 7 The number of *C. porosus* eggs, belly skins and meat (kg) produced by crocodile farms in the Northern Territory for the 2007/08 and 2008/09.

Year	No. farms	Farm-bred eggs	Belly skins	Meat (kg)
2007/08	7	7,431	9,594	52,157
2008/09	6	NA ³	13,763	57776

The Department of Regional Development, Primary Industries, Fisheries and Resources (RDPIFR) has undertaken full audits of the hatchlings in farms every year to validate farm returns (Appendix 3). A full animal audit scheduled every five years and due in 2007 was not undertaken due to occupational health and safety issues. This audit is no longer required under the 2009-2014 Management Program.

PERMITS & COMPLIANCE

The following is a summary of permits and compliance for the 2008/2009 egg collecting season:

- A total of 38 individual permits to collect crocodile eggs were issued.
- Five crocodile farms were audited to check quantities of eggs in incubators against farm records and monthly returns for crocodile egg collection permits submitted to NRETAS. No serious breaches of permit conditions were detected and the level of cooperation with, and support for, the compliance audits was very high. Those facilities where a few minor discrepancies (generally only 1-2 eggs) were detected have been asked to review their data recording systems to help reduce potential data errors.
- To further reduce potential data recording and reporting errors, NRETAS is looking at standardising the minimum amount of data that is required under permit conditions and recorded during egg collection and incubation. A set of draft data recording sheets have been prepared for review by the farms.
- Two egg collection permits were field audited to check reported nest locations against actual field locations for nests.
- Four reported compliance issues were investigated; however there was insufficient evidence to take further action.
- Crocodile egg collection permit holders were required to submit monthly returns during the 2008/2009 crocodile egg collection season and a final return after the close of the season. All returns were submitted, however in a number of instances returns were submitted either late or only after direct intervention by NRETAS. Non-compliance was dealt with through warning letters, caution notices or infringement notices as appropriate.
- For the 2008/2009 crocodile egg collection season, collectors were required as a condition of permit, to provide prior notification of date and location of collection activity via a dedicated

phone number and message bank. Compliance for this trial system was limited due to both technical difficulties associated with the service and reluctance by some collectors to provide this information. Non-compliance was dealt with through warning letters, caution notices or infringement notices as appropriate.

- There was regular interaction with all other relevant jurisdictions; including a two day meeting with Queensland and Western Australia counterparts, largely to discuss problem crocodiles and other matters of joint concern.

WELFARE

The Code of Practice on the Humane Treatment of Captive and Wild 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.

One minor captive crocodile welfare issue is currently being investigated.

ACKNOWLEDGMENTS

Kakadu National Park provided data on the Wildman and West, South and East Alligator Rivers.

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APPENDIX 1. ANNUAL MILESTONE MATRIX FOR 2009-2014 PROGRAM

Milestone	Program Reference	2009/10	Status for 2007-09 Monitoring report
Objective 1 - To facilitate the sustainable use of Saltwater Crocodiles			
Ensure all harvest permits minimise the possible negative impact on or conflict with tourism, social or cultural interests.	4.1 Restrictions on live animal harvesting.	Ongoing	Done. Compliant. Standard part of permit assessment process.
Develop and implement a GIS database to assist with both allocation of eggs and monitoring harvest effort and compliance.	4.1 Harvest ceilings.	Commence	Initial development phase complete. Will be trialled for 2009-10 egg harvest season.
Investigate and take appropriate action on all suspected local impacts on the population.	4.1 Harvest ceilings.	Ongoing, review	No detected or reported local impacts.
Instigate adaptive management actions should there be any increased threats to the Saltwater Crocodile and their habitat.	4.1 Harvest ceilings.	Ongoing, review	No actions required as no perceived threats.
Ensure the harvest ceiling is set in accordance with the provisions of this management program.	4.1 Harvest ceilings.	July - September	The 2008/09 harvest ceiling was set at 35,000 eggs as per agreement with DEWHA. Permits were issued to harvest a total of 35,000 eggs.
Assess all permit applications and ensure egg allocation is distributed across harvest regions in accordance with the provisions of this management program.	4.1 Harvest ceilings	September - October	All permits applications were assessed. Eggs were allocated across the harvest regions as per the management program and publicly available criteria published on the internet.
Ensure that the annual commercial harvest of Saltwater Crocodiles does not exceed the approved ceiling for each category.	4.2 Permits and compliance.	July - September	2007/08 – non compliant for eggs, compliant all other categories. 2008/09 – compliant all categories.
Assess applications and issue permits under the <i>TPWC Act</i> .	4.2 Permits and compliance	Ongoing	2007/08 – not compliant 2008/09 - compliant. Standardised assessment process.
Monitor and audit harvest applications, approvals and returns and investigate and resolve any discrepancies.	4.2 Permits and compliance	Ongoing, review	Compliant; this is a standard part of the permitting system and processes.
Ensure all permit applications have correct landholder approval.	4.2 Permits and compliance	Ongoing, review	Compliant. One dispute as to correct landholder approval in 2008/09 season.
Ensure monthly farm stock returns comply with permit conditions and are reported half yearly to farms and NRETAS.	4.2 Permits and compliance	Ongoing, review	Compliant for 2007//08 season and returns are being finalised for 2008/09.
Audit farm hatchlings annually.	4.2 Permits and compliance	annually	Annual hatchling audits undertaken for the 2007/08 harvest season. Audits currently in progress for the 2008/09 egg harvest season.
Ensure compliance with the issue of skin tags and permits.	4.2 Permits and compliance		Compliant for skin tag and permits.
Conduct random checks on farm stock numbers.	4.2 Permits and compliance	Ongoing	None undertaken in 2007/08. In 2008/09 egg numbers were checked against permits semi-randomly at five farms. High level of compliance with permit requirements.

Milestone	Program Reference	2009/10	Status for 2007-09 Monitoring report
Review permit conditions annually and amend where necessary.	4.2 Permits and compliance	July - September	Permit to Take Protected Wildlife including amendments to Permit Schedules and conditions for 2009/10 egg harvest season has been updated. NRETAS and the Department of Justice are currently committed to reviewing all permits issued under the TPWC Act.
Ensure compliance with permit conditions is at or near 100% and addressing permit breaches through warning letters, caution notices, infringement notices or prosecution is at or near 100%.	4.2 Permits and compliance	annually	Known compliance with permit conditions is very high. Since 2008 investigation of non-compliance has increased and has been at or near 100%. Non-compliance has been dealt with through warning letters, caution notices or infringement notices as appropriate.
Review and analyse available data to describe changes to Saltwater Crocodile populations and their distribution and publish the outcomes as appropriate.	4.3 Management-focused research.	Commence	In progress. Stage-based structured matrix model of crocodile population in the Northern Territory has been developed.
Develop population/harvest simulation models to provide an additional decision support tool to assess harvest options and possible harvest impacts at different spatial scales.	4.3 Management-focused research.	Commence	Substantially completed. To be trialled for the 2009/10 harvest season.
Objective 2 - To promote community awareness and public safety			
Analyse the risk of areas where human interaction with crocodiles may occur and prepare options for the appropriate level of management actions.	Risk Assessment	Commence	Completed.
Analyse problem crocodile capture data to assess trends and identify areas of increasing risk to humans.	Risk Assessment	Commence	Commenced.
Develop and implement a 'CROCWISE' plan to educate and heighten the awareness of the dangers of crocodiles in the Northern Territory's waterways.	Risk Assessment	Commence	CrocWise program approved and being developed for the 2009-10 wet season.
Issue permits to remove problem crocodiles as necessary and appropriate.	4.4 Removal of problem crocodiles.	Ongoing, as needs	Ongoing.
Maintain the program to remove all crocodiles in designated 'Intensively Managed' zones.	4.4 Removal of problem crocodiles.	Ongoing	Ongoing.
NRETAS responds to reports of problem crocodiles and implements appropriate management measures.	4.4 Removal of problem crocodiles.	Ongoing as needs	Ongoing.
Re-define the Darwin Harbour 'Intensively Managed' zone to include high risk areas of the entire catchment and include the waterways of the Darwin rural area.	4.4 Removal of problem crocodiles.	Commence	Completed; management options currently under consideration.
Continue to conduct public awareness, safety and educational message campaigns through Northern Territory Government staff, effective use of the media and on the Northern Territory Government website.	4.5 Community awareness and participation.	Ongoing, as needs	CrocWise program approved and being developed for the 2009-10 wet season.

Milestone	Program Reference	2009/10	Status for 2007-09 Monitoring report
Conduct market research to assess the best communication methods for targeting and informing all sectors of the community about living safely with crocodiles.	4.5 Community awareness and participation	Commence	Not undertaken as yet; due to be commenced as part of the CrocWise program.
Develop and implement a public safety communication plan.	4.5 Community awareness and participation	Commence	CrocWise program approved and being developed for the 2009-10 wet season.
Objective 3 - To ensure humane treatment of Saltwater Crocodiles			
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	4.6 Animal welfare	Ongoing	Compliant.
Ensure all successful permit applicants are competent to comply with the relevant animal welfare standards.	4.6 Animal welfare	July - September	Increased and ongoing presence on Farms and with other permit holders.
Ensure all crocodile farms meet animal welfare standards.	4.6 Animal welfare	Ongoing	Ongoing audits and on an as-needs basis. Welfare conditions are audited when NTG staff are on Farms or visiting other permit holders
Inspect farms regularly to ensure animal welfare standards are met.	4.6 Animal welfare	Ongoing	Ongoing audits and on an as-needs basis.
Investigate and take appropriate action on any suspected breaches of the <i>Animal Welfare Act</i> or the Code of Practice.	4.6 Animal welfare	Ongoing as needs	One minor incident is currently being investigated.
Objective 4 - To monitor and report on the impact of the harvest of Saltwater Crocodiles			
Continue the population survey program for Saltwater Crocodiles as stipulated in this program.	4.7 Monitoring	Commence June-September	Compliant.
Analyse and assess the results of the survey program and implement any resulting management recommendations.	4.7 Monitoring	July - September	No major actions required. Mary River Sampan to be re-surveyed in 2010 due to inappropriate tides for survey in 2009.
Annually audit the progress of the Management Program against each of the performance indicators and adjust management practices as necessary.	4.8 Reporting	March	As recorded in this report.
Submit annual reports to the Australian Government and provide a summary on the Northern Territory Government website.	4.8 Reporting	October	As recorded in this report.
Review and update the Management program by 2014.	4.8 Reporting		Not applicable.

APPENDIX 2. POPULATION SURVEY METHODS - SPOTLIGHT SURVEYS

Crocodiles are surveyed using a small boat and a hand held spotlight. These surveys are timed to coincide with a low tide during the colder, dry season (June-September) to maximise the number of crocodiles visible. At least three people are involved: a coxswain, an observer and a data recorder/navigator. The red eye-shine of a crocodile is detectable from a distance of a few hundred metres.

When an eye-shine is seen an attempt is made to approach within a few metres of the crocodile to accurately estimate its size. By convention, sizes are estimated in feet (30cm intervals) rather than metres. Most crocodiles are in the water when sighted and their total length must be estimated from head length (total length = approximately 7 times of head length). If a size estimate is not possible such as if the crocodile submerges when approached, the individual is recorded as eyes only (EO), and no species identification is assumed. Further detail on the survey methods used is described in Messel *et al.* (1981) and Webb *et al.* (1998).

The length of river surveyed in a particular year is dependant upon the ability to navigate the river although a consistent length over years is attempted. Obstructions such as sand and rock banks and bars when coupled with tide height can reduce the navigable length of river to less than the survey maximum (see Table 8).

Spotlight surveys provide the following data:

1. Total number of crocodiles sighted including EO (a proportion of the actual population) in a given length of river
2. Detailed size structure (at 30cm intervals) of the population of sighted animals that are approachable.

Spotlight counts (Tables 8 and 9) are an index of actual population size that under-estimate the total population as not all crocodiles can be sighted during surveys. Moreover, the areas surveyed are mostly in tidal rivers whereas many high quality habitats with a high density of crocodiles such as wetlands and floodplains are too difficult to access for surveys.

Table 8 River length surveyed and the number of *C. porosus* (excluding hatchlings and EO) sighted in the spotlight surveys in 2007-2009 undertaken by NRETAS.

River	Year	Distance surveyed (km)	Crocodiles sighted
Daly	2007	65	271
	2009	99	326
Adelaide	2008	133	442
	2009	128	416
Mary	2007	41	397
	2009	42	375
Liverpool	2008	58	89
Tomkinson	2008	47	153
Cadell	2008	30	67
Blyth	2008	42	153
Glyde	2008	49	171

Table 9 Rivers in Kakadu surveyed in 2007-2009 (only data from 2007 are available as yet).

River	2007	2008	2009
Wildman	✓	✓	-
West Alligator	✓	✓	✓
South Alligator	✓	✓	✓
East Alligator	✓	✓	✓

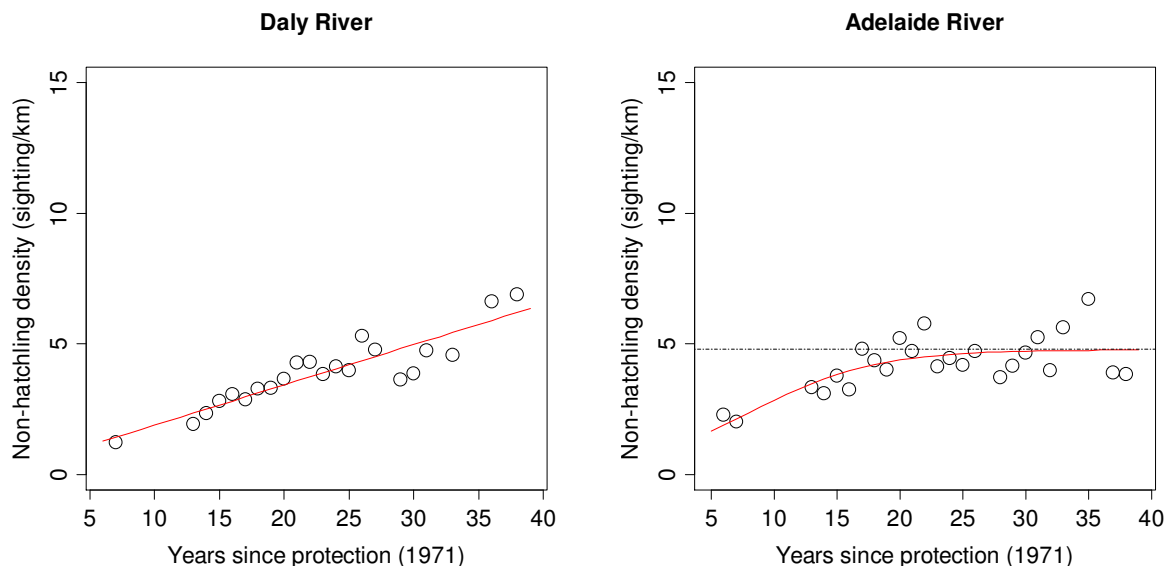
Analysis of non-hatchling density in individual rivers

Non-hatchling density

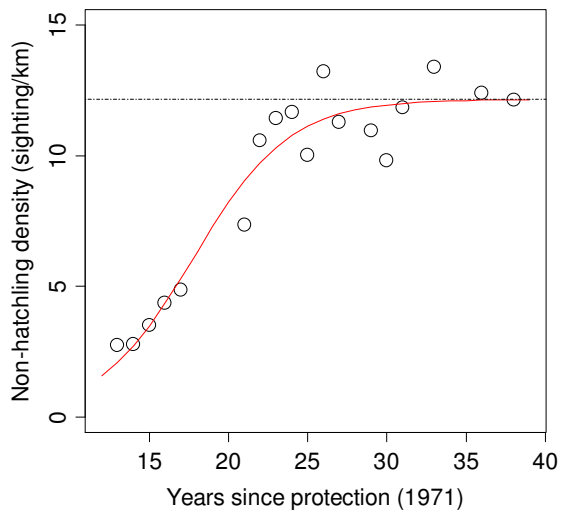
Spotlight survey data are primarily used to estimate the density of crocodiles in individual rivers as an index of the total crocodile population in the catchment. To detect long-term trends, hatchlings are excluded from the analysis because the numbers of hatchling crocodiles fluctuate widely in response to rainfall and flooding, adding considerable noise to the data. EO sightings are assumed to be non-hatchling and proportioned to species based on identified sightings to be included in the analysis as in Webb *et al.* (1998). Densities are calculated as in abundance (sighting/km) and biomass (kg/km) (Webb *et al.* 1984; Leach *et al.* 2009).

Estimated density is plotted for all years since the 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 10 and 11), with the line of best fit plotted for each river (Figures 5 and 6).

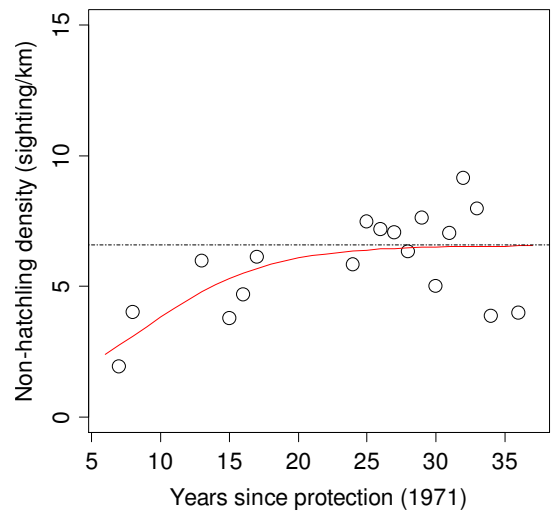
Figure 5 Abundance density (sighting/km) plots with data up to 2007 (Kakadu), 2008 (Arnhem) and 2009 (Daly, Adelaide, Mary). Where the logistic model fitted best, the expected asymptote is shown with a dashed line.



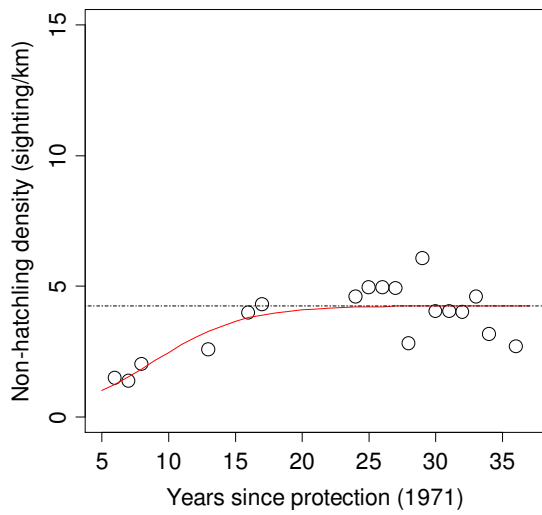
Sampan Creek



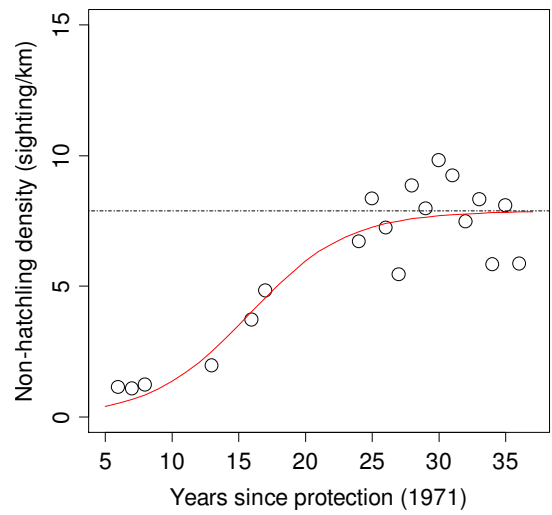
Wildman River



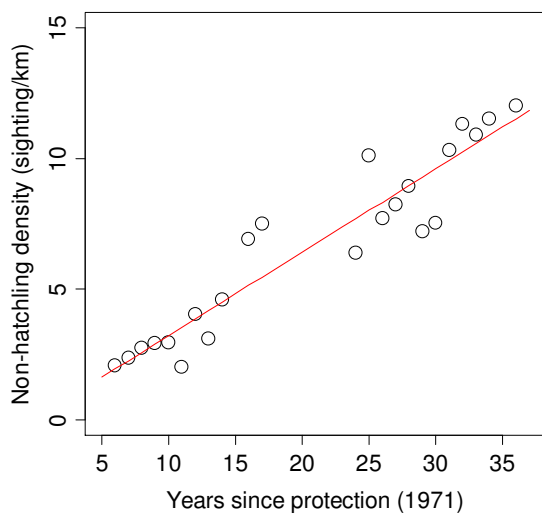
West Alligator River



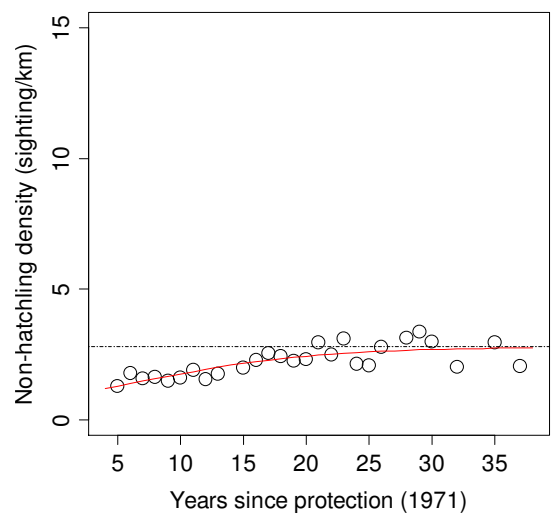
South Alligator River



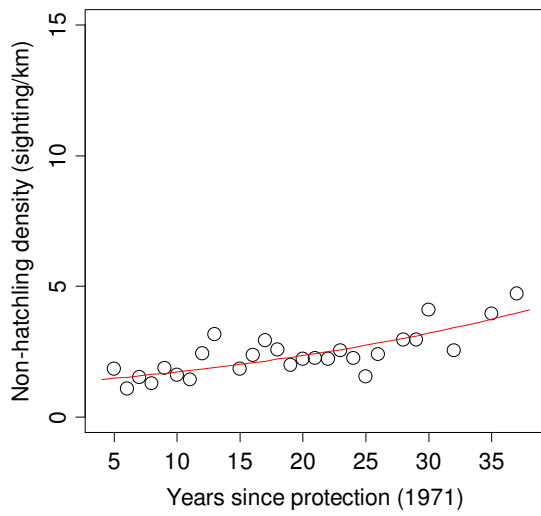
East Alligator River



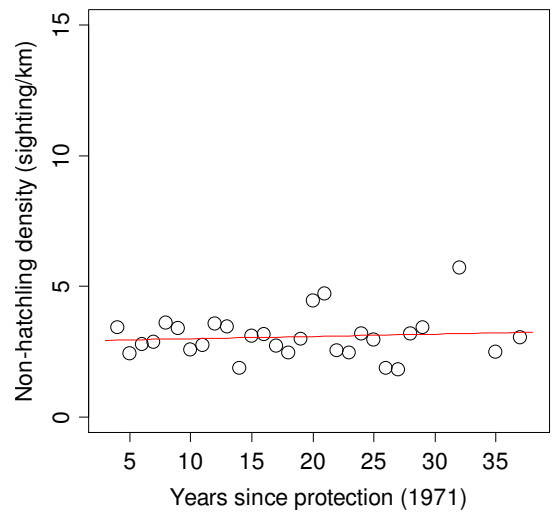
Liverpool River



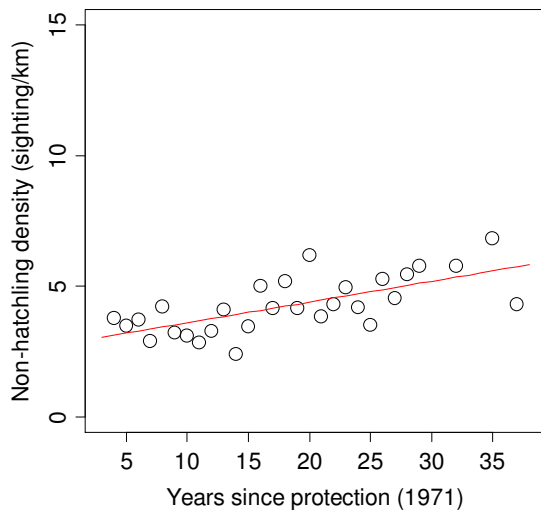
Tomkinson River



Cadell River



Blyth River



Glyde River

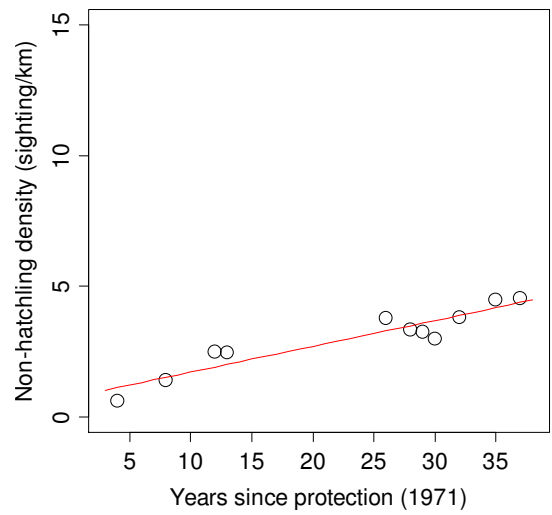
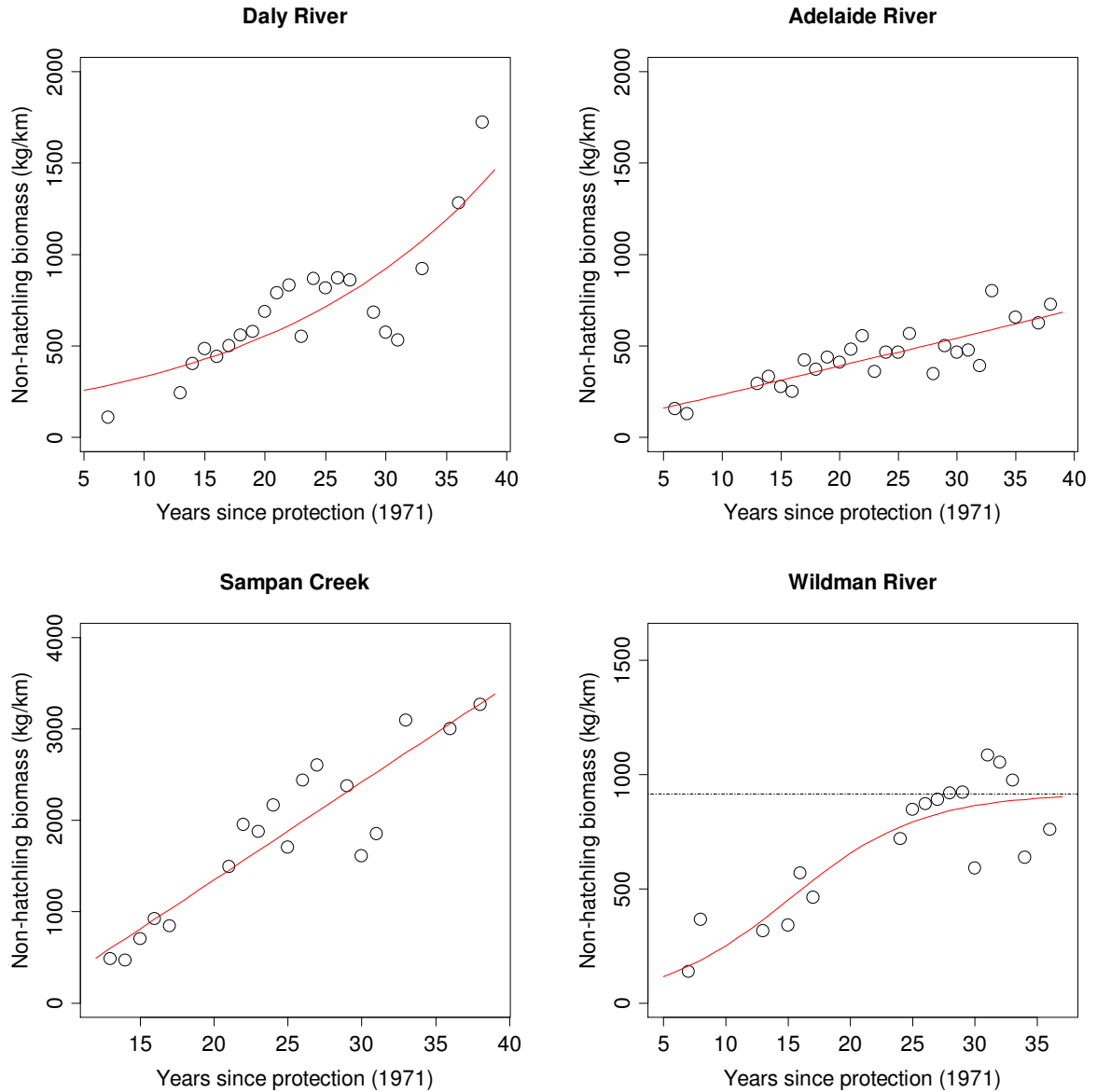


Table 10 Results of model selection fitted to the abundance density data. N = number of years surveyed (-- not converged).

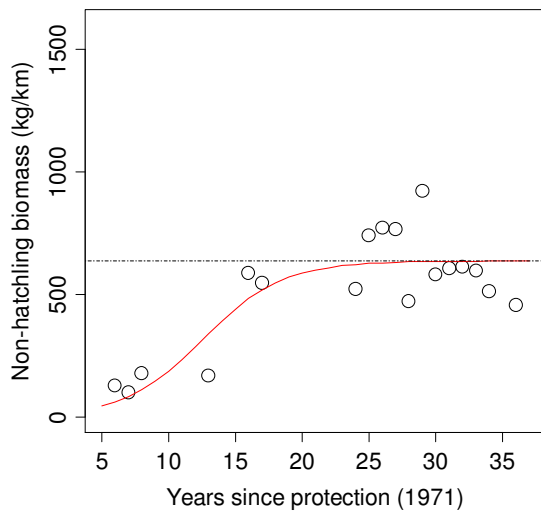
River	Year (N)	Model	AICc	Δ_i	w_i
Daly River	1978-2009 (22)	Logistic	45.26	4.28	7.91
		Exponential	42.97	1.99	24.87
		Linear	40.98	0	67.22
Adelaide River	1977-2009 (25)	Logistic	60.98	0	88.15
		Exponential	67.16	6.18	4.02
		Linear	65.82	4.84	7.83
Mary River (Sampan Creek)	1984-2009 (18)	Logistic	58.78	0	>99.9
		Exponential	84.42	25.64	<0.05
		Linear	77.57	18.78	<0.05
Wildman River	1978-2007 (18)	Logistic	70.74	0	49.07
		Exponential	72.47	1.73	20.65
		Linear	71.7	0.97	30.28
West Alligator River	1977-2007 (18)	Logistic	50.92	0	93.63
		Exponential	58.48	7.57	2.13
		Linear	57.11	6.19	4.24
South Alligator River	1977-2007 (19)	Logistic	65.52	0	97.05
		Exponential	79.04	13.52	0.11
		Linear	72.58	7.07	2.84
East Alligator River	1977-2007 (23)	Logistic	78.85	4.28	9.15
		Exponential	78.14	3.57	13.05
		Linear	74.57	0	77.8
Liverpool River	1976-2008 (27)	Logistic	28.16	0	83.11
		Exponential	34.23	6.07	4
		Linear	31.89	3.73	12.88
Tomkinson River	1976-2008 (27)	Logistic	--	--	--
		Exponential	46.95	0	76.98
		Linear	49.37	2.41	23.02
Cadell River	1975-2008 (29)	Logistic	--	--	--
		Exponential	74.93	0	50.04
		Linear	74.94	<0.01	49.96
Blyth River	1975-2008 (29)	Logistic	74.76	2.36	13.53
		Exponential	72.48	0.07	42.44
		Linear	72.4	0	44.03
Glyde River	1975-2008 (11)	Logistic	22.07	5.39	4.9
		Exponential	19	2.32	22.74
		Linear	16.68	0	72.36

Non-hatchling biomass

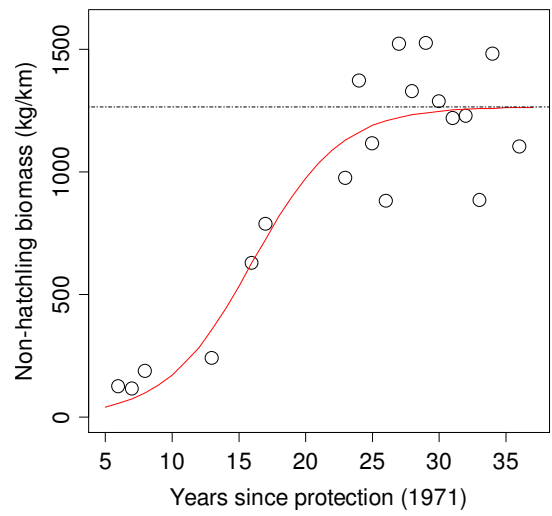
Figure 6 Biomass density (kg/km) plots with data up to 2007 (Kakadu), 2008 (Arnhem) and 2009 (Daly, Adelaide, Mary). Where the logistic model fitted best, the expected asymptote is shown with a dashed line.



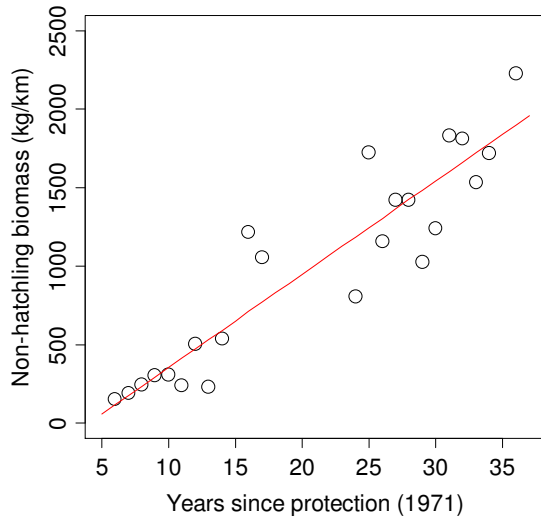
West Alligator River



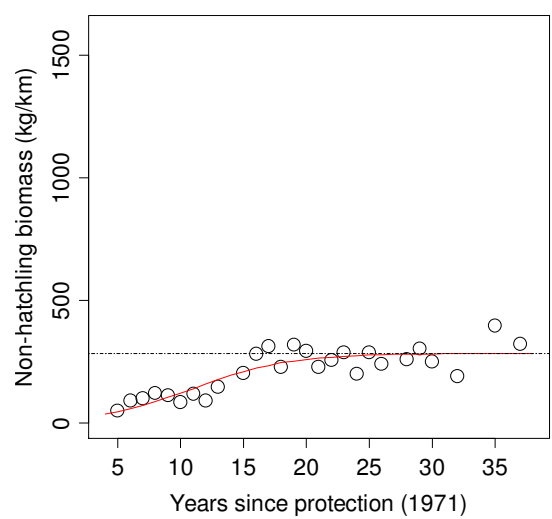
South Alligator River



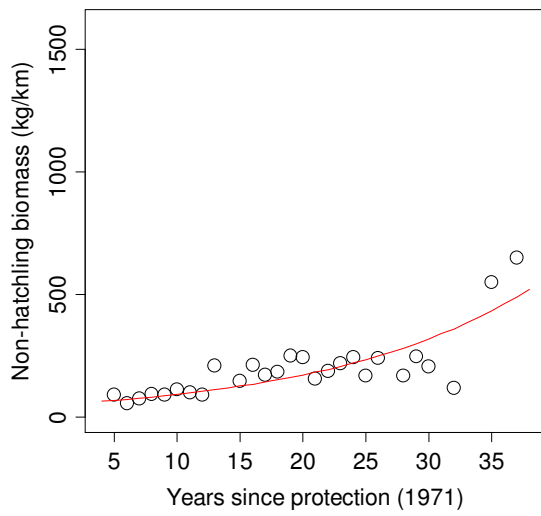
East Alligator River



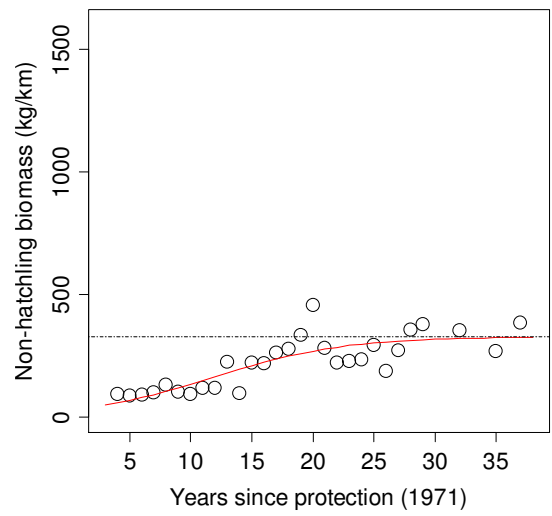
Liverpool River



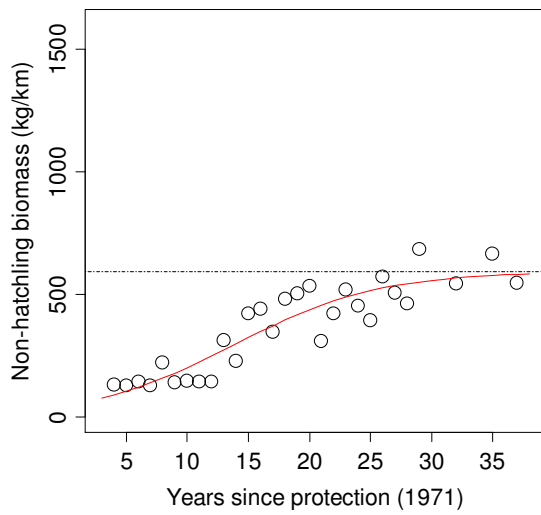
Tomkinson River



Cadell River



Blyth River



Glyde River

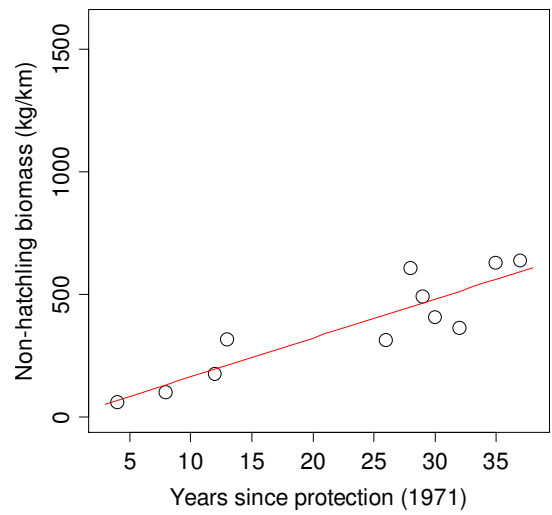


Table 11 Results of model selection fitted to the biomass density data. N = number of years surveyed. (-- not converged)

River	Year (N)	Model	AICc	Δ_i	w_i
Daly River	1978-2009 (22)	Logistic	--	--	--
		Exponential	296.08	0	71.76
		Linear	297.95	1.86	28.24
Adelaide River	1977-2009 (25)	Logistic	301.82	3.55	10.86
		Exponential	300.15	1.88	25.01
		Linear	298.27	0	64.13
Mary River (Sampan Creek)	1984-2009 (18)	Logistic	270.16	3.45	14.51
		Exponential	272.76	6.05	3.96
		Linear	266.71	0	81.53
Wildman River	1978-2007 (18)	Logistic	235.16	0	68.04
		Exponential	240.65	5.49	4.36
		Linear	236.96	1.81	27.59
West Alligator River	1977-2007 (18)	Logistic	232.18	0	96.18
		Exponential	241.97	9.79	0.72
		Linear	239.05	6.87	3.11
South Alligator River	1977-2007 (19)	Logistic	258.56	0	97.31
		Exponential	273	14.44	0.07
		Linear	265.79	7.23	2.62
East Alligator River	1977-2007 (23)	Logistic	327.65	4.64	7.72
		Exponential	326.52	3.52	13.57
		Linear	323.01	0	78.71
Liverpool River	1976-2008 (27)	Logistic	291.53	0	94.83
		Exponential	302.22	10.69	0.45
		Linear	297.54	6	4.71
Tomkinson River	1976-2008 (27)	Logistic	--	--	--
		Exponential	316.27	0	96.64
		Linear	332.98	6.72	3.36
Cadell River	1975-2008 (29)	Logistic	326.15	0	68.54
		Exponential	332.64	6.49	2.67
		Linear	327.88	1.74	28.79
Blyth River	1975-2008 (29)	Logistic	338.64	0	84.01
		Exponential	351.64	13	0.13
		Linear	341.97	3.33	15.87
Glyde River	1975-2008 (11)	Logistic	139.46	4.45	6.1
		Exponential	135.83	0.81	37.53
		Linear	135.02	0	56.37

APPENDIX 3. Production statistics from crocodile farms (2007 – 2009).

C. Poropus stock and production on farms in the Northern Territory for 2007/08 and 2008/09 are summarised in Tables 12, 13, 14 and 15. For production purpose, hatchlings are defined as <9 months old, raisings as 9 – 24 months old and breeders as >24 months old.

Table 12 *C. Poropus* held on farms in the Northern Territory in 2007/08 and 2008/09. Individual farms are not named for commercial reasons.

	Farm A			Farm B			Farm C			Farm D		
	Hatchlings	Raisings	Breeders	Hatchlings	Raisings	Breeders	Hatchlings	Raisings	Breeders	Hatchlings	Raisings	Breeders
Total number at start of 2007/08	2743	6378	81	3265	11508	210	3599	20	33	4264	291	7
Processed/Lost/Sold	658	1085	1	264	556	3	3944	20	20	1009	3646	0
Gains	2461	10	1	6854	10	0	6783	0	0	3437	21	0
Transfer -	2339	0	0	4255	8784	0	66	0	0	3348	0	0
Transfer +	0	2339	0	0	8236	0	0	64	2	0	3348	0
Total number at end of 2007/08	2207	7642	81	5600	10414	207	6372	64	15	3344	14	7
Processed/Lost/Sold	822	1837	7	1196	398	4	3692	1487	0	94	2194	0
Gains	2606	6	2	6973	50	0	5411	0	0	2787	0	0
Transfer -	1588	0	0	5224	9542	0	2772	0	0	3310	0	0
Transfer +	0	1588	0	0	9352	0	0	2772	0	0	3310	0
Total number at end of 2008/09	2403	7399	76	6153	9876	203	5319	1349	15	2727	1130	7

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	Farm E			Farm F			Farm G			Farm H		
	Hatchlings	Raisings	Breeders	Hatchlings	Raisings	Breeders	Hatchlings	Raisings	Breeders	Hatchlings	Raisings	Breeders
Total number at start of 2007/08	4671	8527	7	11	0	17	11839	31107	0	0	0	693
Processed/Lost/Sold	636	2544	0	11	0	8	1172	8283	0	0	0	18
Gains	5568	1784	0	0	0	9	13659	2989	0	0	0	96
Transfer -	4160	0	0	0	0	0	11676	0	0	0	0	0
Transfer +	0	4160	0	0	0	0	630	11676	0	0	0	0
Total number at end of 2007/08	5443	11927	7	0	0	18	13280	37489	0	0	0	771
Processed/Lost/Sold	468	3398	0	0	0	1	635	9942	0	0	0	30
Gains	6854	1491	0	0	0	14	12977	126	0	0	0	216
Transfer -	5506	0	0	0	0	0	13262	0	0	0	0	8
Transfer +	0	5506	0	0	0	0	0	14439	8	0	0	0
Total number at end of 2008/09	6323	15526	7	0	0	31	12360	42412	8	0	0	949



Table 13 *C. Porosus* products produced and/or exported in the Northern Territory in 2007/08 and 2008/09.

Products	2007/08	2008/09
Belly overseas	9392	13550
Belly domestic	202	213
Backstrap overseas	6687	14640
Backstrap domestic	7492	1156
Feet	1712	1458
Heads	1147	0
Hornbacks	0	13
Teeth	0	0
Stuffers	31	202
Tail tips	4576	1040
Tissue Samples	0	25
Infertile Eggs	0	0
Items manufactured	0	263
Whole carcasses	30	0
Live Sales	8684	7565
Bloods (ml)	50	0
Swabs	0	0
Skin Pieces	0	3260
Flesh (kg)	52157	57776

Table 14 Comparison between *C. Porosus* processed and belly skins produced in 2007/08 and 2008/09.

Year	Crocodiles processed	Belly skin produced
2007/08	10350	9392
2008/09	13774	13550

Table 15 *C. Porosus* (live eggs, hatchlings, and Juveniles/Adults) exported to other States 2007/08 and 2008/09.

State	2007/08			2008/09		
	Eggs	Hatchlings	Juveniles/Adults	Eggs	Hatchlings	Juveniles/Adults
QLD	0	1100	9519	0	0	9542
WA	0	0	0	0	0	1000
VIC	0	0	22	1	5	3
SA	0	0	0	0	0	2
NSW	0	0	11	0	2	0