

ECONOMICS, ECOLOGY AND THE ENVIRONMENT

Working Paper No. 130

A Report on the Management of Saltwater
Crocodiles (*Crocodylus porosus*) in the
Northern Territory: Results of a Survey of
Pastoralists

by

Clem Tisdell, Clevo Wilson and Hemanath
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Working Paper No. 131

**Crocodile Farms and the Management of Saltwater Crocodiles in the
Northern Territory: Results of a Survey of NT Crocodile Farmers Plus
Analysis of Secondary Information**

by

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**CROCODILE FARMS AND THE MANAGEMENT OF SALTWATER
CROCODILES IN THE NORTHERN TERRITORY:
RESULTS OF A SURVEY OF N.T. CROCODILE FARMERS PLUS
ANALYSIS OF SECONDARY INFORMATION**

Abstract

After outlining some relevant background information about the NT crocodile farming industry and explaining the purpose of our survey of NT crocodile farmers conducted in the first half of 2005, this paper reports the results of the survey. The information received from the survey is supplemented by secondary data and by information from secondary sources. This report covers the location of respondents; the size of crocodile farms; farmers' stated knowledge of and attitudes towards the NT Crocodile Management Plan; the involvement of farms in the harvesting of crocodile eggs and the costs involved; views of crocodile farmers about whether the NT Crocodile Management Plan encourages landholders to conserve crocodiles and their perceptions of the benefits to landholders; predicted production trends and trends in the number of farms operating in NT; economic characteristics of crocodile farms producing in NT including the economic advantages and disadvantages of crocodile farming in NT. Concluding comments provide, amongst other things, an overview of the structure of the crocodile farming industry in the NT gleaned from a consideration of data available from the NT Government's Department of Business, Industry and Resource Development.

1. Introduction

The Northern Territory Government in Australia has adopted a policy of trying to conserve crocodiles by allowing their managed commercial use. Its approach is based on the philosophy of conservation through sustainable use. Crocodile farms in the Northern Territory (NT) play a pivotal role in ensuring the success or otherwise of this policy because they are the link between landholders and the market for crocodile products. Crocodile farmers collect crocodile eggs, and to a lesser extent hatchlings and juveniles from landholdings, husband these, and sell the resulting products to end-users. Their products mainly consist of skins (mostly raw) and flesh.

Table 1 provides a list of products that have been produced from crocodiles on farms in NT in the period 1999-2004. The quantities of some of the more specialised products sold, such as blood samples, vary and are zero in some years. Table 1 also list NT farm shipments for 1999 and for 2004. It can be seen that for some product categories, there are no shipments in these years. It can also be seen that the range of crocodile products sold by NT farmers had declined in 2004 compared to year 1999.

Table 1 List of crocodile (*C. porosus*) products traded by NT crocodile farms in the period 1998-2005 and quantities in the calendar years 1998 and 2000

List of crocodile products traded, 1998-2005	Quantities traded ^a		
	1998	2004	Change
Belly skins (for export)	6,881	4,526	-2,355
Belly skins (for domestic market)	1,193	538	-655
Flesh	42,931.3 kg	19,017.5 kg	-23,914 kg
Backstraps	6,790	4,468	-2,322
Feet	5,322	237	-5,085
Heads	1,682	12	-1,670
Teeth	1,282	0	-1,282
Tail tips	100	0	-100
Blood	-	650 ml	-

^a Numbers unless otherwise stated

Source: Unpublished information, Northern Territory Government Department of Primary Industries, Fisheries and Mines, 2005.

Apart from being engaged in the husbanding of crocodiles for consumptive use, some NT crocodile farms earn income from tourism and research.

Crocodile farmers in the NT obtain their stock either by collecting crocodile biota (mainly eggs) from landholdings or from eggs produced on their farms. While all collect from the wild, some farms breed crocodiles on their farms.

The pivotal links between NT crocodile farms and landholders is emphasised by Figure 1. The link is established via the ranching activities of NT crocodile farms. Whereas ranching may provide economic incentives to landholders to conserve targeted wildlife species if landholders receive payments for specimens harvested on their properties, closed-cycle or virtually closed cycles (involving limited collection of breeding stock from the wild) does not.

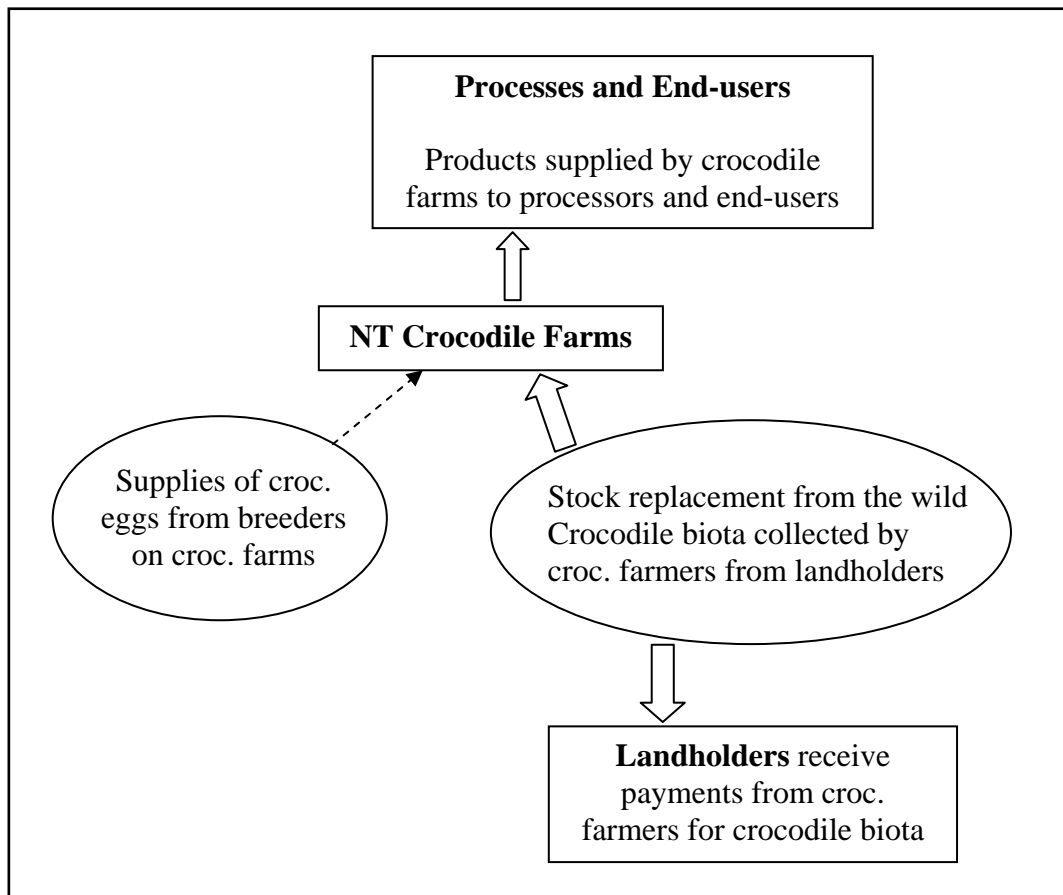


Figure 1 The product chain in NT involving crocodile farms. Currently crocodile biota collected from landholdings constitutes the main source for restocking crocodile farms in NT

It might be noted that two species of crocodile are harvested in NT. These are the saltwater crocodile *Crocodylus porosus* and the freshwater Johnston’s crocodile *Crocodylus johnston’s* but commercial use of the latter (which is unique to Australia)

is negligible (see Tisdell, Swarna Nantha and Wilson, 2005). Consequently the focus here is on the former species.

Apart from drawing on secondary information, this paper reports on a survey of crocodile farmers in the NT which was conducted by means of a mailed survey form, a copy of which is attached as Appendix A. After outlining the purpose of the survey and the procedure adopted, we report the results of the survey and supplement these with secondary information where available and appropriate and then discuss the results.

2. Purpose of the Survey and Procedure

The main purpose of the survey of NT crocodile farmers was to obtain their views about the nature of NT saltwater crocodile farming industry and the economic outlook for the industry and their opinions about the effectiveness of the government's strategy for managing crocodiles in the NT. The survey was designed to provide some general background information about the crocodile farms participating in the survey, the attitude of crocodile farmers to the crocodile management plan of NT; the relationship between crocodile farms and collection of crocodile biota from landholdings, crocodile farmers views about whether the NT crocodile management plan encourages landholders to conserve crocodiles and their opinions about what benefits landholders obtain from the harvesting of crocodiles on their properties. They were also asked to comment on trends in the number of crocodile farms in the NT and in possible production levels as well as to comment on various features of their crocodile farming operations in the NT, such as the importance of exports to them, the relative economic importance of crocodile production, tourism and research for them, economic advantages and disadvantages of operating in NT, and whether they operate interstate or overseas. Particular attention has been given to the economic prospects for the industry because if it should become unviable from a commercial point of view, the strategy of conserving crocodiles in the NT as a result of sustainable use, will surely fail, even if crocodiles continue to be utilised in the wild for tourism. The latter activity may generate some public sympathy for crocodile conservation, but currently landholders obtain little or no economic benefit from it.

The following procedure was adopted: The survey form (in the Appendix) was posted to all the farms in the list in Table 2 obtained through the NT Parks and Wildlife Commission, except those listed as having ceased operation. The list also noted the perceived focus of the farms on different crocodile farming activities; production, tourism and research.

Table 2 List of Crocodile Farms in NT obtained through NT Wildlife and Park Commission, and main activities of these as perceived by the unknown officer completing it. Postal questionnaires were sent to six farms listed with an asterisk. The others had ceased operation for reasons noted

Name of crocodile farm	List of main activities
Crocodylus Park*	Research and tourism
Coolibah Crocodile Farm*	Production and a little tourism
Darwin Crocodile Farm* [†]	Production and tourism
Elizabeth Valley Crocodile Farm * ^a	Hatchery
Janamba Crocodile Farm* [†]	Production only
Lagoon Crocodile Farm*	Production only
Garrangali Crocodile Farm ^b	Closed
Letaba Crocodile Ranch ^c	Closed

Notes: * Posted questionnaires were sent to these farms

[†] The owners/managers of these farms were also interviewed

^a Manager/owner unable to respond because of injuries from a crocodile attack. Farm closed for the time being

^b An Aboriginal farm in Nhulunbuy area. Closed because old infrastructure too costly to maintain

^c Was located on a pastoral property near Winnellie. Closed when the property was sold

Prior to mailing the survey forms in April, 2005, direct unstructured interviews were held with the managers or owners of the following farms: Darwin Crocodile Farm, Crocodylus Park and Janamba Crocodile Farm. The mailed survey was completed for two of these farms but not for Darwin Crocodile Farm. These prior interviews assisted with the formulation of the final questionnaire, and some of the information obtained in the informal interview of Darwin Crocodile Farm was also relevant to the final survey. In addition, useful background information to help us formulate the questionnaire was provided by Dr Mike Letnic who was then with the NT Parks and Wildlife Commission and who also commented on the draft questionnaire. In addition, Charlie Manolis and Graeme Webb of Crocodylus Park provided us with useful suggestions on the draft questionnaire.

Those who failed to respond to our postal survey were contacted by phone. In the end, completed survey forms were not received from two farms which would have been in a position to complete these.

Note that since the survey relies on self-reporting, the results may be subject to biases, particularly if a farmer believes that the requested information is sensitive. This should be borne in mind in interpreting the results. In order to increase the confidentiality of the information supplied, the number identifying farmers or responding farmers do not always refer to the same farm or farmer.

3. Results

3.1 Respondents

Of the six farms considered still to be in operation in NT in early 2005, three returned the completed survey form. One owner/manager was not in a position to complete his form due to injuries from a crocodile attack while collecting eggs and had, at least for the time being, ceased operation. Thus sixty per cent of operational NT crocodile farms were covered by the completed survey forms. Some information was obtained from a fourth by a direct interview prior to the postal survey. Only one operating farm failed to participate in the survey in any way.

The approximate location of the farms that participated in the survey are shown in Figure 2. Most were located in the northern part of NT, but no close clustering was present, except that the Elizabeth Valley farm was not too distant from Janamba. The most 'outlying' farm was in the Katherine area.

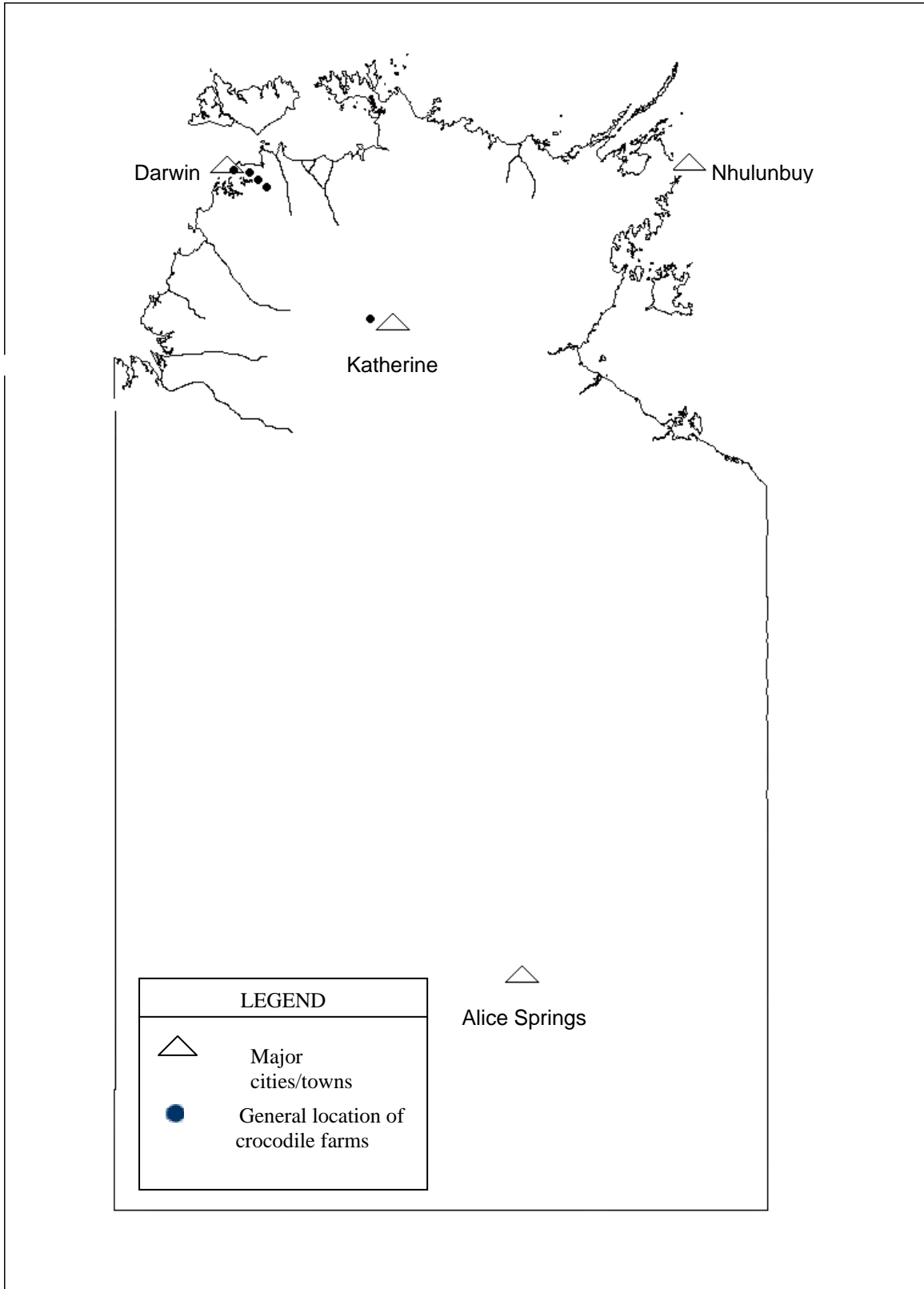


Figure 2 Approximate location of crocodile farms that participated in the survey

3.2 Size of crocodile farms

Responses from two farms indicated that they were smaller than average size whereas the third reported that it was larger than average size. Two engage in processing crocodiles and reported that they respectively process about 3000 and 9000 crocodiles per year averaging in length 1-1.8 metres. A third farm (Crocodylus Park) reported that it does not process any crocodiles.

Table 3 sets out the number of crocodiles reported by respondents to be processed by their farms and provides estimates from other sources for missing farms. On the whole, the figures in Table 3 are higher than in Table 4. The official figures reported to the Department of Business, Industry and Resource Development of NT.

Table 3 Number of crocodile processed by farms last year (2004) as reported by respondents, and as supplemented

Farm	Number of head processed
1	9,000
2	5,000 ^a
3	4,800 ^b
4	3,000
5	0
Total	21,800

^a Estimate (possibly for 2004) obtained from data available on the crocodile farm's Internet website (Porosus Pty. Ltd., 2004). The estimate was obtained as follows. The farm plans to increase output to 10,000 animals a year from 320 female breeders and a stock of 30,000 individuals. It currently has 148 female breeders (half of the planned 320 breeders). Therefore, $10,000 \times \frac{1}{2} = 5,000$ processed animals a year at present. The number of one- and two-year old animals in this farm is about 5,000 individuals. This value may also serve as a surrogate measure of animals skinned a year, and is consistent with the value calculated above.

^b Estimate (possibly for 2000) from the Australian Government Rural Industries Research and Development Corporation publication (Hyde, 2000). The book features the farm concerned. In the relevant section, the farm's production is revealed to be 400 skins a month. Multiplying this by 12 months gives the tabulated value.

Table 4 Number of crocodiles processed by individual crocodile farms in the NT in 2004 according to records of the Department of Business, Industry and Resource Development, NT

Farm*	Number of 'raisings' processed
1	1,733
2	1,021
3	24
4	2,286
5	40
Total	5,104

*Farms are listed in no particular order

^a These consist of 'raisings', crocodiles raised typically to about 3 years of age

3.3 Knowledge of and attitudes towards the crocodile management plan of NT as reported by crocodile farms

All the responding crocodile farmers surveyed stated that their knowledge of the current crocodile management plan of the NT government is either good or very good. They all said they were satisfied, on balance, with the NT management plan, and do not think any changes in it are required.

However, one farmer said he would like to see “more dialogue between government and farms”.

Furthermore, two of the responding farmers would like to see change in the Australian government’s policies that affect the industry. Specifically, they would like “CITES permits for commercial export controlled by state instead of Canberra (to expedite permit application)” and would like live commercial exports allowed.

3.4 Involvement of crocodile farms in harvesting crocodile biota and egg costs

The three responding crocodile farmers each reported collecting 8000, 4000 and 2428 crocodile eggs in 2004, and one of these said it harvested 200 adult crocodiles and another reported harvesting 20 adults in 2004. These three farms reported obtaining most of their harvest from the West coast of NT (e.g., the Moyle River, located on Aboriginal land, the Fitzmaurice River bordered on one side by Aboriginal land, and the Victorian River) and from the Adelaide River, which flows into Adam Bay east of Darwin. It is also known that collections are made from Mary River further east and from Aboriginal land in Arnhem Land. However, collection is reported (interview with Cook of Janamba Crocodile Farm) to be absent below Arnhem Land in the river systems flowing into the Gulf of Carpentaria. Therefore, crocodile egg collection basically occurs in NT in an arc extending from the Western Australia border around to and including Arnhem Land in the catchment areas of rivers flowing towards the sea. The generalised area of collection of saltwater crocodile biota in NT is indicated in Figure 3.

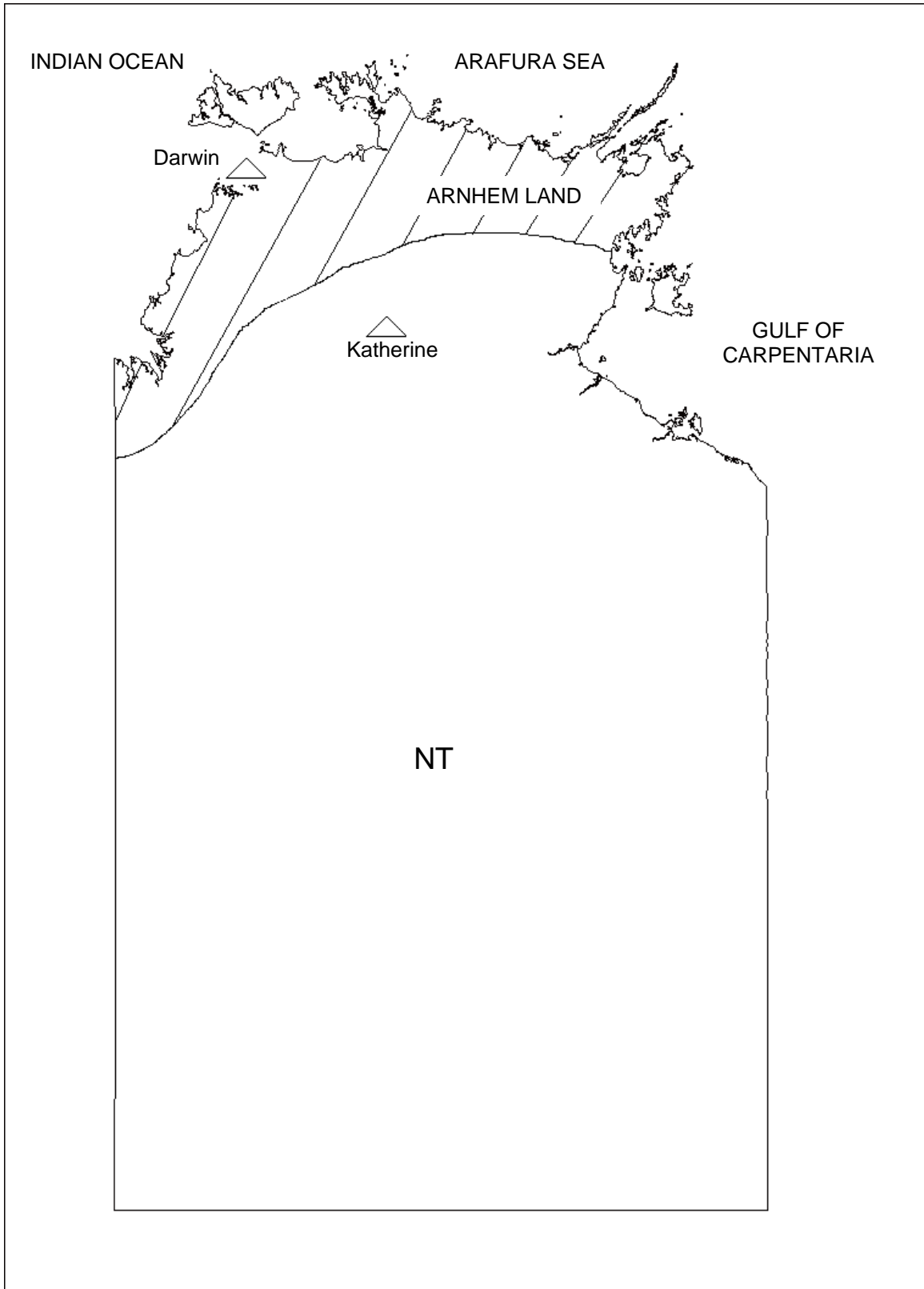


Figure 3 Map of the top end of the Northern Territory showing the generalised area of collection of saltwater crocodile eggs by crocodile farmers

Comparing Figure 2 and Figure 3, it can be seen that crocodile eggs collected by crocodile farmers often have to be transported long distances before they reach their farms. Helicopters are often used to access collection sites and transport eggs.

Crocodile farmers may obtain crocodile eggs to replenish their stock of crocodiles from breeders on their farms or by collecting eggs from the wild. Eggs collected from the wild may be gathered from Aboriginal Lands held under native title or from pastoral lands, usually under leasehold or freehold titles. We asked crocodile farmers what percentage of their eggs they usually harvest from the wild, and of these, what percentage is obtained from Aboriginal lands. The remainder of their collections from the wild come from private cattle properties. Table 4 summarises the responses received.

Table 5 The percentage of crocodile eggs incubated on farms stated by respondents to be collected from the wild and the percentage of these collected from Aboriginal lands. The remainder of the collection is from cattle properties

Farm*	Eggs from wild (%)	Wild eggs from Aboriginal land (%)	Wild eggs from cattle properties (%)
Farm 1	100	0	100
Farm 2	75	40	60
Farm 3	30	70-80	20-30
Farm 4 ^a	?	70-80	20-30

* Farms are listed in no particular order

^a Information from interview only

The percentage of eggs from the wild in relation to those incubated were said the range from 30 to 100 per cent by respondents. The extent to which eggs were harvested from Aboriginal lands varied widely. While one reported no collection from Aboriginal lands of eggs taken from the wild, most respondents collected from Aboriginal lands. In two cases, 70-80% of eggs harvested were obtained from Aboriginal lands. All respondents were engaged in ranching to some extent, that is harvesting eggs from the wild to be later artificially incubated on their farms.

Crocodile farmers were asked why they collected eggs from the wild rather than relying more on farm-laid eggs. The following reasons were given by those respondents:

- Requires less infrastructure; wild harvest is conservation, farm laid is not [Farm 1]
- Financial reasons, ethical reasons, enjoyment [Farm 2]
- Part of nest/population monitoring [Farm 3]

Farmers believe that ranching rather than closed or nearly closed cycle farming is likely to be more conducive to conservation. Two of the respondents indicated that it is cheaper to rely on harvested eggs rather than farm-laid eggs. This is probably true but one of larger farmers, in a private interview, stated that for him the cost of farm-laid and harvested eggs was little different. However, he liked to collect some of his supplies from the wild, especially from Aboriginal lands, because this gave economic benefit to landholders. This is probably the type of ethical reason that Farmer 2, mentioned above, had in mind. It is also interesting to note that enjoyment of the collection activity from the wild is another reason given. Collection can be both dangerous and exciting.

It seems that some collectors enjoy the adventure involved in collecting eggs from the wild during which they run the risk of being attacked by nesting female crocodiles.

Farmers were asked to state (i) the range of price paid to landholders for each crocodile egg harvested, (ii) the price paid on average for each egg, (iii) the factors that influence prices paid, (iii) to give an estimate of the total cost of each egg harvested from the wild, and (iv) to provide an estimate of the total cost of each egg produced from farmed crocodiles. The results for these are presented in Table 6.

While there are gaps in Table 6, some observations can be made. This table reveals that in most cases the price paid to landholders varies between properties depending on the cost of collection and competition. The cost of collection depends on such factors as ease of access to nesting sites on a property and the logistics, distance and ease of transport from the field to the crocodile farm. The average price per egg reported to be paid by two farmers for eggs in 2004 was \$20 but one reported on

average price of \$8. After taking account of their full cost of collecting eggs from the wild, two farmers reported that average overall cost of wild eggs delivered to their farm was in effect 150 per cent on average of the average price per egg they paid to landholders. In one case, the ‘landed’ cost was estimated to be \$20 per egg and in another case \$50 per egg.

Table 6 Responses of crocodile farmers to relevant questions on crocodile egg prices and costs

Farm*	Range of prices paid to landholders in the last year by your farm for each egg	Average price per crocodile egg harvested	The main factors that result in the price of crocodile eggs varying between landholdings	Estimate of total cost per crocodile egg harvested in the wild last year (including payments to landholders)	Estimate of total cost per egg of producing eggs from your farmed crocodiles last year
Farm 1	No variation	8	Nil – one price for all	20	-
Farm 2	15-20	20	Cost of collection	50	-
Farm 3	-	20	East of access, logistics and competition	-	30
Farm 4 ^a	5-10 (goes up to 20)	-	-	-	-

* Farms are listed in no particular order

^a Information from interview only

The crocodile farmers were asked what the trend is in the average cost for eggs harvested. While one farmer stated that it was about constant, two farmers stated that the trend was upwards. One farmer commented that this “will eventually restrict wild harvest”.

The crocodile farmers were also asked what the trend is in the average cost for eggs produced on the farm. One farmer stated that the cost is upwards while another stated that it was about constant. The farmer who said that the trend in cost was upwards added that “no efficient crocodile breeding facility is in existence yet in Australia”.

3.5 Views of crocodile farmers on whether the crocodile management scheme of NT encourages landholders to conserve crocodiles and the perceived benefits to landholders of being paid for crocodile harvesting on their land

It is an objective of the NT crocodile conservation plan that the commercial harvesting of crocodile biota should encourage the conservation of crocodiles. Crocodile farmers were asked if they thought the fact that landholders are paid for the right to collect crocodile eggs and crocodiles on their land encourages them to conserve crocodiles. All three respondents said it does.

To clarify this further, crocodile farmers were asked whether holders of cattle properties are likely to conserve more crocodile habitat as a result of being paid for crocodile harvesting on their land. Two of the respondents said they were unsure. While the third said yes, it seemed from the statement made by this farmer that this has not happened yet.

“As the collection becomes more professional, efficient and lucrative, some stations are seeing the logic of this. Many stations have absentee owners, however, and rely on managers who may not be particularly professional or interested.”

Crocodile farmers were also asked whether they thought traditional Aboriginal landholders are likely to conserve more crocodile habitat as a result of payments received from crocodile harvesting on their land. One farmer stated that he is unsure. Another said ‘no’, adding that “some exceptional leaders may recognise the threats looming over the ecosystems on their traditional lands but most are occupied with the challenges of day to day living”. A third farmer stated that this question is “not really applicable”, arguing that their habitat is not under threat to begin with, whereas one would expect it to be under heavy pressure when subject to pastoral land use.

Crocodile farmers were asked to list the main benefits (social or otherwise) that holders of cattle properties in their view obtained from being paid for crocodile harvest on their lands; and to do likewise for Aboriginal landholders. The responses received are set out in Table 7.

Table 7 Responses of crocodile farmers to questions about the benefits obtained by pastoralists and Aboriginal landowners from payments as a result of payments for allowing crocodile farmers to harvest crocodiles on their lands

Farm*	What do you consider to be the main benefits (social or otherwise) obtained by paying holders of cattle properties for allowing crocodile harvesting on their land? Responses	What do you consider to be the main benefits (social or otherwise) obtained by paying Aboriginal landholders for allowing crocodile harvesting on their land? Responses
Farm 1	N/r	N/r
Farm 2	1. A rare attempt to live with Australia not against it; 2. A truly sustainable wealth producer (unlike cattle); 3. An example of diversification of income	1. Giving money for something in return, not just charity; 2. Giving them a chance to go on country and leave the community; 3. Allowing experience of an equal business negotiation (something that, other than mining, many people never have)
Farm 3	1. Positive attitude towards crocodiles; 2. Greater likelihood to tolerate crocodiles on their land	1. Positive attitude to crocodiles; 2. Economic benefits based on sustainable use of crocodiles

* Farms are listed in no particular order

Two crocodile farmers stated that they do not encounter any difficulties with landholders in gaining access for harvesting crocodile eggs or crocodiles, whereas a third said that he does but that it is part of the business and that difficulties are resolved once both sides get to know each other.

3.6 Production trends and trends in number of farms farming crocodiles in NT

The continuing success of conservation of crocodiles in the NT as a result of their sustainable commercial use depends on crocodile farming remaining economically viable. With this in mind, crocodile farmers were asked their views about general trends in crocodile farming in NT.

Crocodile farmers were told that the number of crocodile farms in NT seemed to have peaked and since then has declined slightly. They were asked why do you think the decline has occurred. The reasons given by the three respondents are set out in Table 8. One crocodile farmer (Farmer 1) attributed this to a combination of factors: a shortage of available crocodile eggs, a temporary decrease in demand for crocodile

products for a time and lack of expertise on some farms. Farmer 2 also indicated lack of expertise on some farms was a factor. Farmer 3 indicated that one farm was on a cattle property that was sold and the new owners decided not to continue with the crocodile farming side of the venture.

Table 8 Reasons given by NT crocodile farmers for the past decline in the number of crocodile farms in NT and for their expectation that industry production will increase

Reasons given for past decline in the number of crocodile farms:

Farmer 1:

Limited base resource – eggs. Decreased demand for product at the time, also lack of expertise at some farms

Farmer 2:

The challenges faced are those of nay large industry but cannot be met by an resource to history or support industries as there si non and are non. Therefore, to succeed requires above average business skills

Farmer 3:

Land on which one farm was located was sold

Reasons given for expecting production of the crocodile industry in the NT to rise:

Farmer 1:

Increased demand for product equals more money

Farmer 2:

Those that can rise to the many challenges will and as new type of industry will evolve – analogous to the pearl industry

Farmer 3:

Increased captive breeding

Crocodile farmers were also asked whether they think production in the NT crocodile farming industry will increase in the future, remain constant, or decline. All three respondents stated that it would increase. The reasons they gave are set out in Table 8. The response of Farmer 1 suggest that these might be economies of scale for farms in the industry, that of Farmer 2 suggests that the industry will evolve into a more sophisticated consumer-oriented industry which might expand demand, and the third sees increased captive breeding as the key to expanding the industry.

Crocodile farmers were asked whether they think the number of crocodile farms in NT will increase, decrease or remain unchanged. All three respondents stated that they expected it to remain unchanged. However, one suggested that greater

specialisation in farming activities in parts of the production process could result in new entrants. The main barrier to entrants was seen by two farmers to be lack of scope for collecting additional crocodile eggs and the high initial cost of setting up a crocodile farm. Their specific comments were:

The collection areas are covered. Cost of setting up a farm [is high] [Farm1].
Limited wild resource (eggs) [Farm 2]

The overall view expressed was although the number of crocodile farms in the Northern Territory declined for economic reasons, the number of farms are expected on the whole to stay constant in the future. Production is expected to rise. Therefore production per farm can be expected to rise on average. Possibly there are economies of scale in production at the farm level. Expansion could be restricted by the limited amount of eggs available for harvest from the wild. It seems likely that major expansion in the production of the NT crocodile industry would require greater dependence on farm-laid eggs.

3.7 Economic features of crocodile farms operating in NT – nature of sales (exports, sources of income), whether farmers have multiple farms or not and where, economic advantages and disadvantages of NT operations

Crocodile farmers were asked if their farming enterprise in the NT is involved in the export of crocodile products and if ‘yes’ whether export income was very important, important or unimportant for the economic success or viability of their business.

Crocodylus Park and Janamba Crocodile farm both mentioned that they are involved in the export of crocodile products. The manager of Coolibah Crocodile farm stated that his enterprise is not directly involved in the export of crocodile product. Darwin Crocodile Farm, which is the second largest crocodile farm in NT, is also involved in export of crocodile products according to secondary sources. The fifth farm, Lagoon Crocodile Farm, is also involved in the export of crocodile products according to a secondary source.

For the larger-sized crocodile farms in the NT, export income is important. It is, for example, important for Janamba Crocodile Farm, and it is indirectly of importance for

few farms that do not export. For example, the Elizabeth Valley Crocodile Farm (currently closed) has been a supplier of hatchlings to Janamba. Possibly also indirectly some of the product of Coolibah Crocodile Farm is exported. Crocodylus Park reported that export income was relatively unimportant for it, probably because it had greater relative dependence on tourism and research as a source of income than other farms in NT (see Table 2). Nevertheless, to the extent that tourists come from overseas there is external economic dependence and Crocodylus Park is successful in gaining some overseas research contracts and consultancies.

Crocodile farmers were asked which countries are the main competitors in the export market. One significant exporting farm said that its main competition in the export market comes from Nile crocodile farming in Africa, from alligator farming in the USA, and saltwater (*C. porosus*) farming in Asia, mainly Indonesia, China and Thailand.

Crocodile farms may obtain income from three sources: crocodile production, tourism and research. Farmers were asked in relation to the economics of their crocodile farming operations to rank the importance of each of these factors for their business success on a scale: (1) Very important, (2) Important, (3) Of little importance, (4) Of no importance. The responses received are shown in Table 9.

Table 9 The ranking^a of responding crocodile farmers of the importance to them of crocodile production, tourism and research for their economic success

Respondent	Crocodile production	Tourism	Research
Farm 1	V. important	^b	Important
Farm 2	V. important	^c	V. important
Farm 3	Important	V. important	Important

^a Respondents could rank activities as (1) very important, (2) important, (3) of little importance and (4) of no importance

^b Of little importance

^c This respondent stated that research was more important for his business success than for others in the industry but seems to have in mind the application of his research results directly to his crocodile production

It may have been that some respondents interpreted this question differently because it was quite open-ended. All respondents reported that production was important for their economic viability (two said it was very important), and only one believed that

tourism was of importance for its economic viability and rated it as very important for its economic viability. Rather unexpectedly all three responding crocodile farms said that research was important for their economic viability.

At first glance, the result just mentioned seems to be at variance with the observation in Table 2 which only lists research as important for Crocodylus Park. Possibly the listing there is of estimated direct sources of income; Crocodylus Park earns some income from research contracts and consultancies. In other cases, the perceptions of the managers of Coolibah and Janamba appears to be that their own research and its direct application plays a major role in their business success. The industry is relatively new so there is a lot of scope for improving production and marketing methods.

All of the crocodile farms in NT operate at only one site in NT but as pointed out above, homee are very close to one another. Only one crocodile farmer farms in other states. This farmer has a farm in Northern Queensland and another in the north of Western Australia. In addition, this farmer has a network of contacts in Papua New Guinea and assists in the marketing of crocodile products from there. However, none of the NT farmers have overseas farming operations.

Crocodile farmers were asked to outline briefly the economic advantages and disadvantages of crocodile farming in NT. Responding farmers reported that the advantages of crocodile farming in the NT are:

- (1) A hot/warm climate which stimulates growth of crocodiles.
- (2) Availability of natural crocodile resources such as crocodile eggs in the wild.

Disadvantages were said to be:

- (1) Lack of local availability of cheap food supplies for crocodiles. Food often has to be freighted to NT and this is costly [In some areas, crocodiles are fed 'waste' by-products from poultry processing plants and meat works].
- (2) Small market for products locally.
- (3) High cost of labour, capital works and logistics in the NT.

3.8 Additional comments by crocodile farmers about crocodile management in the NT

Crocodile farmers were invited to add any extra points they wished to make about policies for the management of crocodiles in the NT, and about the future of crocodile farming in the NT. Two farmers stated that the government sector should consult and work more closely with the crocodile industry. Another stated that the slow evolution of the crocodile industry should not deter greater utilization of Australia's natural resources in a sustainable way. One farmer suggested that the development of crocodile farming in NT would be helped if the government provided advice on farm design and engineering as well as training.

4. Concluding Comments

While, in general, responding crocodile farmers stated that they are satisfied with the NT Crocodile Management Plan, some thought that crocodile management in NT would be more efficient if the NT Government rather than the Australian Commonwealth Government were responsible for the issue of export permits. All crocodile farmers collect crocodile eggs from the wild but some also rely on farm-laid eggs. The cost of collecting crocodile eggs from the wild is considerable and amounts on average to be about 150% of the amount paid to landholders for eggs collected from their properties. The amount paid to landholders for crocodile eggs collected on their properties in 2004 varied according to locality and conditions involved in collecting the eggs and the crocodile farm. The most frequently stated average price was \$20 per egg on average making the delivered price at the farm gate on average \$50. Nevertheless, several respondents said that the cost of farm-laid eggs exceeds on average that of harvested eggs.

All responding crocodile farmers thought that payments to landholders for crocodile harvesting encourages landholders to conserve crocodiles. However, most were unsure about how this might be reflected in conservation of suitable habitat on farms for crocodiles. One crocodile farmer stated that since Aboriginal landholders do not significantly modify natural habitat anyway, payment to Aboriginal landholders would not change this practice unlike on cattle properties where considerable alteration of natural habitat occurs.

All respondents thought that the level of production of the NT crocodile will increase but that the number of farms operating will probably remain unchanged. One, however, suggested that more specialisation in the industry could occur and if so, this might raise the number of farms. Barriers to entry to the industry were said to be the high capital cost involved in setting up a farm and the limited availability of crocodile resources in the wild.

Given the relatively small size of the local market, the industry appears to be quite dependent on exports, and it faces considerable competition from other exporting countries. At least one of the crocodile farmers said that live crocodile exports should be allowed. Presumably, the relatively high value of the Australian dollar in recent years has added to the industry's economic difficulties of the exporting.

Production of crocodile products is the mainstay of this farming industry. Some farmers supplement their income by encouraging on-farm tourism. Although this is an important source of income for at least one farm, it is of little economic importance for most. All responding farmers stated research is important for their economic success (mainly it is presumed because their industry is relatively young and still evolving) but only one farm seems to earn a significant share of its income from contract research and consultancy. Economic advantages of crocodile farming in the NT were said to be warm or hot weather which promotes the growth of crocodiles and the comparative closeness of farms to natural stocks of crocodiles, the eggs of which can be harvested for restocking. Economic disadvantages included the absence of adequate supplies of low cost food for crocodiles (such as offal and waste products from meatworks), the high cost of transporting food and other supplies, the high costs of capital and labour, and the small size of the local market.

It is interesting to consider some of the trends in the NT crocodile farming industry using data from the NT Government's Department of Business, Industry and Resource Development. Tables 10-12 are based on this data and provide indications of recent trends in the period 1999-2004. During this period, the number of operating farms fell from 8 to 6 and production varied considerably. Raisings (that is crocodiles being raised mainly for production) were at a high in 1999 and fell to a low in 2002 (see Table 10). Numbers have increased since then. Meat production (see Table 11)

exhibited a similar pattern. On the other hand, the stock of crocodile raisings (see Table 12) exhibited a somewhat different pattern. It fell to a low in 2001 but had increased to a high in 2004. This appears to indicate that the production of the industry is in the process of expanding which accords with the predictions made by responding crocodile farmers.

Table 10 Number of crocodile ‘raisings’ processed by crocodile farms in NT, 1999-2004

Year	1st half	2nd half	Full year	
1999	4,152	4,814	8,466	High
2000 ^a	4,104+	3,463+	7,567+	
2001	3,813	2,626	6,439	
2002 ^a	2,034+	1,904+	3,938+	Low
2003	2,364	1,750	4,114	
2004	2,296	2,808	5,104	

^a Figures incomplete

Source: Unpublished information, Northern Territory Government Department of Primary Industries, Fisheries and Mines, 2005.

Table 11 Crocodile flesh production in NT in kgs, 1999-2004

Year	1st half	2nd half	Full year	
1999	25,711.5	19,940.2	45,651.7	High
2000 ^a	22,019.6+	19,482.5+	41,502.1+	
2001	12,298.8	16,335.3	28,634.1	
2002 ^a	7,661.9+	7,133.0+	14,794.9+	
2003	9,149.0	9,595.3	18,744.3	Low
2004	9,309.0	9,708.5	19,017.5	

^a Figures incomplete

Source: Unpublished information, Northern Territory Government Department of Primary Industries, Fisheries and Mines, 2005.

Table 12 Stock of crocodile ‘raisings’ on NT crocodile farms, 1999-2004

Year	As at end of June	As at end of December	June and December figures averaged	
1999	23,280	20,852	22,066	High
2000 ^a	19,803+	12,117+ ^a	15,960+ ^a	
2001	12,378	12,961	12,669	Low
2002 ^a	16,587+	17,760+	17,173+	
2003	19,413	20,136	19,794	
2004	23,774	36,295	30,345	

^a Figures incomplete

Source: Unpublished information, Northern Territory Government Department of Primary Industries, Fisheries and Mines, 2005.

Data available from the Department of Business, Industry and Resource Development, NT indicates that there is considerable variation in the size of crocodile farms in NT and that few farms account for the major part of production. For example, at the end of June 1999, the stock of crocodile raisings at the largest two farms accounted for 13,935 head of the industry stock of 23,280, that is, 60%. At the end of June 2004, they accounted for 15,449 head in the level of industry stock of 23,774, or 65%. Thus, one-third of crocodile farms in NT accounted for almost two-thirds of crocodile raisings in the NT in 2004. There is also considerable unevenness in the number of breeders held on farms. At the end of June 1999, the two largest farms in this industry accounted for 744 of the 861 breeders in this industry, or 86%. At the end of June 2004, they accounted for 775 breeders out of an industry total of 806, or 87%. Thus the holding of breeders is even more uneven than the crocodile raisings, which in turn seems to be more concentrated than the holdings of hatchlings. This may partly reflect the fact that capital and other costs rise as one moves up the production chain.

This survey indicates that the economic conditions facing NT crocodile farmers are by no means easy, even though respondents seem relatively confident about the future of the industry. The continuing economic viability of the NT crocodile farming industry is necessary if the Crocodile Management Plan of the NT is to work.

5. Acknowledgements

We thank those crocodile farmers who have assisted us with information and also Dr Mike Letnic previously with the NT Wildlife and Parks Commission and Vicki Sinlesa, Technical Officer, NT Department of Business, Industry and Resource Development for providing us with secondary data. We alone, however, are responsible for this report. An Australian Research Council Discovery Grant helped to finance our research.

6. References

Tisdell, C.A. Swarna Nantha and Wilson, C. (2005) Australian tropical reptile species: ecological status, public valuation, attitudes to their conservation and commercial use. Pp.1-40 in A.R. Burk (ed.) *Trends in Biodiversity Research*, Nova Science Publishers, New York.

APPENDIX

Questionnaire Distributed to Crocodile Farmers in NT about Management of Saltwater Crocodiles in the Northern Territory



**MANAGEMENT OF SALTWATER CROCODILES IN THE NORTHERN TERRITORY:
SURVEY FOR CROCODILE FARMERS**

This survey is being conducted by the staff of the University of Queensland and Queensland University of Technology as part of their independent research into the commercial use of Australian tropical wildlife. This study is for scientific purposes only and is partly supported financially by the Australian Research Council. Its purpose is to obtain views of crocodile farmers about the saltwater crocodile farming industry and its outlook, and their opinions about the government's management of crocodiles in the NT. **Please assist this research by completing this survey form and returning it in the postage-paid envelope enclosed.** Your identity and answers will be kept **strictly confidential** and your answers will only be used for research purposes. Respondents will be given a summary of the results.

Contact details (e.g., if you have any queries):

Clem Tisdell, School of Economics, The University of Queensland, Brisbane, QLD 4072
Tel: (07) 3365 6570 Fax: (07) 3365 7299
Email: c.tisdell@economics.uq.edu.au

Thank you. Clem Tisdell

A. BACKGROUND INFORMATION

1. Date of completion of survey:
2. Name of crocodile farm:
3. Name of person answering this form:
(First name)..... (Family name).....
4. Position of person answering this form (e.g. Manager, Manager/Owner):
.....
5. Location of crocodile farm (delivery address):
.....
.....
6. In the Northern Territory, do you regard your crocodile farm to be
Smaller than average About average Larger than average
7. About how many head of crocodile would you have processed in the last full year
of production? head

What on average is their length in metres?metres long (approx.)



B. CROCODILE MANAGEMENT PLAN OF NT

8. Do you regard your knowledge of the current crocodile management plan of the Northern Territory Government to be? Very good Good Poor Very Poor

9. On balance, are you satisfied with the current crocodile management plan of the NT Government? Yes No
Please give your reasons for your answer:

.....
.....
.....

10. Would you like to see any changes in the current crocodile management plan of the NT Government? Yes No
If 'yes', what are the main changes would you like to see?

.....
.....
.....

11. Would you like to see any changes in the Australian Government's policies that affect your industry? Yes No
If 'yes', please indicate the main changes you would like.

.....
.....



C. RELATIONSHIP OF FARM WITH HARVESTING

12. In the last year, how many (approximately) of the following did you harvest from the wild in NT?

..... EggsHatchlings JuvenilesAdults

13. Where in the NT did you mainly collect your crocodile eggs from the wild?

1)2)

14. What percentage of your crocodile eggs are usually supplied from harvesting in the wild?%

15. What percentage of your harvested eggs usually are obtained from Aboriginal lands?%

16. If you have harvested crocodile eggs from the wild, why have you done this rather than making more use of farm-laid eggs?
.....
.....
.....

17. Landholders expect to be paid for crocodile eggs collected on their property. Please give an indication of the range of prices paid to landholders in the last year by your farm.

Price per crocodile egg (range) \$..... to

Average price per crocodile egg \$.....

18. What are the main factors that result in the price of crocodile eggs varying between landholdings?
.....
.....
.....

19. On average, what do you estimate was your total cost per crocodile egg harvested in the wild last year? (Include payments to landholders) \$..... per egg

What is the trend in this average cost? (Tick whichever applies)

Upward Downward About constant

Any comment on the trend?
.....
.....
.....

20. On average, what is your estimate of your total cost per egg for the last year of producing eggs from your farmed crocodiles? \$..... per egg

What is the trend in this average cost? (Tick whichever applies)

Upward Downward About constant

Any comment on the trend?

.....
.....
.....

21. Any information that you are able to provide on prices paid to landholders for permission to take crocodile hatchlings, juveniles and adults would be of interest.

	Price range	Average price each
Hatchlings	\$..... to	\$.....
Juveniles	\$..... to	\$.....
Adults	\$..... to	\$.....



D. LANDHOLDERS AND CONSERVATION OF CROCODILES

22. Landholders are paid for rights to collect crocodile eggs and crocodiles on their land. Do you think this encourages them to conserve crocodiles?

- Yes No Unsure

Please elaborate on your answer.

.....
.....
.....

23. Do you believe that holders of cattle properties are likely to conserve more crocodile habitat as a result of payments they receive for crocodile harvesting on their land?

- Yes No Unsure

Please elaborate.

.....
.....
.....

24. Do you think that traditional Aboriginal landholders are likely to conserve more crocodile habitat as a result of payments they receive for crocodile harvesting on their land?

- Yes No Unsure

Please elaborate.

.....
.....
.....

25. What do you consider to be the main benefits (social or otherwise) obtained by paying holders of cattle properties for allowing crocodile harvesting on their land?

1).....
2).....
3).....

26. What do you consider to be the main benefits (social or otherwise) obtained by paying Aboriginal landholders for allowing crocodile harvesting on their land?

1).....
2).....
3).....

27. Do you encounter any difficulties with landholders in gaining access for harvesting crocodile eggs/crocodiles? Yes No

If 'yes', please elaborate.

.....
.....
.....



E. TRENDS IN FARMING CROCODILES IN NT

28. The number of crocodile farms in NT seem to have peaked and has since then slightly declined.

Why do think that this decline has occurred?

.....
.....
.....

29. Which of the following do you think applies to the future of the production of the crocodile industry in the NT?

- Its production will increase
- Its production will remain about the same as now
- Its production will decline

Why do you believe this?

.....

.....

.....

30. Do you think the number of crocodile farms in the NT will

- Increase
- Decrease
- Remain unchanged?

Why?

.....

.....

.....



F. FEATURES OF YOUR FARMING OPERATIONS

31. Is your farming enterprise in the Northern Territory involved in the export of crocodile products? Yes No

32. If 'yes' to Q. 31, do you consider this export income to be very important important unimportant for the economic success or viability of your business? (Tick whichever applies)

Products from which countries are your main competition in the export market?

.....

.....

33. In relation to the economics of your crocodile farming operations, rate the importance to you of each of the following for your business success using the following scale:

(1) Very important (2) Important (3) Of little importance (4) Of no importance

Activity	Rating (Select from above)
-----------------	-----------------------------------

Crocodile production
----------------------	-------

Tourism
---------	-------

Research
----------	-------

Any comments?

.....
.....
.....

34. Does your crocodile farming enterprise operate at more than one site (location) in NT? Yes No

If Yes, at how many locations?

35. If your crocodile farming occurs at more than one site in the NT, briefly indicate how operations differ between sites.

.....
.....
.....

36. Please outline briefly the economic advantages and disadvantages of crocodile farming in the NT.

.....
.....
.....

37. Do you operate in other Australian states? Yes No

If 'yes', in which states?

Do you operate overseas? Yes No

If 'yes', in which countries?



H. MISCELLANEOUS

38. Please add any extra points you wish to make about policies for the management of crocodiles in the NT.

.....
.....
.....

39. Please list any points you would like to raise about the future of crocodile farming in the NT.

.....
.....
.....

THANK YOU FOR HELP PLEASE DO NOT FORGET TO POST YOUR COMPLETED FORM IN THE POSTAGE PAID (PRE-ADDRESSED) ENVELOPE PROVIDED.



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