Aust. Wildl. Res., 1983, **10**, 373–82

Crocodylus johnstoni in the McKinlay River Area, N.T. II.* Dry-Season Habitat Selection and an Estimate of the Total Population Size

Grahame J. W. Webb[A], *S. Charlie Manolis*[A] *and Rik Buckworth*[AB]

[A] School of Zoology, University of New South Wales, P.O. Box 1, Kensington, N.S.W. 2033; and Conservation Commission of the Northern Territory, P.O. Box 38496, Winnellie, N.T. 5789.
[B] Present address: Fisheries Division, Department of Primary Production, P.O. Box 4160, Darwin, N.T. 5794.

Abstract

In July 1979, midway through the dry season, most *C. johnstoni* were congregated in pools greater than 1 m deep and 900 m^2 in area. Use of some, but not all of these large, deep pools is not dependent on whether the pools are in the mainstream or not, nor on the clarity (an indicator of siltation) of the water in them. Food availability and access to nesting banks may be related to selection of individual pools, although the former is considered unlikely. The homing ability of *C. johnstoni* would seem a decided advantage for relocating specific refuge sites, which tend to be used each year by the same individuals. The *C. johnstoni* population in the McKinlay River study area is estimated at 963 individuals (826–1156).

Introduction

Crocodylus johnstoni Krefft are widely distributed in Northern Australia (Worrell 1964, pp. 4, 5; Cogger 1979, p. 118), where they occupy a variety of wetland habitats. In the Northern Territory they occur in most river systems and are typically spread throughout the upstream freshwater regions. In some rivers they extend downstream into areas of tidal influence (Messel *et al.* 1979*a*, 1979*b*), although some of these extensions may be recent in origin and appear temporary in nature (Webb *et al.*, unpublished).

In most areas, the extent of the upstream wetlands available for occupation by *C. johnstoni* is strongly dependent on season. During the peak of the annual monsoon, or wet season, widespread flooding essentially obliterates wetland margins, uniting large areas of otherwise variable habitat in a more or less continuous body of water. As water levels drop, margins reappear and individual bodies of water regain their integrity; subsequently many of them dry up completely during the dry season.

Habitats characterized by such marked fluctuations in available water are utilized by a number of extant crocodilians, and consideration of the restrictions imposed by such dynamic systems may well be important to the assessment of many aspects of crocodilian biology. For example, terrestrial activity is usually restricted in crocodilians, yet there are many examples of them travelling long distances overland between drying pools (*C. johnstoni*, Webb and Gans 1982; *Crocodylus niloticus*, Cott 1961; Pooley and Gans 1976; *Crocodylus palustris*, Whitaker 1977; *C. porosus*, personal observation; *Caiman crocodilus crocodilus*, Staton and Dixon 1975; Gorzula 1978).

*Part I, *Australian Journal of Zoology*, 1982, **30**, 877–99.

0310-7833/83/020373$02.00

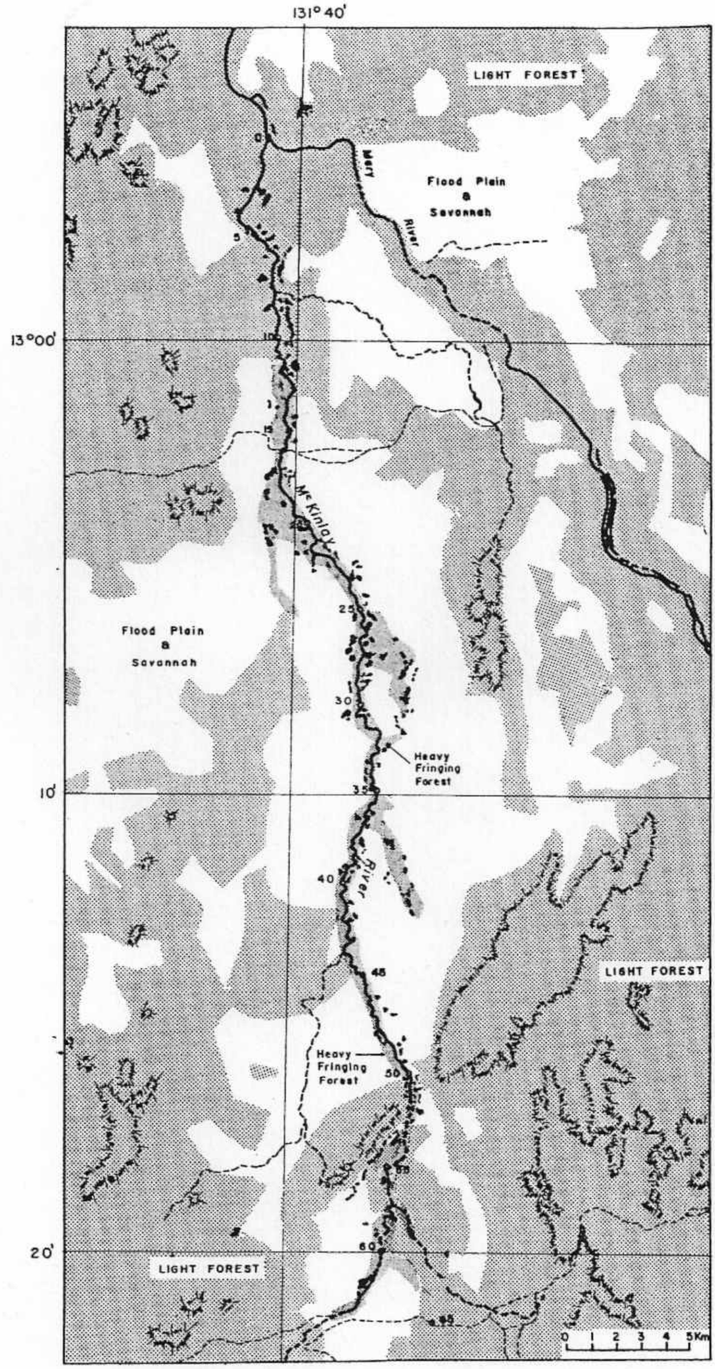

Fig. 1. The McKinlay River area in which *C. johnstoni* were studied. Spots indicate billabongs and swamps. Numbers are river kilometres from the Mary River.

The present study was undertaken to determine whether or not the McKinlay River pools occupied by *C. johnstoni* during the dry season were a random selection of those available, and, if not, to attempt to quantify attributes of pools likely to be involved in site selection. The study is based on a survey of pools in which their attributes and the relative densities of crocodiles were recorded. Attributes examined were pool size (depth and area), type (mainstream pool, *Melaleuca* swamp, billabong) and the extent of siltation, as indicated by water clarity. Crocodile densities were determined by spotlight counts. By utilizing limited data on the relationship between spotlight counts and total numbers present in specific pools, an estimate has been made of the total size of the population.

Methods

Study Area

The study area extends from 12°46′S. to 13°20′S., at approximately 131°50′E., and includes an area of some 100–150 km² adjacent to the main stream (Fig. 1). The land systems, soils and vegetation of the area have been described by Story *et al.* (1969) and are only briefly alluded to here. Data summarizing the annual weather pattern are included in Table 1.

Table 1. Meteorological data from Middle Point, 50 km north-west of the study area

Data accumulated over at least 15 years by the Australian Bureau of Meteorology

Month	Temperature (°C)			Relative	Rainfall		
	Daily max.	Daily min.	9 a.m.	humidity (%)	Mean (mm)	Median (mm)	No. of raindays
Jan.	32·8	23·9	27·6	84	323	289	20
Feb.	31·7	23·9	26·8	87	281	262	20
Mar.	31·9	23·7	27·0	85	262	229	18
Apr.	33·0	22·1	26·8	77	87	61	7
May	32·0	19·4	24·8	71	24	3	3
June	31·1	17·0	22·8	67	4	0	0
July	30·9	15·1	21·5	61	0	0	0
Aug.	33·0	17·7	24·3	67	1	0	0
Sept.	34·7	20·3	26·9	65	10	6	2
Oct.	35·5	22·9	28·5	68	54	34	6
Nov.	35·5	23·8	29·1	70	116	113	12
Dec.	33·7	23·9	28·2	79	245	224	16

During the dry season (April–November), there is no flow in the main stream, which consists of a sandy river bed, with steep banks and numerous isolated pools of varying dimensions. To the sides of the river are drainage lines containing chains of discrete billabongs (=lagoons), and less well defined depressions in the floodplain, typically surrounded with paperbark (*Melaleuca* sp.), which may contain water for most of the dry season. Following the start of wet-season rains (November; Fig. 2), the isolated bodies of water gradually fill, and as they coalesce the river begins to flow. By the peak of the wet season (usually February), widespread flooding is common, and a single sheet of water may unite many isolated pools for varying periods.

The study area has been subjected to heavy grazing, particularly by the introduced water buffalo, *Bubalus bubalis*, and throughout the system there appears to be accelerated erosion with increases in siltation, and a reduction in aquatic and fringing vegetation.

Survey Methods

Using maps prepared from aerial photographs, we systematically surveyed the study area, usually by walking in teams of two, but occasionally singly in a motor vehicle. Typically, a survey covered a segment of river bed or billabong chain during the day, with a return through the area at night to count the crocodile eyeshines. Each body of water greater than 2 m in length was considered a discrete pool and was assigned a consecutive number written on tape and left at the site (for navigation at night). The length and mean width of pools were crudely measured by pacing, with corrections being made for individual pace lengths. Maximum depth (<20 cm, <40 cm, <60 cm, <80 cm, <1 m, 1–2 m, 2 m+) and water clarity (<10 cm visibility, extremely muddy; 10–50 cm, partly muddy; >50 cm, reasonably clear) were crudely estimated, and the number of crocodiles seen during the day, if any, was noted.

Pools were categorized into the following broad types:

Mainstream pools. Usually sandy but sometimes with rocky substrates. Water clarity usually >50 cm but sometimes reduced due to decomposing vegetation. Typically shaded by trees, particularly *Melaleuca* spp. and *Pandanus* spp. Subjected to rapid and continual water flow in the wet season.

Paperbark swamps. Depressions in the floodplain surrounded by and sometimes containing *Melaleuca*. These were usually shallow and many were greatly silted; water clarity was typically <10 cm visibility.

Billabongs. Separate pools, usually in chains within discrete drainage lines leading to the mainstream. The extent of siltation varied considerably and appeared to depend on both the extent of utilization by buffalo and the substrate type. Pools with rocky substrates tended to have clearer water with more aquatic vegetation than those without; pools used extensively by buffalo were invariably muddy with little aquatic vegetation.

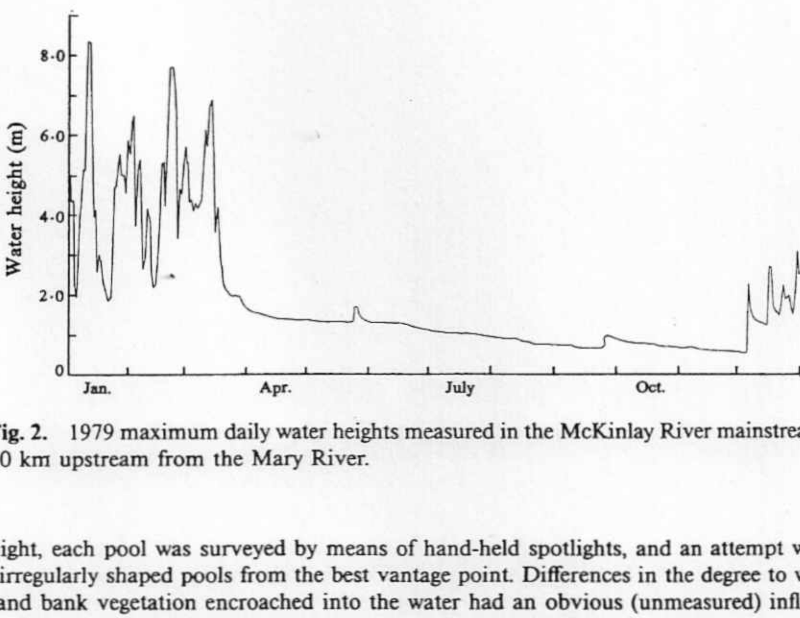

Fig. 2. 1979 maximum daily water heights measured in the McKinlay River mainstream 50 km upstream from the Mary River.

At night, each pool was surveyed by means of hand-held spotlights, and an attempt was made to scan irregularly shaped pools from the best vantage point. Differences in the degree to which the littoral and bank vegetation encroached into the water had an obvious (unmeasured) influence on the visibility of crocodiles. Where the water's edge was free of obstructions most crocodiles on the edge could be seen, but in heavily vegetated waters a proportion had their eyes shielded from the light and were no doubt missed. The wariness of crocodiles throughout the system appeared reasonably constant, except for those in a few billabongs adjacent to main tracks; the crocodiles in these pools were more wary and appeared to have been harassed (Webb and Messel 1979).

The complete study area was surveyed between 7 and 19 July 1979 and, to obtain an indication of the extent of continued dry-season evaporation, one small area was resurveyed on 10 September 1979.

The Relationship between Night Counts and the Number of Crocodiles Present

In nine pools surveyed, intensive efforts were made to catch and/or account for all crocodiles present. Nets were criss-crossed through the pools and, after an initial flurry of catching, pools were waded and poled repeatedly until no more crocodiles were caught. If after a prolonged wait an eyeshine was sighted, the wading and poling was repeated. Occasionally an elusive animal was not caught, but its presence was noted. That a very high proportion of the crocodiles present can be caught by such methods is indicated by the generally high recapture rates being achieved in the McKinlay River area. For example, 61% of all animals marked in 1978 have been recaught at least once in two subsequent recatch efforts (1979 and 1980) (Webb *et al.* 1983*a*).

Results

C. johnstoni *Locations and Pool Characteristics*

Altogether, 982 separate bodies of water were examined: 72·4% mainstream pools, 23·4% billabongs and 4·1% swamps. All except one pool were surveyed for crocodiles during the day and/or night. For a variety of logistic reasons, mainly navigational mishaps, not all pools were surveyed both during the day and night: 98·0% at night; 98·8% by day; 96·8% by both day and night. Within the study area all mainstream pools were examined, but some billabongs and swamps were known to have been missed (see p. 379).

Table 2. Distribution of *C. johnstoni* in pools of varying depth which were surveyed at night

The number of pools with *C. johnstoni* includes those where crocodiles were seen by day as well as those with night sightings

Pool depth (cm)	No. of pools	No. of pools where *C. johnstoni* present	No. of *C. johnstoni* sighted at night
0–20	293	1	1
21–40	182	0	0
41–60	108	1	2
61–80	58	4	7
81–100	40	1	1
101–200	204	35	110
>200	77	43	384
Total	962	85	505

Pool depth in July (Table 2) had an obvious relationship with both crocodile presence or absence ($\chi^2_6 = 187$; $P \ll 0 \cdot 001$) and the number of crocodiles present ($\chi^2_6 = 821$; $P \ll 0 \cdot 001$); most *C. johnstoni* were congregated in deep pools. This is not surprising, because when the sample area was resurveyed in September, well before the wet season (Fig. 2), most shallow pools had already dried and deeper pools often divided into smaller pools of varying depth:

Depth in July (cm)	No. in July	No. remaining September	Depth in July (cm)	No. in July	No. remaining September
0–20	23	2	61–80	2	1
21–40	5	0	81–100	1	1
41–60	10	2	101–200	13	12
			>200	1	1

i.e. only four of 38 pools of 60 cm depth or less had survived, compared to 15 of 17 deeper pools.

Of the original seven July sightings from shallow pools (<1 m; Table 2), five were close (0·1–0·6 km) to deep pools containing crocodiles and two were reasonably isolated (2·8 and 4·4 km). These sightings may have been of animals moving between centres, as *C. johnstoni* occasionally move overland between pools during the dry season (Webb and Gans 1982). Altogether, 97·8% of *C. johnstoni* were in pools >1 m deep and, of those, 22·3% were in pools 1–2 m deep and 77·7% in pools >2 m deep.

Pools more than 1 m deep varied considerably in area, and it was apparent during the surveys that large pools more consistently contained crocodiles than did small ones. Furthermore, small pools estimated as having a depth of 1–2 m, unless spring-fed, may have dried completely by the end of the dry season. In Table 3, categories based on the square root of pool length by width (pool 'size'; PS) are presented for three categories of pool depth (>1 m, >2 m, 1–2 m). In pools >2 m deep, 100% of the larger pools (>90 m PS) were occupied, and occupancy declined with decreasing pool size. This same trend was apparent in the pools 1–2 m deep (with the exception of those 91–120 m PS), and when all deep pools were lumped (Table 3; >1 m deep). It was concluded that among the deeper pools (>1 m), those >60 m PS were generally acceptable (69–80% occupancy), those 31–60 m PS were marginally acceptable (32% occupancy), and those <30 m PS were generally unacceptable. There were 164 pools >30 m PS.

Table 3. The distribution of *C. johnstoni* in pools >1 m deep as a function of pool size

Pool size is taken as the square root of the area, in metres. NA, not applicable

Pool depth (m)	Pool size (m)	*N*	Pools with *C. johnstoni* *N*	Pools with *C. johnstoni* Percentage	No. of *C. johnstoni* sighted at night *N*	No. per pool	No. per pool with crocodiles
	0–30	132	10	8	14	0·1	1·4
	31–60	99	32	32	147	1·5	4·6
>1	61–90	29	20	69	179	6·2	9·0
	91–120	16	12	75	122	7·6	10·2
	>120	5	4	80	32	6·4	8·0
Total		281	78	28	494	1·8	6·3
	0–30	117	6	5	9	0·1	1·5
	31–60	68	19	28	30	0·4	1·6
1–2	61–90	13	9	69	58	4·5	6·4
	91–120	5	1	20	13	2·6	13·0
	>120	1	0		0		
Total		204	35	17	110	0·5	3·1
	0–30	15	4	27	5	0·3	1·3
	31–60	31	13	42	117	3·8	9·0
>2	61–90	16	11	69	121	7·6	11·0
	91–120	11	11	100	109	9·9	9·9
	>120	4	4	100	32	8·0	8·0
Total		77	43	55·8	384	5·0	8·9

Numbers of crocodiles sighted in the deeper pools (Table 3) showed similar trends. In the smallest pools (0–30 m PS) there were 0·1 sightings per pool, increasing to 1·5 in pools of 31–60 m PS, and 6·2–7·6 in those >60 m PS. By comparing the value 'crocodiles per pool with crocodiles' in Table 3 with the relevant pool sizes, it can be seen that density may actually decrease with increasing pool size. For example if crocodiles were present in pools 31–60 m PS, there were 4·6 per pool, or approximately 1 per 440 m^2 (assuming a mean PS of 45 m); this decreases to 1 per 625 m^2 (61–90 m PS) and 1 per 1081 m^2 (91–120 m PS) as pool size increases.

The 164 pools >1 m deep and >30 m PS were categorized on the basis of siltation (water clarity) and pool type, and the distribution of pools available was tested against both the distribution of pools containing crocodiles, and the numbers of crocodiles sighted in them (Table 4). In neither case was presence or absence, or numbers sighted, significantly different from pools available (χ^2; $P \gg 0 \cdot 05$), which indicates that utilization of a pool is probably independent of water clarity and the categories of pool we used.

Population Size

Of the 982 pools examined, 962 were surveyed at night yielding a total of 505 *C. johnstoni* sightings (from 85 pools). Of the 20 pools not surveyed at night, 19 were surveyed during the day; by use of the mean but highly variable relationship between night counts (C_N) and day counts (C_D) (from 74 pools surveyed at both times: $C_N = 2 \cdot 3 + 2 \cdot 3\, C_D \pm 7 \cdot 6$) it was estimated that those 19 pools would have yielded approximately 38·7 sightings. The remaining pool was >2 m deep and 0–30 m in size, and from Table 2 was assigned 0·3 sightings, making an estimated total of 544 crocodile sightings for 982 pools.

Table 4. The distribution of *C. johnstoni* with regard to water clarity and pool type in 164 pools considered acceptable with regard to pool depth and size

Water clarity				Habitat			
Category (cm)	N	No. with crocodiles	No. of sightings	Category	N	No. with crocodiles	No. of sightings
<10	16	9	38	Mainstream	85	34	228
10–50	100	40	304	Swamps	4	1	18
>50	48	23	143	Billabongs	75	37	239

Table 5. The approximate relationship between night counts and total numbers of *C. johnstoni* in nine pools in the McKinlay River

Unless otherwise stated, all were surveyed from the best vantage point on the bank

Pool No.	Night count	Total number	Percentage seen	Edge cover	Notes
1	32	61	52	None	Surveyed from side; not from best vantage point
1	44	61	72	None	Re-surveyed from best vantage points
2	9	10	90	None	
3	13	15	87	None	
4	37	51	73	Slight	
5	11	14	79	Slight	
6	14	20	70	Slight	
7	15	29	52	Medium	
8	6	8	75	Medium	
9	13	25	52	Heavy	

As stated previously, all mainstream pools were examined, but a number of billabongs and swamps were not. One large pool previously unsurveyed has since been examined, and gave a night count of 25. From aerial photographs we know that no other large pools were missed, but small billabongs are often difficult to locate from aerial photographs. It is possible that up to 20% of the total number of smaller pools may have been missed. Excluding the largest pools examined in the study (>120 m $\sqrt{\text{area}}$), 44 *C. johnstoni* were sighted in 167 smaller billabongs; 20% would indicate approximately nine sightings missed. With the addition of these, the total number of *C. johnstoni* which could have been expected to be sighted, if all pools had been surveyed, would be about 578.

The relationship between numbers sighted in a pool at night, and the actual number of crocodiles present in that pool is difficult to quantify. The relationship centres on the proportion of crocodiles which are on the surface, and the proportion of those that are actually seen. Wariness may have an influence, because wary crocodiles are more likely to dive (Webb and Messel 1979), but in the McKinlay River wariness seemed reasonably constant. An obviously important variable was the condition of the bank with regard to visibility at the water's edge: as stated previously, if the banks were free of logs, vegetation, etc., the eyes, if present, were readily sighted. Table 5 contains data comparing numbers of *C. johnstoni* sighted at night with total numbers accounted for by intense catching efforts in nine McKinlay River pools. The maximum percentage sighted from the best vantage point was 90% and the minimum was 52%; the mean value was 72%.

The majority of pools containing *C. johnstoni* in the McKinlay River area have slight to heavy edge obstruction, and due to the irregular shape of many pools good vantage points were often unobtainable. In the absence of additional data, we believe that 50–70% is probably a more realistic correction applicable to the McKinlay pools as a whole. These corrections indicate the McKinlay River population within the study area in 1979 was between 1156 and 826 individuals, with a mean estimate (60% correction) of 963 individuals.

Discussion

In the McKinlay River area, the reasonably distinct wet and dry seasons (Table 1; Fig. 2) greatly alter the extent of wetlands available throughout the year. For most of January–March 1979 (Fig. 2) the water level in the mainstream had risen a few metres, and all isolated pools in the mainstream and adjoining drainage lines would have been united in a single flowing stream. A downstream billabong out of the mainstream which was visited in February 1979 had water 3 m above its July–August level, and was within a continuous body of water spreading over many kilometres of floodplain. At the end of the wet season (Fig. 2), however, water levels fell rapidly, and the larger, deeper pools were isolated as entities from at least April. Due to evaporation, these pools continued to recede and subdivide, but the larger pools, containing most crocodiles, tended to be distinct throughout the dry season.

The survey was carried out in July, four months before significant wet-season rains, and the *C. johnstoni* were already congregated in the larger, deeper pools. Permanent water would appear a major factor influencing the choice of pools. Nevertheless, 164 deep, large pools were recognized, yet only 72 of them contained *C. johnstoni*. Neither the extent of siltation, as indicated by water clarity, nor the basic pool type (mainstream, swamp, billabong) could be used to distinguish the 72 occupied from the 92 unoccupied pools.

Differences in food availability between pools is a possible factor influencing choice. *C. johnstoni* in the McKinlay River area rarely feed in the dry season, and most individuals lose weight (Webb *et al.* 1982, 1983*a*), but the small amounts of food available could be critical. The general tendency towards increased siltation of pools in the area can be expected to alter both the diversity and density of prey species (Hynes 1976), yet the extent of siltation had no influence on which pools were occupied, nor on the numbers of crocodiles occupying a pool. If food availability was an important factor influencing choice of pool, one would expect silted pools to have more, or fewer, crocodiles in them.

Access to nesting banks is a further possible factor influencing pool choice. *C. johnstoni* nest in August–September (Webb *et al.*, unpublished) and the hole-type nests they excavate are made in what appears to be the area of friable substrate (usually sand) nearest the pool a female occupies. Some billabongs and swamps lack sandy banks, but almost all mainstream pools have an abundance of them; yet no preference was shown for mainstream pools (Table 5). We did not record the presence or absence of sandbanks during the survey, but in most pools where *C. johnstoni* had congregated in July, nesting areas were both present and used in August–September. Factors other than substrate type, perhaps those contributing to nest success rather than simply nest construction, could well be involved.

Little information is available on the extent of movements made by *C. johnstoni* during the wet season. In the Mary River, the majority of animals appear to remain at the water's edge, and spread out with this edge as the pools expand and coalesce (Webb *et al.* 1982). General observations in the McKinlay River indicate a general dispersal from dry–season refuge sites with the first heavy wet-season rains, and the same pattern was apparent in the Adelaide River (Webb *et al.*, unpublished). Such movements could be expected to place individuals in drainage lines which would lead away from their refuge site when the waters recede after the wet season. However, in successive dry seasons 83·4% of recaught animals were within 1 km of their original capture site; 72·8% at the same site (Webb *et al.* 1983*a*). The homing ability of *C. johnstoni* (Webb *et al.* 1983*b*) may be strongly implicated in returning individuals to specific dry-season refuge sites. As subadult *C. johnstoni* also tend to be recaught in the same sites (Webb *et al.* 1983*a*), they must learn the location of a dry-season refuge site well before reproductive maturity or any active need for nesting or associated behaviour. It would seem possible that some form of imprinting occurs soon after hatching.

For the efficient survey or monitoring of *C. johnstoni* numbers in areas such as the McKinlay River, the present study indicates that emphasis should be placed on the larger pools (>900 m^2 in area), most of which can be recognized from aerial photographs; they contained 96% of all crocodiles sighted in this study.

The extent to which the estimated population size in 1979 reflects the original size before exploitation is difficult to ascertain. It is certainly less, as *C. johnstoni* skins from the McKinlay River numbered well into the thousands over a relatively short period (1960–64; information from local hunters). However, given maintenance of the current protection, recovery (Webb *et al.* 1983*a*) can be expected to continue. It has yet to be clarified whether or not habitat alteration, particularly increasing siltation, will have a significant effect on *C. johnstoni* populations, and this would seem a worthwhile area for investigation.

Acknowledgments

We would particularly like to thank Tony Spring for his assistance with all field aspects of the study. Others who assisted with the survey were Mike Bennell, Allen Hilder, David Stammer, Laurie Taplin and Gregory Webb. Alex Mazanov discussed most aspects of the paper, and Alistair Graham, Robert Begg, Murray Elliott, Bob Fox, Alex Mazanov, George Sack and Paul Wettin commented on a draft of the manuscript. Financial support came from the Conservation Commission of the Northern Territory and from the University of New South Wales.

References

Cogger, H. G. (1979). 'Reptiles and Amphibians of Australia.' Rev. Ed. (A. H. and A. W. Reed: Sydney.)

Cott, H. B. (1961). Scientific results of an inquiry into the ecology and economic status of the Nile crocodile, *Crocodylus niloticus*, in Uganda and Northern Rhodesia. *Trans. Zool. Soc. Lond.* **29**, 211–337.

Gorzula, S. J. (1978). An ecological study of *Caiman crocodilus crocodilus* inhabiting savanna lagoons in the Venezuelan Guayana. *Oecologia (Berl.)* **34**, 21–34.

Hynes, H. B. N. (1976). 'The Ecology of Running Waters.' (Liverpool University Press.)

Messel, H., Gans, C., Wells, A. G., Green, W. J., Vorlicek, G. C., and Brennan, K. G. (1979*a*). The Victoria and Fitzmaurice River Systems. Surveys of Tidal River Systems in the Northern Territory of Australia and their Crocodile Populations. Monogr. No. 2. (Pergamon Press: Sydney.)

Messel, H., Gans, C., Wells, A. G., and Green, W. J. (1979*b*). The Adelaide, Daly and Moyle Rivers. Surveys of Tidal River Systems in the Northern Territory of Australia and their Crocodile populations. Monogr. No. 3. (Pergamon Press: Sydney.)

Pooley, A. C., and Gans, C. (1976). The Nile crocodile. *Sci. Am.* **234**, 114–24.

Staton, M. A., and Dixon, J. R. (1975). Studies on the dry season biology of *Caiman crocodilus crocodilus* from the Venezuelan Llanos. *Mem. Soc. Cienc. Nat. La Salle* **35**, 237–65.

Story, R., Williams, M. A. J., Hooper, A. D. L., O'Ferrall, R. E., and **McAlpine, J. R.** (1969). Lands of the Adelaide Alligator area, Northern Territory. CSIRO Land Res. Ser. No. 25.

Webb, G. J. W., Buckworth, R., and **Manolis, S. C.** (1983*a*). *Crocodylus johnstoni* in the McKinlay River area, N.T. III. Growth, movement and the population age structure. *Aust. Wildl. Res.* **10**, 383–401.

Webb, G. J. W., Buckworth, R., and **Manolis, S. C.** (1983*b*). *Crocodylus johnstoni* in the McKinlay River area, N.T. IV. A demonstration of homing. *Aust. Wildl. Res.* **10**, 403–6.

Webb, G. J. W., and **Gans, C.** (1982). Galloping in *Crocodylus johnstoni*: a reflection of terrestial activity? *Rec. Aust. Mus. Syd.* **34**, 607–18.

Webb, G. J. W., Manolis, S. C., and **Buckworth, R.** (1982). *Crocodylus johnstoni* in the McKinlay River area, N.T. I. Variation in the diet and a new method of assessing the relative importance of prey. *Aust. J. Zool.* **30**, 877–99.

Webb, G. J. W., and **Messel, H.** (1979). Wariness in *Crocodylus porosus* (Reptilia : Crocodilidae). *Aust. Wildl. Res.* **6**, 227–34.

Whitaker, R. (1977). Notes on the status of the Gir crocodile. *J. Bombay Nat. Hist. Soc.* **75**, 224–7.

Worrell, E. (1964). 'Reptiles of Australia.' (Angus and Robertson: Sydney.)

Manuscript received 17 December 1981; accepted 10 September 1982