Bills. For example, in the recently concluded 93rd Congress, a Bill introduced to strengthen the Bureau of Land Management was approved by the House Public Lands Subcommittee, but only after inclusion of a provision to compensate graziers in case of government cancellation of their grazing permits. The issue raised by the provision is a recurring one in the history of the public domain; it contrasts the viewpoints of the ranchers, who argue that they need security against possible capricious actions by the Bureau, against supporters of a strong BLM, who claim that compensation would constitute recognition of a proprietory right in the public lands. If legally established, such a right would further strengthen the position of livestock graziers as the primary users of the public domain.

During the 94th Congress, convened in January 1975, revision of the public land laws will again be considered. BLM Director Berklund has promised to present this year a full report on the Bureau's range management programme and on range conditions (Bureau of Land Management, 1974*b*). If that report presents findings similar to those in the recent study on Nevada, it will aid the effort to transform the Bureau of Land Management into an agency protecting all resources, and the interests of all users, of the public domain.

REFERENCES

BUREAU OF LAND MANAGEMENT (1974*a*). *Effects of livestock grazing on wildlife, watershed, recreation and other resource values in Nevada*. Washington, D.C., Bureau of Land Management. (Mimeographed.)

BUREAU OF LAND MANAGEMENT (1974*b*). BLM reports on conditions of western rangelands. Washington, D.C., *Bureau of Land Management News Release*, 3 September 1974.

CALEF, W. (1960). *Private grazing and public lands*. University of Chicago Press.

FOSS, P. (1960). *Politics and grass: The administration of grazing on the public domain*. Seattle, University of Washington Press.

PUBLIC LAND LAW REVIEW COMMISSION (1970). *One third of the nation's land*. Washington, D.C., Government Printing Office.

VALE, T. (1974). Sagebrush conversion projects: an element of contemporary environmental change in the western United States. *Biol. Conserv.*, **6**, 274–84.

THE ROLE OF COMMERCIAL CROCODILE FARMING IN CROCODILE CONSERVATION*

D. K. BLAKE & J. P. LOVERIDGE

Department of National Parks and Wildlife Management, P.O. Box 8365, Causeway, Rhodesia, and Department of Zoology, University of Rhodesia, Salisbury, Rhodesia

ABSTRACT

Commercial crocodile rearing stations in Rhodesia are described, including regulations which govern their operation. When crocodile eggs are collected from the wild a quota of juveniles equivalent to 5% of the number collected must be released at the age of 3 years. Figures for hatching success and juvenile growth on rearing stations compared with wild populations indicate that both these parameters are better on the rearing stations. The growth rate on a rearing station is twice as fast as in the wild. Data on juvenile survival on the rearing stations suggest that it is of the order of 50% to the age of 3 years. No comparative information is available for wild populations. Survival of station-reared crocodiles after release into the wild is good, although growth slows substantially. Juveniles for release are a valuable tool in management, for restocking suitable areas or supplementation of natural recruitment. Crocodile farms may provide an answer to future management of this species, and a ready source of breeding stock is available in 'problem' animals which are relocated rather than shot. Crocodile rearing and farming in developing countries could provide the incentive to maintain a renewable resource rather than to exploit and destroy existing populations.

INTRODUCTION

In Rhodesia it is now accepted (Blake, 1970, 1974; Attwell, 1973) that crocodile rearing and farming have an important role to play in the conservation of the Nile crocodile (*Crocodylus niloticus* Laurenti), the status of which is currently causing concern in Africa (Cott & Pooley, 1972). It is pertinent here to define what is meant

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by 'rearing' and by 'farming'. Rearing of crocodiles is not carried out independently of natural populations, and relies on annual quotas of eggs collected from the wild. All three crocodile 'farms' in Rhodesia operate on this basis and are therefore called rearing stations (Blake, 1974). A crocodile farm would have adult breeding stock, and hatch out young from eggs laid by these animals.

The Rhodesian crocodile rearing stations are located at Kariba, Binga and Victoria Falls (Fig. 1), and collect their eggs from the Zambezi and its tributaries.

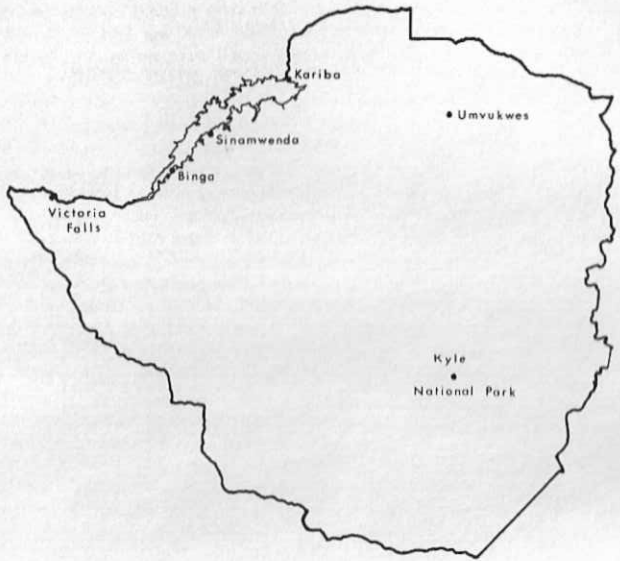

Fig. 1. Map of Rhodesia showing places mentioned in the text.

They operate under permits issued by the Department of National Parks and Wildlife Management (Blake, 1974). The main points are that the number of eggs to be collected is regulated (it has never exceeded 2,500 per station per year and none are taken from National Parks and Game Reserves); monthly reports are to be submitted by the stations, including numbers of eggs collected, number of young hatched, mortality and sales. Finally an annual quota of crocodiles 3 years old (in the 1·0 m size range) is to be surrendered to the Department of National Parks and Wildlife Management for restocking the rivers. This quota is currently set at 5% of the number of eggs collected 3 years previously. Thus, if 1,500 eggs were collected in 1971, 75 3-year-olds would be surrendered in 1974.

COLLECTION AND HATCHING OF EGGS

Details of eggs collected and hatched since 1967 by the three rearing stations are given in Table 1. The number of eggs allowed has varied from 1,200 to 2,500/annum, normally at the request of the station concerned. Prior to the 1973 season collecting has been dependent on availability of suitable pens and food on the stations rather than being limited by the number of nests found. Egg collection in 1973 was adversely affected by the closure of the Zambezi River below Lake Kariba and parts of the lake for security reasons.

From 1967 to 1973 (Table 1) a total of 22,679 eggs have been collected of which

TABLE 1
EGGS COLLECTED AND HATCHED BY 3 RHODESIAN CROCODILE REARING STATIONS

Station	*Eggs collected*	*Eggs hatched*	*% hatched*
Binga 1967–73	9903	6874	69·4
Kariba 1968–73	6250	5352	85·6
Victoria Falls 1971–73	6526	4471	68·5
TOTALS	22679	16697	73·6 (average)

16,697 were hatched, giving a mean hatching success of 73·6% (*cf.* 72·6% reported by Pooley, 1969). Pooley (1971) suggests that using artificial incubation a success of 80% should be achieved. In individual years and on separate stations this success rate has been exceeded, though poor years, with as low as 49·9% hatch, bring the average down. Reasons for variations in hatching success are difficult to ascertain, but from the limited data available to us (Table 2) there would appear to be an indication that collection of eggs shortly after laying (normally occurring late September) has a detrimental effect on hatching success as compared with late collection. Pooley (1971) recommends early collection as 'with eggs in an advanced state of incubation there is the danger that the delicate system of blood vessels or the yolk sac will rupture'. Our limited experience indicates that crocodile eggs are more susceptible to handling in the early stages than at a later stage. Similar observations have been reported by MacFarland *et al.* (1974) for tortoise (*Geochelone elephantopus*) eggs. It is proposed to carry out further investigations on this phenomenon.

From Table 2 it will be seen that with one exception (Binga 1970) collections in

excess of 1,800 have a hatching success below 75% whereas all collections under 1,500 are above 80% successful. This could be a consequence of rearing stations having more clutches than can be carefully managed at hatching time, and may be solved by limiting the quota to 1,500/station/annum. Another possible factor arising from the rearing station returns is that where hatching is continued through into January, the success rate is poor (Victoria Falls 1971–73 and Binga 1968). This could well be indicative of incubation temperatures being too low. Experimental work (unpublished) indicates that sub-optimal temperatures, away from the recommended 28–34°C (Pooley, 1971), prolong the incubation period and result in higher mortalities.

There are data available on hatching success in the wild. Pooley (1973*a*) gives instances of nest predation being as high as 49·4% 3 weeks after laying. Observations at Sinamwenda, Lake Kariba, confirm this. From the conservation angle it would be advantageous to collect eggs early and so remove clutches from the risk of predation which takes place from laying to hatching (Cott, 1969). The main known predators of eggs in Rhodesia are the Nile monitor (*Varanus niloticus* (L.)), baboon (*Papio ursinus* (Kerr)), honeybadger (*Mellivora capensis* (Schreber)) and spotted hyaena (*Crocuta crocuta* (Erxleben)). Yet this may lead to lowered incubation success on the rearing station. Modha (1967) gives an estimate of hatching success in the wild. On Lake Rudolf, Kenya, 6 clutches had a hatching success rate of 68·6–96·4%, but another 5 failed completely. Cott (1969) found that predators in Murchison Falls National Park, Uganda, destroyed 55·1% of clutches, and flooding and damp meant that the eggs in as few as 30% of nests actually hatched.

Collection and partial artificial incubation ensures a high hatching success, and eliminates predation at the time of hatching, which can be substantial (Cott, 1961). Important predators known to attack hatchling crocodiles in Rhodesia are fish eagles (*Haliaëtus vocifer* (Daud.)), Nile monitor (*Varanus niloticus*), goliath heron (*Ardea goliath* Cretzschmar) and fishing owl (*Scotopelia peli* Bonaparte). The programme of egg collection, as at present carried out, does nothing to eliminate egg predation prior to collection.

TABLE 2
MONTH OF EGG COLLECTION AND HATCHING SUCCESS

Station	*Year*	*Number eggs collected in*			*Total*	*% hatch*
		October	*November*	*December*		
Binga	1967	—	2000	—	2000	67·5
Binga	1968	180	1653	—	1833	49·9
Binga	1969	800	1403	—	2203	53·6
Binga	1970	—	1971	—	1971	89·2
Binga	1971	—	128	—	128	93·0
Binga	1972	—	890	—	890	90·8
Binga	1973	—	878	—	878	84·7
Victoria Falls	1971	—	2250	—	2250	73·3
Victoria Falls	1972	1345	1130	—	2475	63·5
Victoria Falls	1973	—	1801	—	1801	69·4
Kariba	1968	—	—	1395	1395	85·4
Kariba	1969	—	—	1324	1324	81·6
Kariba	1970	—	1150	—	1150	90·0
Kariba	1971	—	832	—	832	87·7
Kariba	1972	—	956	—	956	81·3
Kariba	1973	—	593	—	593	91·1

SURVIVAL OF THE HATCHLINGS

Figure 2 gives the cumulative per cent mortality by year of stocks held by Binga rearing station. These data are typical of the three stations and show that mortality can be substantial in the first three years, after which few deaths take place, a fact also noted by Yangprapakorn *et al.* (1971). There is also a clear trend indicating that as the operators become more experienced they can reduce the high juvenile

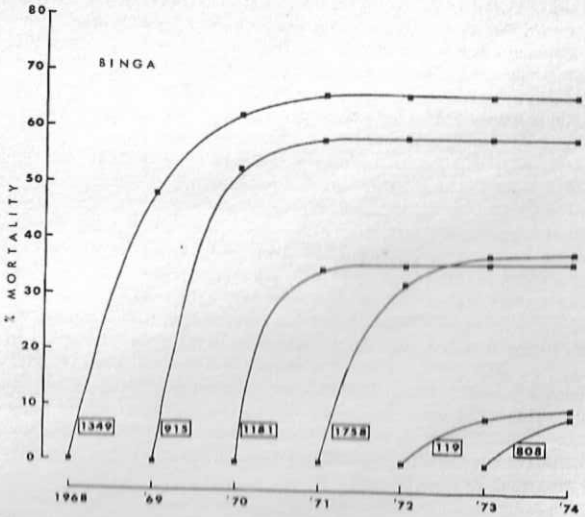

Fig. 2. The cumulative percentage mortality of crocodiles hatched at Binga rearing station. The figures in blocks indicate the number of crocodiles hatched that year, for example 915 hatchlings were produced in 1968/69.

mortality. This is not always true; heavy losses were experienced by Kariba in the dry season of 1973 after transferring the hatchling crop to less sheltered pens and changing their diet. There is no reason why experienced operators of rearing stations should not be able to crop 50% of the number hatched at the age of 4–5 years, allowing for return of the release quota at the age of 3 years.

Mortality is due to a number of factors, of which cold may be the most important. Low temperatures lead to loss of appetite with subsequent deterioration of condition and increased susceptibility to disease. Other factors such as suffocation in overcrowded conditions and predation (fishing owls, monitor lizards, leopard) are of relatively minor importance. Recent work (Mitchell, 1974) has clearly shown that heating either the water or the air in rearing pens can substantially decrease mortality and at the same time increase food intake and growth rate. Similar experiments on *Alligator mississippiensis* in Louisiana are reported by Joanen & McNease (1974).

Of the parameters used in this paper, survival in natural populations is the most important, and the most elusive of all. Various estimates, ranging from 2–3% recruitment (Pooley, 1973*b*) to 1% survival (Graham & Beard, 1973), have entered the literature. None of these are more than informed guesses, even if they are derived from attempts to model the population (Graham, 1968; Parker & Watson, 1970). The only thing that we can safely say of recruitment is that it is likely to be low, and that we would estimate that a return of 5% of the number of eggs taken as crocodiles in the 1 m size range will adequately represent natural recruitment from hatching to the 1 m size class.

To date a total of 355 crocodiles has been returned by rearing stations for release. This figure does not include 1974 quotas, yet to be released. Of these, 53 were marked and released into the Mwenda Bay, Lake Kariba, with the object of ascertaining growth and survival of these captive-reared crocodiles in the wild. Twenty of these 53 (37·7%) have been caught at least once in the twice-yearly recapture exercises carried out since 1970. While a large proportion has not been recaptured, there is hope that some of these may have survived. For example, a crocodile released in May 1970 was first recaptured in June 1974; on the other hand another crocodile released in May 1970 has been recaptured regularly at 6-month intervals ever since. There is other information on survival. Pooley (1969) released 114 hatchlings into a pan in Zululand, but none could be found after 3 weeks. Twenty 0·45 to 0·60 m animals were released into the same pan, and of these 3 were seen after 7 days, 2 after 30 days and only one was found after 90 days. Graham (1968) marked and released 152 young crocodiles on Lake Rudolf, and only 3 of these were recaptured. These, and our own experience on Lake Kariba (33 hatchlings released with one animal recaptured 6 and 22 months later), in a small dam in Kyle National Park (43 hatchlings released, none found after 6 months) and in Matopos National Park (20 hatchlings released, seen an hour later but none found in subsequent checks), indicate that to release hatchlings into the wild as suggested by Pooley (1971) is a wasteful procedure. There is now good evidence (Cott, 1971; Pooley, 1974) that hatchlings in the wild are looked after by the mother for up to 3 months after hatching, so any released hatchlings would have to survive without parental protection.

GROWTH OF JUVENILE CROCODILES

There are a number of reports (Cott, 1961; Pooley, 1962) on growth of captive crocodiles. The information currently available indicates that growth is quite rapid over the first 7–10 years, slowing down appreciably afterwards. Graham (1968) reported the average growth of three wild juveniles on Lake Rudolf to be only 17 mm/annum. Cott (1961) gives a growth of 266 mm/annum for the first seven years, which agrees well with Pooley's data.

Figure 3 presents and compares some data on growth in length for juvenile wild and captive crocodiles. If the hatching date for all individuals were known the curves would extrapolate back to 0·3 m. Growth rates are given for 40 crocodiles from 42 months of age to 75 months (sample reduced to 36 by this stage) on Victoria Falls station and for 50 randomly sampled crocodiles from the 1971 hatching to the age of 27 months on Victoria Falls station. The growth rates of 233 mm/year and 330 mm/year respectively agree well with published data. On the curves substantial slowing of growth is evident in the cold months (the middle of the year).

That much higher growth rates can be achieved by individual animals will be noted from measurements of two crocodiles on Kariba station (Fig. 3). The first, a partial albino, grew from 0·91 m length and 2·6 kg body weight at 20 months to 1·718 m and 16·0 kg at 45 months, an increase of 807 mm and 13·4 kg in two years. The second (no. 117) increased from 1·211 m and 6·2 kg at 32 months to 1·868 m and 19·5 kg at 55 months, an increase of 657 mm and 13·3 kg in just under two years.

As far as the natural population is concerned growth is given both for wild animals marked and subsequently recaptured and also for released rearing station animals in the same environment (Sinamwenda, Lake Kariba). Very slow growth takes place in the released crocodiles, possibly as a result of having to learn to hunt for food and adapt to a new environment. Although these animals show growth in length, this is accompanied by fairly substantial weight losses. It has been seen that within 3 years of release the rearing station crocodiles have slimmed down to the body conformation of those in the wild, and this is particularly evident in the shape of the head, which is long and pointed in the wild juveniles. Growth in wild crocodiles has been slower than that of captive animals, but somewhat better than that of released animals. A hatchling (no. 224) grew from 339 mm shortly after birth to 532 mm at 6 months and 639 mm at 22 months, a total growth of

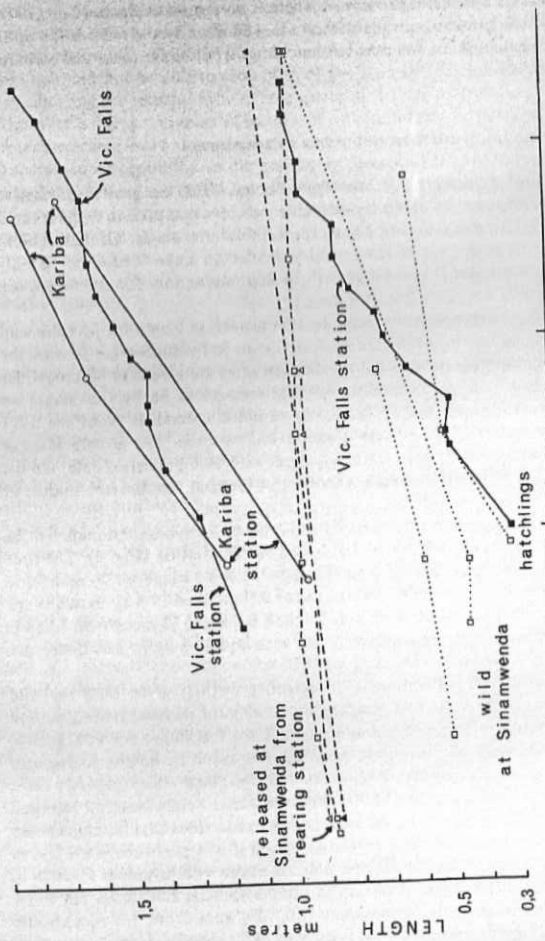

Fig. 3. Growth in length of juvenile crocodiles. ——— animals on rearing stations (○ single individuals, ■ average lengths for a sample of hatchlings and a sample of initially 42-month old crocodiles on Victoria Falls rearing station). – – – individual crocodiles released at Sinamwenda from rearing stations; ····· individual wild crocodiles at Sinamwenda.

300 mm in just under two years. This information indicates a positive contribution to be made by crocodile rearing. In the 2–3 years it takes to rear an animal to 1 m on a rearing station the growth in length is twice as fast as in wild populations. Thus station-reared crocodiles of 1 m size are only 2–3 years old, longer and very much heavier than wild crocodiles of the same age (Fig. 4) and well able to survive in the wild.

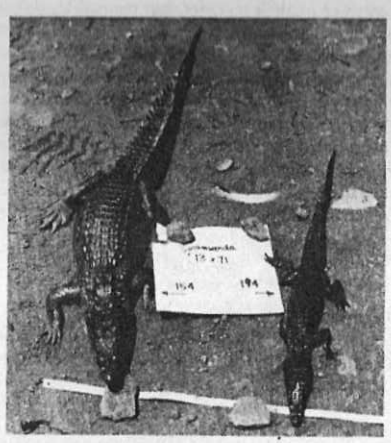

Fig. 4. Comparison of a rearing-station crocodile (no. 154 on left) and a wild crocodile from Sinamwenda (no. 194 on right). Photograph taken 13 October 1971 when both were estimated to be 21 months old. Photo: J. P. Loveridge.

SEX RATIO

In the American alligator, sex ratios of about 3 males to 1 female have been reported (Coulson *et al.*, 1973). If this were true of the Nile crocodile it would have implications for the management of breeding stocks. Cott (1961) reports a 1:1 sex ratio in a large sample, and our limited data do not provide evidence for an excess of males in samples of juvenile crocodiles.

THE PROSPECTS FOR FARMING

The keeping of adult crocodiles for the production of eggs was not initially considered an economic proposition by the rearing stations. Moreover, there were few

recorded instances of the Nile crocodile having bred successfully in captivity. Since 1970, however, crocodiles kept by Mr V. R. Townsend at Umvukwes have laid regularly (Townsend, 1972). Captive animals have bred for the last two seasons in pens at Kyle National Park, and Kariba rearing station has an adult pair, the female of which successfully laid and hatched a clutch of eggs in their pen in 1973. Laying took place in September 1974 in the Kyle pens, at Umvukwes and at Kariba and Victoria Falls rearing stations. The Kariba and Victoria Falls hatchlings were excavated by their mothers, and the two Umvukwes clutches were successfully artificially incubated.

A supply of sexually mature crocodiles is available in problem animals which are now captured and relocated rather than being destroyed (Loveridge & Blake, 1972). A 'problem' crocodile is one which has become a nuisance due to predation on man or his livestock. To date a total of 35 such problem animals has been translocated. With the possibility of the closure of the Zambezi below Kariba for egg collection, the rearing stations may well re-examine the possibility of supplementing, and perhaps eventually replacing, sources of eggs from wild areas with eggs laid by captive crocodiles.

DISCUSSION

Concern has been expressed (Cott & Pooley, 1972) at the policy of the Department of National Parks and Wildlife Management in Rhodesia to allow the collection of up to 7,500 eggs annually for rearing purposes. Table 3 summarises the statistics presented in this paper in the form of a comparison between wild crocodiles and station-reared crocodiles. Assuming nest predation to be constant over the incubation period (Cott, 1969) and that eggs are collected at the end of November, the nest predation will be two-thirds that in the wild population. Hatching success is lower in the wild due to factors such as flooding (Cott, 1969). Predation at the time of hatching on the rearing stations is nil, and in the wild, high (Cott, 1961).

TABLE 3
SUMMARY OF POPULATION PARAMETERS FOR WILD AND STATION-REARED JUVENILE CROCODILES

	Rearing	*Wild*
Nest predation	37·7%* (over 2 months)	55·1%* (over 3 months)
Hatching success	73·6% (of eggs taken)	60·2%† (in nests surviving predation)
Predation at hatching	NIL	HIGH
Survival to 3 years	50%	MUCH LESS THAN 50%
Recruitment to 1·0 m size class	5% of eggs collected for release	?
Growth to 3 years	230–330 mm/year	less than 150 mm/year

* Data from Cott (1969).
† Data from Cott (1969) and assuming 90% hatching in successful nests.

Survival to 3 years on the rearing stations is at least 50% and growth is at least twice as fast as in the wild. For supplementation of wild recruitment and restocking suitable habitats, the source of juvenile crocodiles on rearing stations is a valuable resource in the wise management of this species.

Observations on the annual nesting on the Mwenda River, Lake Kariba, indicate no significant change in the number of nests laid, despite repeated collection dating back to 1967. With present collection techniques a number of nests are always missed, allowing a proportion of females to complete nesting successfully. We are unable to say whether the artificial recruitment of 5% of the number of eggs collected to the 1·0 m size class is an adequate estimate of the state of affairs in wild populations. Rough counts indicate that the population at Sinamwenda is increasing rather than declining, and our feeling is that the 5% replacement is adequate. We would stress, however, that a most urgent need is an assessment of mortality patterns in a natural crocodile population.

The quota of 3-year-old crocodiles taken from rearing stations for release into the wild allows a flexible restocking policy. For example 194 crocodiles have been released into the Zambezi above the Victoria Falls where they were previously nearly eliminated by shooting. The fact that breeding populations of crocodiles in the wild now have a substantial value as the basis for rearing station operations should not be underestimated as a motive for crocodile conservation. It is our opinion that few developing countries can afford to conserve animals and their habitat purely on the basis of sentiment. This is particularly true of the Nile crocodile, which is likely to be eliminated in areas populated by humans, unless cogent reasons are put forward for its wise management.

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REFERENCES

ATTWELL, R. I. G. (1973). Crocodile status report for Rhodesia. *Publs int. Un. Conserv. Nat. nat. Resour., N.S.*, **41**, 41–3.
BLAKE, D. K. (1970). *Crocodile farming in Rhodesia*. Salisbury, Rhodesia. Department of National Parks and Wildlife Management. (Mimeographed.)

BLAKE, D. K. (1974). The rearing of crocodiles for commercial and conservation purposes in Rhodesia. *Rhod. Sci. News*, **8**, 315–24.
COTT, H. B. (1961). Scientific results of an enquiry into the ecology and economic status of the Nile crocodile (*Crocodylus niloticus*) in Uganda and Northern Rhodesia. *Trans. zool. Soc. Lond.*, **29**, 211–356.
COTT, H. B. (1969). Tourists and crocodiles in Uganda. *Oryx*, **10**, 153–60.
COTT, H. B. (1971). Parental care in the Crocodilia, with special reference to *Crocodylus niloticus*. *Publs int. Un. Conserv. Nat. nat. Resour., N.S.*, **32**, 166–80.
COTT, H. B. & POOLEY, A. C. (1972). The status of crocodiles in Africa. *Publs int. Un. Conserv. Nat. nat. Resour., N.S.*, **33**, 1–98.
COULSON, T. D., COULSON, R. A. & HERNANDEZ, T. (1973). Some observations on the growth of captive alligators. *Zoologica, N.Y.*, **58**, 47–52.
GRAHAM, A. (1968). *The Lake Rudolf crocodile* (Crocodylus niloticus *Laurenti*) *population*. Nairobi, Kenya. Report to Kenya Game Department. (Mimeographed.)
GRAHAM, A. & BEARD, P. (1973). *Eyelids of morning. The mingled destinies of crocodiles and men*. New York Graphic Society, Greenwich, Conn.
JOANEN, T. & MCNEASE, L. (1974). Propagation of immature American alligators in controlled environmental chambers. *Paper presented at the Southern Zoo Workshop, Monroe Louisiana*. 11 pp. (Mimeographed.)
LOVERIDGE, J. P. & BLAKE, D. K. (1972). Techniques in the immobilisation and handling of the Nile crocodile, *Crocodylus niloticus*. *Arnoldia*, **5**(40), 14 pp.
MACFARLAND, C. G., VILLA, J. & TORO, B. (1974). The Galápagos giant tortoises (*Geochelone elephantopus*) II: conservation methods. *Biol. Conserv.*, **6**, 198–212.
MITCHELL, P. (1974). *An investigation into the factors affecting the growth of the Nile crocodile* (Crocodylus niloticus) *in captivity*. Certificate in Field Ecology project report, Salisbury, University of Rhodesia.
MODHA, M. L. (1967). The ecology of the Nile crocodile (*Crocodylus niloticus* Laurenti) on Central Island, Lake Rudolf. *E. Afr. Wildl. J.*, **5**, 74–95.
PARKER, I. S. C. & WATSON, R. M. (1970). Crocodile distribution and status in the major waters of Western and Central Uganda in 1969. *E. Afr. Wildl. J.*, **8**, 85–103.
POOLEY, A. C. (1962). The Nile crocodile, *Crocodylus niloticus*. *Lammergeyer*, **2**, 1–55.
POOLEY, A. C. (1969). Preliminary studies on the breeding of the Nile crocodile *Crocodylus niloticus* in Zululand. *Lammergeyer*, **10**, 22–44.
POOLEY, A. C. (1971). Crocodile rearing and restocking. *Publs int. Un. Conserv. Nat. nat. Resour., N.S.*, **32**, 104–30.
POOLEY, A. C. (1973*a*). Notes on the ecology of the Lake St Lucia crocodile population. *Publs int. Un. Conserv. Nat. nat. Resour., N.S.*, **41**, 81–90.
POOLEY, A. C. (1973*b*). Conservation and management of crocodiles in Africa. *J. sth. Afr. Wildl. Mgmt Ass.*, **3**, 101–3.
POOLEY, A. C. (1974). Parental care in the Nile crocodile: a preliminary report on behaviour of a captive female. *Lammergeyer*, **21**, 43–5.
TOWNSEND, H. (1972). There are crocs at the bottom of our garden. *Afr. wild Life*, **26**, 90–4.
YANGPRAPAKORN, U., CRONIN, E. W. & MCNEELY, J. A. (1971). Captive breeding of crocodiles in Thailand. *Publs int. Un. Conserv. Nat. nat. Resour., N.S.*, **32**, 98–101.

THE EFFECTS OF DREDGING OPERATIONS ON THE BENTHIC COMMUNITY OF A CHALK STREAM

R. G. PEARSON* & N. V. JONES

Zoology Department, The University, Hull HU6 7RX, Great Britain

ABSTRACT

Sampling of the benthic fauna showed that dredging operations produced relatively short-term effects on invertebrate population levels. The behaviour of the animals was immediately affected, the differences between species were noted and the implications of dredging at different times of year are discussed.

INTRODUCTION

Stream management procedures such as dredging and weed cutting are widespread but there seems to have been little attention paid to the effects of these activities on the fauna of the streams. The present work was carried out to examine the effects of drag-line operations on the benthic community of a gravel stretch of the River Hull, North Humberside (O.S. Ref. TA 088602). This part of the river was of uniform appearance with chalk chips of up to 3 cm forming the substratum. The depth of water was of the order of 10 cm during the study period, November 1972–May 1973. Dredging was carried out to the consolidated chalk bedrock, thus disturbing the whole depth of gravel which was about 30–40 cm in this case.

METHODS

This study included a survey of the benthos before, and for five months after, the dredging, as well as the monitoring of drifting and upstream-moving animals

* Present address: Zoology Department, James Cook University of N. Queensland, Queensland 4811, Australia.

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