CROCODILES

Proceedings of the 10th Working Meeting of the Crocodile Specialist Group

of the Species Survival Commission of IUCN - The World Conservation Union

convened at

Gainesville, Florida, U.S.A., 23 to 27 April 1990

Volume 1

(Unedited and Unreviewed)

IUCN - The World Conservation Union

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Cover photo: Adult male American alligator, *Alligator mississippiensis*, bellowing.

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FOREWORD

The two volumes of this PROCEEDINGS are a record of the presentations and discussions that occurred at the 10th Working Meeting of the Crocodile Specialist Group in Gainesville, Florida, U.S.A. 23 - 27 April 1990. The manuscripts are unreviewed and unedited. The CSG PROCEEDINGS, by definition, are records of what occurred at the meeting. They are not tomes filled with articles that were critiqued, edited, revised, and polished subsequent to the meeting. Apart from preparing a table of contents, cut-and-pasting captions to figures, compiling the articles alphabetically by author, and numbering the pages consecutively, the papers are published just the way they were submitted. For this reason, they appear in a variety of formats and typefaces. James Perran Ross was the managing editor.

The opinions expressed herein are those of the individual authors and are not the opinions of IUCN - The World Conservation Union, or its Species Survival Commission.

IUCN - The World Conservation Union was founded in 1948, and has its headquarters in Gland, Switzerland; it is an independent international body whose membership comprises states (irrespective of their political and social systems), government departments, and private institutions, as well as international organizations. It represents those who are concerned about man's modification of the natural environment through the rapidity of urban and industrial development and the excessive exploitation of the earth's natural resources, upon which rest the foundations of his survival. IUCN's main purpose is to promote or support action which will ensure the perpetuation of wild nature and natural resources on a world-wide basis, not only for their intrinsic cultural or scientific values but also for the long-term economic and social welfare of mankind.

This objective can be achieved through active conservation programs for the wise use of natural resources in areas where the flora and fauna are of particular importance and where the landscape is especially beautiful or striking, or of historical, cultural, or scientific significance. IUCN believes that its aims can be achieved most effectively by international effort in cooperation with other international agencies, such as UNESCO, FAO, and UNEP, and international organizations, such as World Wide Fund for Nature (WWF).

The mission of IUCN's Species Survival Commission (SSC) is to prevent the extinction of species, subspecies, and discrete populations of fauna and flora, thereby maintaining the genetic diversity of the living resources of the planet. To carry out its mission, the SSC relies on a network of over 2,500 volunteer professionals working through more than 90 Specialist Groups and a large number of affiliate organizations, regional representatives, and consultants, scattered through nearly every country of the world.

SUMMARY OF THE MEETING

The 10th Working Meeting of the IUCN/SSC Crocodile Specialist Group was hosted by the Florida Museum of Natural History, Florida Game and Fresh Water Fish Commission, Florida Cooperative Fish and Wildlife Research Unit, American Alligator Farmers Association, St. Augustine Alligator Farm, Florida Alligator Farmers Association, and Florida Alligator Trappers Association. The local committee, headed by Prof. F. Wayne King, worked with great dedication to make the arrangements and ensure the smooth running of the meeting.

The meeting took place between April 23 and April 27 at the Holiday Inn West, Gainesville, Florida, U.S.A. This Working Meeting of the Specialist Group was by far the largest yet held with over 320 participants from 40 countries attending. A total of 80 papers were scheduled for presentation and four workshops convened on special issues. Sixteen additional papers were proposed for inclusion in the proceedings although they were not presented at the meeting. A total of 53 manuscripts and one workshop report were received by the editor in time for inclusion in these published proceedings.

Sessions of papers were presented on The Status of Crocodilians, Crocodilian Management, Farming and Ranching, and on Research. Noteworthy was the very high standard of presentations and the very broad range of topics and participants. Researchers, conservationists, farmers and ranchers, management authorities, and leather tanners and traders all exchanged views and discussed their concerns. This diversity is reflected in these published proceedings. Workshops on the Action Plan for Crocodilian conservation, International Trade in Crocodilian products, a booklet and directory of farming methods and operations, and a Model Crocodilian Management Program were heavily attended. The Working Meeting has evolved from a restricted group of specialists concerned about conservation to a comprehensive forum for the exchange of information that will make conservation and sustainable use of crocodilians a reality.

Following the reorganization announced in the CSG Newsletter, Volume 8, Oct - Dec 1989, pp. 1-4, the Vice Chairmen and deputy Vice Chairmen are responsible for keeping the membership and public informed of CSG decisions and activities. As a consequence a general business meeting was not scheduled. The CSG Steering Committee met on 22 April and again 27 April 1990 to transact the official business of the Group. The minutes of these meetings have been published separately in the CSG Newsletter, Volume 9, April - June, 1990.

Fieldtrips were arranged during the meeting to St. Augustine Alligator Farm Crocodilian Center at Ocala, Florida; Paynes Prairie State Preserve; and Orange Lake. Following the meeting fieldtrips were led to Okeefenokee Wildife Refuge; Everglades National Park; and to alligator farms in central and south Florida.

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AN INVESTIGATION OF THE ONTOGENY OF THE MULLERIAN DUCT REGRESSOR AS WELL AS THE SENSITIVE PERIOD IN THE AMERICAN ALLIGATOR.

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AN INVESTIGATION OF THE ONTOGENY OF THE MULLERIAN DUCT REGRESSOR AS WELL AS THE SENSITIVE PERIOD IN THE AMERICAN ALLIGATOR. Harriet B. Austin, Dept. of Zoology and Physiology, University of Wyoming

The mullerian ducts regress in most male vertebrates during embryogenesis. In mammals and birds, regression results from the actions of the testicular glycoprotein, mullerian-inhibiting substance (MIS). MIS is produced from the time of testicular differentiation until sexual maturity; however, the mullerian ducts are only capable of responding during a brief period of development, the "sensitive period". Unfortunately, little is known about regression in other vertebrates, however, testicular grafts from male hatchling alligators are able to induce normal mullerian-duct regression when implanted in castrated female hatchlings (Austin, 1989). Furthermore, the administration of testosterone does not induce regression; therefore, mullerian-duct regression in the alligator appears to be caused by some other testicular substance, possibly an MIS-like molecule. In this experiment, castrated female hatchlings were implanted with testis grafts from both hatchling and yearling males to determine whether the regressor is still produced by the testes of yearlings. In addition, yearling females received testis implants from both hatchling and yearling males to determine whether the mullerian ducts are still capable of responding to the regressor at one year of age. Both hatchling and yearling testes caused some regression of the ducts indicating that the regressor is produced for an extended period of time after hatching. In the yearling females, however, the testis grafts became hypertrophied and lost their typical testicular morphology. Therefore, it was not possible to determine the ontogeny of the sensitive period in the alligator.

SEX RATIO OF AFRICAN DWARF CROCODILES
(*Osteolaemus tetraspis* COPE, 1861)
EXPLOITED FOR FOOD IN CONGO

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INTRODUCTION

During a study on crocodiles in the Congo I found in some captured crocodiles about two males for one female. Was that sex ratio the same in the wild or was it due to specific hunting techniques or other factors ?

It has been shown that the sex ratio of some crocodile populations averages 0.50 (COTT 1961). Others might differ up to 0.33 (HUTTON 1986), with a female predominance in this case . Beside, it has been well demonstrated that the temperature of incubation exerts an influence on the sex determination of the hatchlings (WEBB et al. 1987).

In the wild temperature variations, and possibly other factors, might also affect the development of embryos (HUTTON 1986). Therefore it is not easy to give a full account of the factors influencing a sex ratio, particularly concerning a species like *Osteolaemus tetraspis*, the biology of which is still very poorly known.

In view of this lack of information, the following simple observation might be of some interest for future research on the biology of the species in Congo, especially concerning the impact of the exploitation on the natural population.

STUDY AREA:

The two main fluvial axes where the crocodiles are usually collected for the meat trade are the Obanguy River and the Sangha River along with the Congo River, into which the two previous ones flow. The main collection area is along the shores from the Oubangui and the Congo from Impfondo (1° 38' North lat., 17° 52' East long.) to Mossaka (1° 10' South lat., 18° 2' East long.).

The crocodiles are kept alive in small villages scattered along the shore, and brought in pirogues aboard two large craft passing each once every fortnight during the high water season. The boat goes to Brazzaville, the capital, where the people in possession of crocodiles sell them or eat them within the family circle.

This study only concerned the Oubangui and the Congo Rivers from Impfondo to Mossaka in the period between the 17th and the 19th of July.

METHODS

With the help of two Congolese Water and Forest agents, all the crocodiles coming onboard were first located on arrival, then measured, and sexed by manual means at the cloaca (Brazaitis 1986) (a procedure which was easy since all animals were adults). The crocodiles were weighed with a precision of 0.5 kg.

RESULTS

103 *Osteolaemus tetraspis* were counted but it was only possible to measure and sex 50 of them. A clear predominance of males was observed, the sex ratio being 0.36 (32 males, 18 females).

The males had an average total length of 125.6 cm (max. 154 cm, min. 91 cm, sd 12.91) and an average weight of 8.35 kg (max. 15.5 kg, min. 2.5 kg, sd 2.93).

The females had an average total length of 118.8 cm (max. 137 cm, min. 101 cm, sd 9.26) and an average weight of 6.5 kg (max. 11 kg, min. 3.5 kg, sd 1.95).

10 males of the 32 measured showed injuries due to fights and had sometimes up to half of their tail (1 specimen) or an entire leg (2 sp.) missing. The other injuries being fingers (1 sp.) and part of the tail missing. Two females also showed injuries; one having 2 fingers missing, and the other one half of the lower jaw.

DISCUSSION

If this sex ratio is really the same in the wild one can ask himself why?

Until more is known about the biology of *Osteolaemus tetraspis*, it will be very difficult to interpret the large number of males captured along those rivers. Some *Osteolaemus tetraspis* populations in central Africa do not apparently show such sex ratio skewed toward males (BEHRA pers. obs. 1984-1986).

Even if injuries might suggest larger concentrations of males because of their supposed aggressivity, we really don't as yet know what the real sex ratio of this population along those rivers might possibly be.

Some efficient hunting techniques used locally (BEHRA in prep.) are based on the aggressive response of crocodiles in their burrows. Therefore one might well ask the question: is it because males are more naturally aggressive that they are captured more easily than females?

In South America *Paleosuchus trigonatus* is morphologically relatively close and has almost the same habitat preference as than of *Osteolaemus* in Africa. So it could also be possible that as with *Paleosuchus* one male may share territory in a small stream with many females and force other males to inhabit larger streams and rivers subject to local hunting pressure by boat (MAGNUSSON pers. com.). Moreover, it seems there is a movement of population which usually starts at the end of June when the water tide goes up. The crocodiles move from the main rivers into the forest and settle in small streams. They are more easily captured in the forest and the hunting season last around 4 month, until the end of November. Does this movement of population concern both males and females at the same time? This might be an other aspect worth studying.

CONCLUSION:

It has been estimated (BEHRA 1987) that during the annual four months of exploitation along the Oubangui, Sangha and Congo, about 3500 *Osteolaemus tetraspis* were brought on the market for food. There is no doubt that there is an increase in the demand for *Osteolaemus* meat (BEHRA 1988). So even if we consider that the killing of males is usually of less importance than the killing of females in a crocodile population, it could be of great interest to study these populations as quickly as possible.

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IMPACT OF LEGAL PROTECTION
ON CROCODILES IN MADAGASCAR

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Introduction:

At the beginning of the century crocodiles (*Crocodylus niloticus*) were considered vermin in Madagascar. Their commercial exploitation in the 1950's was considerable. The first conservation measure has been international in 1975 and amended in 1985 and 1988. It's interesting to note the impact these measures had on effective conservation of the crocodiles.

Methods:

The legal text published since the end of the 19th century have been reviewed. To determine their impact on the crocodile populations, the historical evolution of these populations has been analyzed. This has been done from old published papers, custom data on exportation, discussions with people with relevant knowledge, and finally from analyses of the current situation in the field.

Results and discussion:

During colonial rule crocodiles were considered vermin and at the end of the 19th century the French authorities offered a bounty for the destruction of crocodiles and their eggs. Far more eggs were collected than the authorities could afford paying bounty on and the system was discontinued. Commercial exploitation started in the 1920's. Exploitation reached a peak in the late 1940's but continued well into the 1970's. During this period the Malagasy Government formalized the status of the crocodile as vermin in the legislation in 1961.

By 1970 exploitation had such an impact than offtakes from the wild were less than 1% of the levels in the late forties. In 1975 Madagascar ratified the Washington Convention (CITES), which considered the nile crocodile (*Crocodylus niloticus*) as threatened and, consequently prohibited specimens in world trade.

However the animals status remained unaltered within Madagascar. Oral evidence strongly suggest that populations quickly recovered from 1975. By 1985 populations were thriving though far from their level in earlier times but enough to pose real problems to human populations. Here we note that the fact that guns and hooks were not obtainable at that time certainly played no small part in this increase.

In 1985 Madagascar was allowed by CITES a quota of 1000 skins for export. Between 1986 and 1989 the number of animals actually killed exceeded the original quota by more than five times. The quota carried no size restriction and large number of reproductive animals were killed to the detriment of the wild population. In 1988 the internal legislation was altered to give the crocodile a degree of protection as a game animal. However these steps inadequate to satisfy the parties to CITES and at the 1990 meeting no further wild quota was allowed.

During both periods that crocodile exploitation was aloud in Madagascar, crocodiles have been overharvested and seriously depleted. The obvious inference is that commercial exploitation for export of skins should be avoided in order to conserve crocodiles. But this is oversimplistic and might even be counterproductive. Even if no exports are allowed their exists a lively local market that has expanded since 1987 and which would ensure the continuation of exploitation. Even with a determined Wildlife Department this local market is very difficult to control and it is unlikely that the local trade could be stopped. In any case local people still consider that crocodiles should be exterminated because even though crocodile populations have declined, human populations have dramatically increased and conflicts remain at a high level.

While humans and their livestock are being killed by crocodiles, it is not possible to ask them to live with the animal because of his ecological or esthetic value! The Wildlife Department because of lack of material resources is hard pressed even to manage National Parks, where there are in any case few crocodiles. So obviously legal protection will not stop the people breaking crocodile's eggs and trying as hard as possible to kill all the crocodiles. Even in retired areas where they might not be able to kill big animals, the increasing use of sand banks along water edge by fishermen or rice cultivators will drive breeding females away from good nesting sites.

Interviews with people who have had relatives killed by crocodiles and who have petition the government to exterminate them, have indicated quite clearly that they would be more tolerant if they could benefit economically from wild crocodiles.

While continuing to discourage the killing of wild animals people can be given an interest in preserving crocodiles through the capture of problem animals and the collection of eggs for ranching.

TILETAMINE-ZOLACEPAM-ACEPROMAZINE-ANAESTHESIA IN CROCODYLUS NILOTICUS WITH REGARD TO THE RESPIRATORY AND CARDIOVASCULAR SYSTEMS

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25 ranched crocodiles (crocodylus niloticus; body weight 2 - 40,5 kg, M $\pm$ SD 10,6 $\pm$ 8,8 kg) of the Baobab-Farm in Mombasa, Kenya were anaesthetized with a combination of the anaesthetics tiletamine-zolacepam (Zoletil^R^, 5 - 10 mg/kg bodyweight) and acepromazine (Vetranquil^R^, 1 mg/kg bodyweight). The injection was performed IM at the base of the tail using a blowpipe. To accelerate the muscular resorption 50 I.U. of hyaluronidase per animal were added to the injection. The investigations were carried out in August 1989 at an environmental temperature between 25,7 $\pm$ 2,9°C (22,2 - 31,9°C).

The quality of anaesthesia was checked using muscular relaxation, righting reflex (tolerance of dorsal recumbancy), biting activity, avoiding reactions (after painful stimulation of the toes, nail bed or interdigital tissues), palpebral and corneal reflexes (figure). It was found that whereas 5 - 6 mg tiletamine-zolacepam lead to a moderate, 7,5 mg cause a moderate to deep and 10 mg/kg b.w. a deep sedation.

Table shows the effects of 7.5 resp. 10 mg tiletamine-zolacepam on cardiovascular and respiratory parameters of a selected number of animals. The significant changes of the cardiovascular and respiratory functions have only minimal importance from a medical point of view. The increased heart rate is due to the specific pharmacological influence of tiletamine-zolazepam, which has a positively inotropic effect on the contractility of the heart muscle; furthermore heart rate is increased by the rise in environmental temperature. The significant depression of respiratory rate is a typical consequence of anaesthesia, but clinicaly relevant only in animal patients with respiratory or circulatory diseases and/or if combined with a drastic reduction of the oxygen saturation over a longer period of time. The electrocardiograms performed on 3 animals of every dosage-group showed no indication of changes due to anaesthesia.

Metabolism and excretion of the anaesthetics are only possible in an optimal way in the environmental temperatures prefered by the crocodile (Bonath 1977, 1979). The animals should therefore be kept at a temperature between 29 and 31 degrees centigrade during anaesthesia recovery. During anaesthesia, the environmental temperature must never be lower than 26 degrees; in this case, the elimination of the anaesthetics is limited in the crocodile, so that anaesthesia is prolonged unnecessarily and the danger of death during anaesthesia exists.

Reflexfunction is impaired considerably or not existent. Changes in respiratory and cardiovascular functions do not have clinical consequences in healthy crocodiles. This means that a tiletamine-zolacepam-acepromazine anaesthesia permits the safe execution of farmtechnical treatments and animal husbandry for man and animals as well as smaller painful veterinary procedures. It can be used as a premedication for more painful surgical procedures which can be supplemented with local anaesthesia or intubation and inhalation anaesthesia.

7,5 mg tiletamine-zolazepam + 1 mg acepromazine/kg b.w.

	0	60	120	180 min.post.inj.
HF	40,7 ± 9,9(9)	45,2 ± 6,4(9)	49,3 ± 4*(9)	52,1 ± 5,1**(8)
AF	8,1 ± 2,8(8)	7 ± 3,8(9)	5,4 ± 2,1*(7)	4,8 ± 2,3*(6)
$\%O_2$	78,9 ± 9(9)	69,7 ± 8,8*(9)	77,7 ± 11,1(9)	79,9 ± 7,5(9)
BT	25,4 ± 1,3	27,2 ± 1,5	27,5 ± 2,0	28,6 ± 2,7

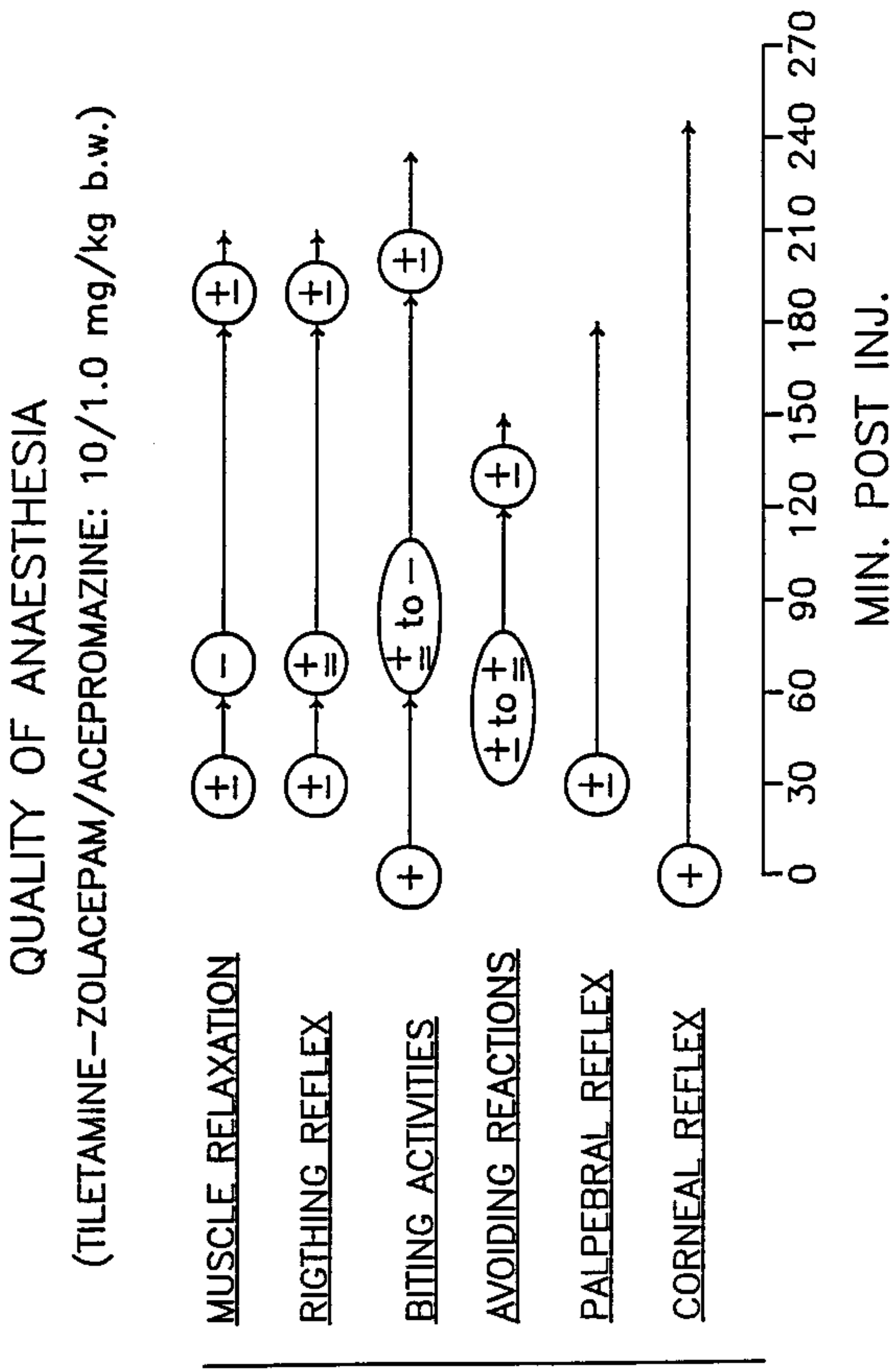
10 mg tiletamine-zolazepam + 1 mg acepromazine/kg b.w.(8)

HF	42 ± 2,6	46,3 ± 3,6	46,8 ± 9,8	48,1 ± 9,2
AF	6,4 ± 2,2	5 ± 2,1	3,9 ± 2,3*	5,3 ± 2,6
$\%O_2$	78,5 ± 1,9	79,1 ± 6,1	78 ± 3,5	80,1 ± 4,5
BT	25,3 ± 0,4	26,5 ± 0,7	27,1 ± 0,8	27,9 ± 0,7

Table: Influence of tiletamine-zolatepam/acepromazine anaesthesia on heart- (HR), respiratory rate (RR) per minute and oxygene saturation of the blood ($\%O_2$) of crocodylus niloticus. °C BT = °C body temperature. In parenthesis number of animals. Min post inj. = minutes after injection.Student's t-test for independent samples: * = significance < 0,05, ** = significance < 0,01

Figure: Quality of tiletamine-zolazepam/acepromazine-anaesthesia (10/1,0 mg/kg b.w.) in crocodylus niloticus, judged by muscle relaxation, reflexes and biting activities.

(+) = biting activity, reflex unchanged
(+̲) = muscle tension, reflexes, biting activities partly reduced
(±) = severely reduced
(-) = no muscle tension or biting activities



QUALITY OF ANAESTHESIA
(TILETAMINE–ZOLACEPAM/ACEPROMAZINE: 10/1.0 mg/kg b.w.)
MUSCLE RELAXATION
RIGTHING REFLEX
BITING ACTIVITIES
AVOIDING REACTIONS
PALPEBRAL REFLEX
CORNEAL REFLEX
+ to –
± to +
0 30 60 90 120 150 180 210 240 270
MIN. POST INJ.

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THE INFLUENCE OF GALLAMINE ON IMMOBILISATION, CARDIOVASCULAR AND RESPIRATORY PARAMETERS OF CROCODYLUS NILOTICUS

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14 Crocodylus niloticus (body weight 27 to 58,5 kg, M $\pm$ SD = 35,6 $\pm$ 8,6 kg; 11 male, 3 female) living in pens and under free range conditions on the Baobab-Farm, Mombasa, Kenya, were immobilised with 0,5 - 0,6 mg/kg b.w. of the neuromuscular blocking agent gallamine trithiodide IM in the base of the tail, using a blowpipe. To accelerate the muscular resorption, 50 I.U. hyaluronidase per animal were added to the injection.

The possibilities for safe handling of the animals were judged according to the duration of immobilisation, muscle relaxation and biting activity. The muscle relaxation was achieved after 15 to 30 minutes, with individual differences, and had a duration of 90 to 295 minutes, exceptionally up to 450 minutes. During the examination period, spontaneous or occasional sluggish weak movements due to experimental minipulations were seen. Biting activity ceased 8 to 15 minutes after the injection and was absent for the duration of muscle relaxation.

In selected animals the influence of gallamine on cardiovascular and respiratory functions was studied (table). Heart rate, respiratory rate, and oxygen saturation demonstrate, that the influence of the immobilisation with gallamine on the vital functions of crocodylus niloticus is negligible from a veterinary point of view. The respiratory rate was significantly depressed, but this is a reaction which can be attributed to gallamine as the muscles used in respiration are also subject to the neuromuscular blocking. However, the oxygen saturation was not influenced; the reasons for this phenomenon have not yet been found. The respiratory specialities of a species adapted to longer diving, as well as changes in the metabolism in crocodiles immobilised with gallamine leading to a decrease of the need for oxygen have been suggested.

	0	20 - 40	50 - 70	80-100 min.post.ing
HR		32,7 ± 8,6(9)	32,9 ± 6,6(8)	31,2 ± 7,4(11)
RR	3,9 ± 1,3(7)	2,1 ± 1,0(7)*	1,6 ± 1,1(7)**	2,6 ± 1,2(7)
$\%O_2$	76,3 ± 15(31)	75,9 ± 10,2(7)	79,8 ± 6(8)	78,4 ± 4,9(9)
BT		25,9 ± 0,7	27,1 ± 1,6	26,3 ± 1,4

Table: Influence of gallamine on heart-(HR), respiratory rate (RR) per minute and oxygene saturation of the blood ($\%O_2$) of crocodylus niloticus. BT = °C body temperature. In parenthesis number of animals. Min. post. inj. = minutes after injection. Student's t-test for independent samples, * = significance < 0,05, ** = significance < 0,01.

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EXTENDED MAINTENANCE OF AMERICAN ALLIGATORS ON A DRY FORMULATED RATION

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ABSTRACT

Nineteen young American alligators (Alligator mississippiensis) were successfully maintained for a period of 40 months following hatching, on a diet consisting exclusively of a commercially prepared dry formulated ration. This ration was formulated to contain a minimum of 45.0% crude protein, a minimum of 8.0% of crude fat and a maximum of 2.5% crude fiber and was readily accepted by the alligators after being mixed with an equal weight of water to form a thick pasty pelleted crumble. Growth rate of body weight of the ration-fed alligators did not differ significantly from that reported for captive alligators fed on standard diets of meat and fish, even though the ration-fed alligators were raised under less than ideal conditions. As the alligators became larger, feed wastage increased as a result of trampling of uneaten food. An important area for further research would be the development of less wasteful methods of delivering such formulated rations to larger animals. It should now be possible however to raise alligators on a diet consisting exclusively of a dry formulated ration which will be readily accepted by the animals and which will maintain them in a general state of good health, over a length of time sufficient to attain market size.

INTRODUCTION

Increased interests in the commercial farming/ranching of crocodilians have resulted in many advances in techniques for the maintenance and rearing of these animals in captivity. An important component of this technology has been advances in the area of nutrition and particularly the development of dry formulated rations for use in the feeding of captives. As has been pointed-out in previous studies (Staton and Edwards, 1987; Staton, 1988; Staton et al., 1989; Staton et al., in press a, b, c, d), such formulated rations offer many advantages to the commercial farmer/rancher. These advantages over standard diets of meat or fish include greater convenience, reduced storage and handling costs and particularly a greater ability to control the nature and amounts of important dietary constituents such as protein, fats, vitamins and various trace nutrients. To date however, most all of the studies describing the performance of crocodilians fed these rations have dealt with animals of a very young age - usually less than one year. (Staton, 1988; Staton et al., 1989; Staton et al., in press a, b, c, d).

This report describes the successful maintenance of a group of American alligators (Alligator mississippiensis) on a diet consisting exclusively of a dry formulated ration, for a period of 40 months following hatching. This time period is of a length that would approximate or exceed that which would be required by most commercial farming operations to raise alligators to a marketable size and also extends across the important age at which a growing wild juvenile alligator would normally make a transition from an insect/invertebrate diet, to one consisting mostly of larger vertebrate prey (Coulson and Hernandez, 1983).

MATERIALS AND METHODS

The alligators used in this study were the same individuals which had been used as hatchlings in previously published studies of growth performance under various dietary regimes of dry formulated rations (Staton, 1988; Staton et al., in press b, c, d). In the present study no attempt was made to differentiate between the different dietary treatments to which individual alligators had been exposed during these earlier feeding trials. Most of these earlier trials were of a relatively brief duration (usually 10-20 weeks) relative to the length of the study reported here, and a number of the individuals were used in more than one feeding trial and were thus exposed to a variety of controlled variations in dietary composition during this period.

The alligators used in this study were hatched from wild-laid eggs from Louisiana. Further details concerning the program from which these alligators were produced have been provided by Joanen and McNease (1977). Additional information concerning the conditions under which the alligators were housed and raised during their first year have also been provided elsewhere (Staton, 1988). Several weeks after conclusion of the final formal feeding trial, 20 alligators were transferred to the Aquatic Animal Housing Facility of the Savannah River Ecology Laboratory (SREL) where they were housed for the duration of this study. One of these animals was later euthanized following injuries suffered during an aggressive encounter with one of its larger pen-mates. No data from this individual have been included in the growth analyses reported here.

While at the SREL, alligators were housed in tanks of 5, 5 and 10 animals each, with an attempt being made to house individuals of similar size together in order to minimize the consequences of aggressive encounters during feeding. The holding tanks provided floor space of 1.5 m^2/individual. Water depths ranged from 0.23-0.31

m, and varied according to the size of the alligators. Tanks were equipped with wooden basking platforms occupying between 8-28% of the floor surface areas.

Each tank was provided with a continual flow of partially preheated water, with water temperatures which varied seasonally between 22.0-28.3 °C throughout the study. Air temperatures also varied seasonally as a result of an inability to completely heat or cool the building in which the animals were housed, especially during the first year after the alligators arrived at the SREL. During this period air temperatures were occasionally as high as 50°C and as low as 10°C in the building depending on the season. During the last 19 months of the present study, improved temperature controls in the SREL housing facility reduced variability in air temperatures to a range of about 18-37°C throughout the year. Translucent roofing of the housing facility exposed all alligators to seasonally-varying photoperiods typical of the latitude of Aiken, South Carolina.

Throughout their 31-month maintenance at the SREL, alligators were maintained exclusively on a dry formulated commercial alligator ration (Burris Feed Mills, Franklinton, Louisiana) which, according to the manufacturer's specifications, contained a minimum of 45.0% crude protein, a minimum of 8.0% crude fat and a maximum of 2.5% crude fiber. Ingredients, also according to the manufacturer's specifications, included fish meal, blood meal, corn gluten meal, hydrolyzed feather meal, dehulled soybean meal, ground corn, wheat middlings, stabilized animal fat, salt, calcium carbonate, vitamin A supplement, D-activated animal sterol, vitamin B-12 supplement, vitamin E supplement, Riboflavin supplement, choline chloride, niacin, calcium pantothenate, vitamin B-6 supplement, ascorbic acid, biotin, menadione sodium bisulfite, sodium selenite, ferous sulfate, zinc oxide, copper sulfate, manganous oxide and calcium iodate. This dry feed was mixed with an equal weight of water to produce a thick pasty pelleted crumble. At the SREL, alligators were offered this food every 3-4 days (twice a week) throughout the warmer months in 1987 and 1988 until, with declining photoperiod and cooler air temperatures, the alligators stopped feeding. In 1989, feeding frequencies were decreased to once every 7-10 days. Feeding activity generally ceased between September-November and resumed again between February-March each year, as air temperatures warmed the following spring

Moistened food was presented in a flat tray which was placed on the basking platform in the mid-late afternoon, and left overnight, although alligators usually emerged and began feeding almost immediately. Amounts of feed offered were adjusted as the alligators grew, to insure that an excess of feed would still be available the next morning after the animals had stopped feeding. As will be discussed later however, by the time that feeding activity ceased, much of the uneaten feed had been packed-down into the tray as a result of the alligators crawling over the feed and pressing it down with their bodies. The feed was broken-up with tongs the following morning and some subsequent feeding resumed on this crumbled feed. Eventually however, this rebroken feed became hard and dried and was no longer accepted by the alligators. As a result, some of this remaining feed may not have actually been available to the animals and amounts of feed offered were therefore increased in an effort to minimize this possibility.

Alligators were weighed and measured during the period that they were used in earlier feeding trials according to the schedules and procedures described by Staton (1988) and Staton et al. (in press, b, c, d). After their arrival at the SREL, alligators were weighed approximately 5 times between October-December, 1987 and 3 times at 1-4 month intervals between January-July 1988. Beginning in July 1988, both weights and total body lengths were recorded at approximately 8-month intervals through January, 1990. At the SREL, body weights were recorded to the nearest 0.1 kg with a hanging spring scale, and total body lengths were measured from the tip of the snout to the tip of the tail to the nearest 0.1 cm. Data for growth in body weight were only available in sufficient quantity for quantitative analysis for 11 individuals. Body length data from the first month after hatching were only available for 7 individuals, and this together with a lack of body length data between 1-2 years of age, resulted in body length being presented and compared with published literature values in only a qualitative fashion.

Growth in body weight was analyzed by standard regression analyses (PROC REG) of SAS (1985). Regression statistics were used to evaluate the fit of data to linear, quadratic, ln (weight) and ln (age)/ln (weight) models. After selecting the most appropriate model, the growth of the ration-fed alligators was compared to that of other captive alligators raised on standard diets - usually consisting of meat and/or fish. The latter data was taken from that summarized by Brisbin (in press) and includes data from the following sources: Arthur (1928), Ditmars (1936), Bothe (1948), Brandt (1948), Palmer (1952), Dowling and Brazaitis (1966), Coulson et al. (1973) and (Joanen et al. (1981). No differences due to sex were considered in any of these analyses. Once the most appropriate regression model had been selected, the PROC GLM analysis of SAS (1985) was used to compare growth rates of the dietary treatment groups, using the F-value for the interaction of the treatment class x the independent variable (age).

RESULTS

The results of regression analyses of data for growth in body weight by the alligators maintained on the dry formulated ration are presented in Table 1 and Figure 1, and growth in total body length of the same alligators is presented in Figure 2, in comparison to published data for captive alligators raised on standard diets of meat and/or fish. The ln (weight)/ln (age) model was selected as the most appropriate to analyze for growth in body weight, with this selection being made on the basis of R^2 values (Table 1) and examinations of the magnitudes and patterns of residuals. Using this model, there was no significant difference in the rate of growth in body weight of the alligators raised on the formulated ration for 40 months, vs. that of alligators reported in the literature as being raised on standard diets of meat or fish for the same period of time ($F=1.12$; $df=1,170$; $P=0.29$).

With the exception of the single alligator which was euthanized as a result of injuries incurred during a fight as noted above, no mortality was observed during this study, and all 19 individuals remained in a state of general good health and vigor at the end of the 40-month study period. With the exception of the colder winter months when all alligators ceased feeding as temperatures declined in the housing facility, acceptance of the formulated ration, prepared and presented as described above, was excellent.

When eating the prepared ration, alligators often initially swallowed the first mouthfuls of food on the basking platform while at the feeding tray. As the feeding bout continued however, later mouthfuls of food would be chewed and swallowed after returning to the water. This resulted in considerable waste and fouling of the water as the feed tended to break-apart and disperse into the water as a result of the chewing action. In addition, feed on the basking platform tended to be packed flat as time progressed, by the action of the alligators crawling back and forth over the feeding tray as they left and reentered the water. Although the alligators showed considerable skill in using sideways bites with their jaws to pick-up even single pellets of the feed (which were of cylindrical form, measuring approximately 1.2 cm in diameter x 2.0 cm in length), once the feed was no longer in a pelleted form and had been packed flat into the feeding tray, it seemed to become unavailable to them - again resulting in wastage, which was minimized to some extent by breaking-up the packed-down feed with tongs the following morning, as described above.

In addition to the 40-month-old alligators described above, the same dry formulated ration, after being similarly prepared and presented, was also readily accepted by a larger alligator which was housed in a separate tank in the same housing facility at the SREL. This larger alligator, which had been used in a variety of other studies unrelated to the work reported here, had previously been maintained on a diet of meat and fish. Starting in February 1989 however, this larger alligator was fed exclusively on the dry commercial ration. After 14 months on this ration, this alligator weighed 28 kg and measured 1.85 m in total length. The weight/length relationship of this alligator was similar (within 1.6 kg/m) to that which would have been predicted by a regression relationship presented by Coulson et al. (1973) for alligators of this size which were fed marine fish and were considered by these authors to be in a "well-nourished state." This suggests that the dry ration provided an adequate diet even for an alligator of this size. When feeding on the prepared ration, this larger alligator showed similar behavior to that described above for the smaller animals. Even this larger alligator was able to pick-up the pellets offered, albeit with some difficulty, by again using a sideways action of the jaws.

DISCUSSION

The conditions under which the alligators used in this study were maintained were, in many respects, much less than ideal in comparison to those currently known to promote maximum growth under captive conditions (e.g. Joanen et al., 1981). This was particularly true with regard to the inability to maintain optimal air and water temperatures in the housing facility during much of the study - resulting in the alligators ceasing to feed during the colder months. Nevertheless, none of these deficiencies prevented the alligators maintained on the dry formulated ration from growing in body weight at the same rate as captive alligators fed standard diets of meat or fish. Alligators maintained on the formulated ration remained in a general state of vigor and good health for 40 months following hatching - a period of time that would, under most current conditions of crocodilian husbandry, be sufficient to produce animals of marketable size. Moreover, the less than adequate conditions under which the alligators were raised in this study would argue strongly that the growth rates observed for these animals should be considered minimal as compared to those which could probably be produced under more ideal housing conditions - particularly with regard to more adequate control of air and water temperatures.

The feeding behavior of the alligators used in this study resulted in two major sources of feed wastage: (1) dispersal of feed into the water as a result of the alligators returning to the water to chew and swallow, and (2) packing the moistened feed flat into the feeding tray as a result of the alligators crawling over it as they left and reentered the water. Both of these sources of wastage could probably be significantly reduced if some form of water-resistant binder could be incorporated into the ration and/or if the feed could be extruded into some form of digestible casing material such as that used in the production of sausage. These would seem to be fruitful areas for future research and technology development in this field.

Recently, D. H. Burris (pers. comm.) provided unpublished data suggesting that American alligators on certain farms in Louisiana were showing growth rates of 2.5 cm/week and feed/gain weight conversion ratios of 2.2:1, while also being raised on a diet composed exclusively of a dry formulated ration containing 45% protein. When combined with the results of the present study, these findings suggest that the technology is now currently available to economically raise such alligators to market size while feeding nothing other than a dry commercially-prepared ration.

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Table 1. Regression statistics for growth in body weight by American alligators fed a dry formulated ration for 40 months following hatching, as compared to growth over a comparable period of time for captive alligators fed conventional meat and/or fish diets.[1]

Growth Model[2]	Intercept (g)		Slope (g/day)		R^2	
	Formulated Diet	Meat Diet	Formulated Diet	Meat Diet	Formulated Diet	Meat Diet
Linear	50.0[3]	50.0[3]	3.69	11.4	0.743	0.364
Ln (weight)	5.42	4.66	0.00324	0.00472	0.698	0.717
Ln (weight/ Ln (age)	0.570	1.83	1.099	0.986	0.877	0.601
Quadratic	50.0[3]	50.0[3]	3.79[4]	-6.42[4]	0.743	0.475
			-0.00013[5]	0.0201[5]		

[1]Data set from that compiled from the literature by Brisbin (in press) for captive alligators.
[2]Growth models expressed in the form: weight=f (age).
[3]Intercept constrained to a hatching weight of 50g.
[4]Coefficient for (age).
[5] Coefficient for $(age)^2$.

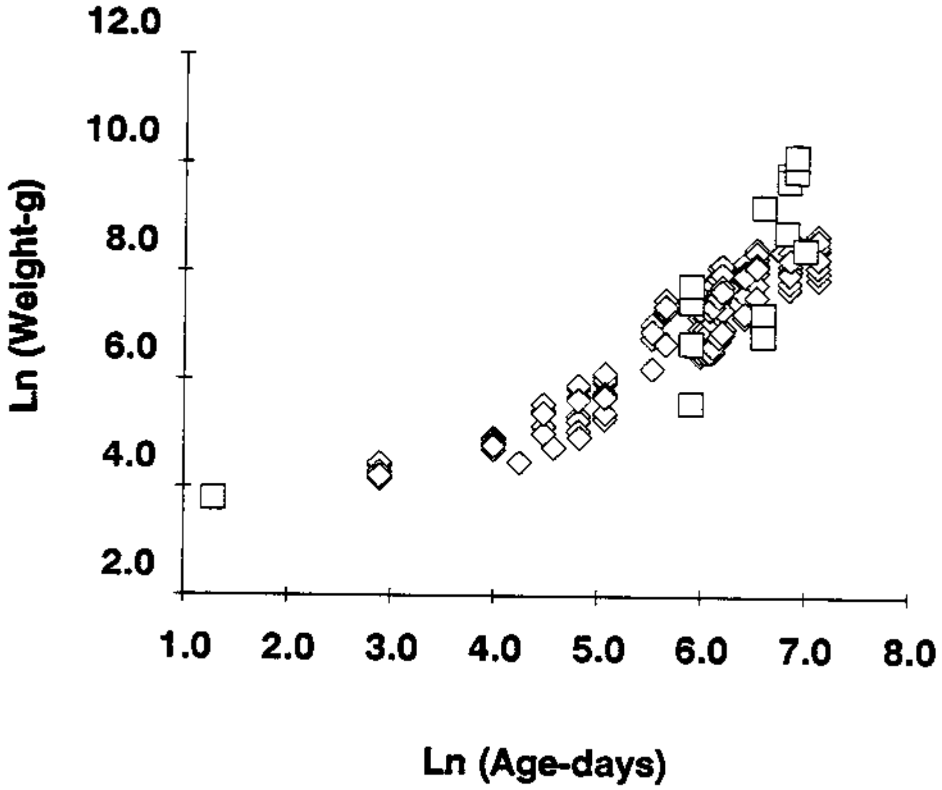

Figure 1. Growth in body weight of American alligators raised for 40 months following hatching, on a dry formulated ration, (open diamonds), vs. comparable growth data taken from the literature by Brisbin (in press) for captive alligators raised on standard diets of meat and fish (open squares).

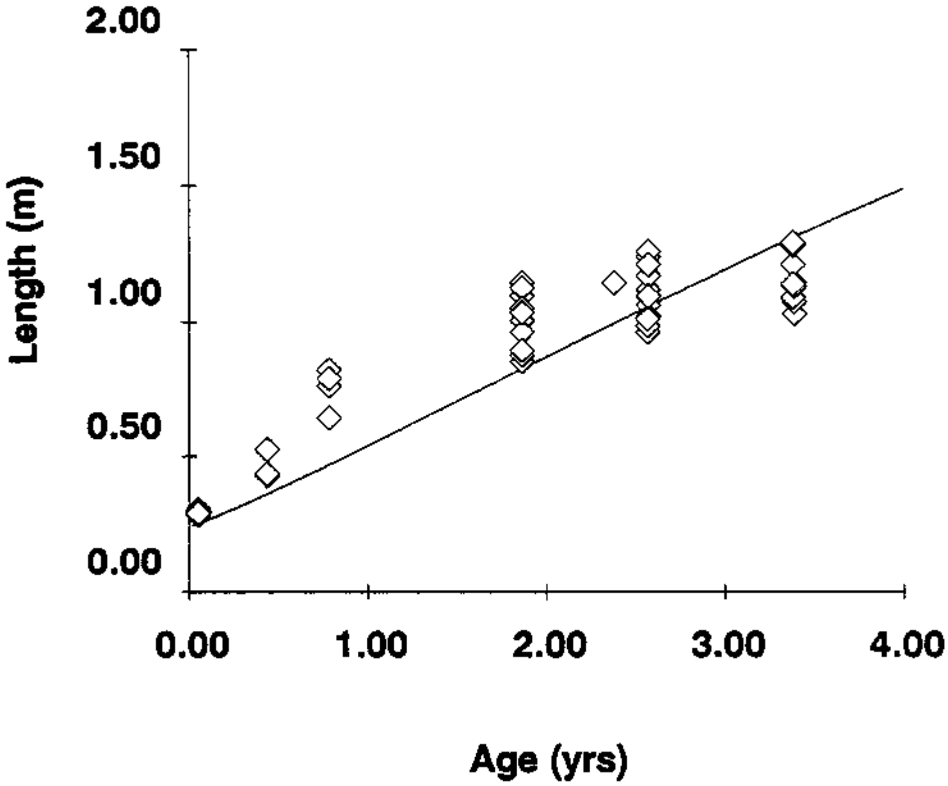

Figure 2. Total body lengths of American alligators raised for 40 months following hatching, on a dry formulated ration (open diamonds), vs. a regression for the fit of a Richards growth model to data (N = 72) for captive alligators raised on standard diets of meat and fish. Data and Richards regression coefficients for the latter were taken from Brisbin (in press).

POPULATION SIZE, COMPOSITION, AND RECRUITMENT OF AMERICAN ALLIGATORS IN FRESHWATER MARSH

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Abstract.--Aerial surveys of alligator nests on Lacassine National Wildlife Refuge, Louisiana indicated that there were 332 and 744 nests on the refuge in 1986 and 1987, respectively. A sample of 47 nests was examined in 1986 and 63 nests were examined in 1987. The mean clutch size was 32.9 eggs. High water in 1987 resulted in the loss of 4.8% of the eggs. The mean number of hatchlings per nest was 31.5. Adult alligators comprised 26.7% of the alligator population on the refuge. The sex ratio of adult alligators was 2.3:1.0 (males to females). The estimated alligator population on the refuge in 1986 was 7,918 but in 1987 it was estimated at 17,743. We estimated that 83.6% of the hatchlings were lost before they reached 1 year of age.

The decline, protection, and recovery of the American alligator (*Alligator mississippiensis*) has raised much public and scientific interest. Much of what is now known about this species has been learned since the 1950's. Research in Louisiana has been conducted on aspects of nesting biology (Joanen and McNease 1979) and nesting ecology (Joanen 1969). Those data were largely derived from alligator populations in intermediate (ca 4 ppt salinity) and brackish (ca 8 ppt salinity) coastal marshes. However, such data serve as parameters in population models that are projected on a statewide basis (Nichols et al. 1976:6, Taylor and Neal 1984). Freshwater marsh constitutes 30.8% of Louisiana's coastal marsh area (Chabreck 1970:37) and harbors an estimated 34% of the state's alligator population (McNease and Joanen 1978). However, no information is available on the productivity of alligators in this habitat. The objective of this study was to estimate the size, composition, and recruitment of an alligator population in a freshwater marsh.

The authors are grateful for the assistance of the U. S. Fish and Wildlife Service and the Louisiana Department of Wildlife and Fisheries in conducting the investigation.

DESCRIPTION OF STUDY AREA

The study was conducted on the 12,869-ha Lacassine National Wildlife Refuge (NWR) in southwestern Louisiana. The refuge contains a 6,478-ha freshwater impoundment that is permanently flooded and referred to as Lacassine Pool. A 941-ha intensive study area was established in Lacassine Pool. The intensive study area was divided into 3 sections: north (320-ha), middle (356-ha), and south (265-ha).

Selective commercial harvesting of alligators was conducted on the Refuge during the study and was resumed in 1983 after 32 years of protection (Brown and Yakupzack 1983:27). In that interim, the population greatly increased and served as an important source of animals for restocking within Louisiana and elsewhere.

Precipitation constitutes the only source of water stored in Lacassine Pool. The refuge receives approximately 144 cm of rainfall annually, and excess water in Lacassine Pool is allowed to escape over three spillways located along the eastern, western, and northern levees.

Lacassine NWR lies within the Mermentau Basin, a man-made reservoir for storage of irrigation water. Much of the water used for rice field irrigation in southwestern Louisiana is drawn from the Mermentau Basin, and this use causes wide variation in water levels outside of Lacassine Pool. The greater depth and controlled level of water in the pool, compared to the surrounding marsh on the refuge outside the pool, affords a wider range of environmental conditions inside the pool. Vegetation is denser outside the pool because the periodic drawdown enhances growth of emergent plants.

METHODS

Nest Surveys

Alligator nests were counted from fixed-wing aircraft on 24 June 1986 and 10 July 1987. Surveys were flown in a Cessna 172 aircraft with a pilot and two observers. The plane was flown at a speed of 150 km/hr and a height of 50 m along north-south transects 0.8 km apart. In both flights observer 1 sat on the right side of the airplane next to the pilot and helped navigate, and observer 2 sat on the left side of the aircraft behind the pilot. The seating arrangement for the observers was kept constant. All transects were flown between 0900 and 1600 hrs. to reduce potential problems of differentiating alligator nests from muskrat (*Ondatra ziberthicus*) lodges and overlooking nests completely during adverse light conditions.

All transects were 200 m wide and strip width delineation was achieved by placing tape markers on the windows of the aircraft to define the outer boundaries of strips 100 m wide on each side. These strips were calibrated by flying, at an altitude of 50 m, over a 200 m wide transect marked on the ground (Roberts 1986:14). Navigation to transect endpoints was aided through the use of LORAN C navigational equipment. Endpoint coordinates were taken from the same maps (1:24,000 scale) used for transect selection. Map distortion of the latitudinal scale was corrected by ground-truthing along marked section lines.

An attempt was made to locate all the nests in the intensive study area, and each nest location was marked with a numbered metal pole. Eggs were removed to determine their condition and the number present. Care was taken not to rotate the eggs or position them differently from the way they occurred in the nest. Beginning on 22 August 1986, the marked nests were visited weekly to determine hatching success.

On 20 July 1987, all alligator nests were again located and marked on the intensive study area by the method previously described. The nests were visited in late August, prior to hatching, and the eggs were examined to determine their condition. Eggs were classified as fertile, killed by flooding, or faulty.

Population Size, Composition and Recruitment

The number of alligators in the study area was computed by the method developed by Chabreck (1967). The Chabreck method uses a formula that requires information on the number of alligator nests in the area plus information on 3 other factors. The first factor is the percentage of adult alligators (animals 1.8 m and longer) in the population. This was determined from night count data collected in accordance with Chabreck (1967). In 1973, 3 night count transects (each 4.8 km long) were established in Lacassine Pool and 3 additional transects were established outside the pool. The lines were surveyed annually by refuge personnel, and the total distance surveyed was 23.3 km.

The second factor required for the formula is the percentage of adult females in the population. This information was determined from alligator harvest data from the refuge. The third factor is the percentage of adult females nesting. Data for this factor were derived from Chabreck (1967), Joanen and McNease (1978), and Kinler et al (1987:17).

Recruitment was determined from the data gathered on the number of nesting females, the proportion of nests producing young, and observed embryonic mortality.

RESULTS AND DISCUSSION

Population Size

The number of alligators in the pre-hatching population on Lacassine NWR was estimated using the procedure developed by Chabreck (1967).

Percent Adult Alligators in the Population. During night counts on Lacassine NWR, alligators observed were listed by size classes; and from 1973-1986 (excluding 1978), 684 alligators were observed in Lacassine Pool and 1,235 were observed outside the pool. In Lacassine Pool, 28.8% of the alligators were adults and outside the pool adults represented 25.5% of the population. The combined results from night counts in both areas indicate that adults comprised 26.7% of the alligator population on Lacassine NWR. Chabreck (1967) reported that 15.8% of the alligators in a sample on Rockefeller Refuge were adults. Wilkinson (1985:100) found adults comprised 26.3% of a sample in South Carolina. A variety of techniques were used by Wilkinson (1985:99) to obtain his adult to juvenile ratio because he felt that night counts alone might result in an under representation of small alligators.

Woodward and Marion (1978) reported that all alligator size classes were readily observed in late May and early June and that night counts should be made at that time. Night counts at Lacassine NWR were usually conducted in late June, after the females had started nesting, and may have resulted in an under representation of adult alligators. Homogeneity of habitat on Lacassine NWR probably increased the accuracy of the counts.

Adult Sex Ratio. The adult sex ratio among alligators on Lacassine NWR, as determined from 1983-1986 harvest data, was 2.4 males:1.0 female (29.4% females). Other studies have indicated a surplus of adult males in the population. Chabreck (1967) reported a sex ratio of 1.55:1.0 and Wilkinson (1985:99) reported a 1.5:1.0 sex ratio. Hines et al. (1968) observed a 4.0:1.0 sex ratio, which they felt was possibly biased by incorrectly sexing some small alligators and by capturing alligators mainly in canals, which was selective to males. Hines et al. (1968) also stated that more recent captures indicated a 1.9:1.0 sex ratio. It was not clear if Hines et al. (1968) included immature alligators in their later sample. A 1.2:1.0 sex ratio was reported by Bara (1972). Alligators harvested during spring, summer and fall on Marsh Island in Louisiana brackish marsh (Kinler et al. 1987:15) indicated an adult sex ratio of 1.3:1.0.

Percent of Adult Females Nesting. In a study on Sabine Refuge in 1964, Walters and Ivy found evidence that 68.1% of the adult females had laid (Chabreck 1967). In another report from coastal Louisiana, Joanen and McNease (1978) reported that 63% of the adult females were productive; however, Kinler et al. (1987:17) reported an annual nesting rate of only 29.8%. More information is needed concerning the percentage of adult female alligators that nest annually on Lacassine NWR. Using an average of the values reported for alligators elsewhere in Louisiana (Chabreck 1967, Joanen and McNease 1978, and Kinler et al. 1987:17), we assumed that 53.6% of the adult females nested annually.

Wilkinson (1985:96) states that stress induced by drought, high salinities, and prolonged cool temperatures in the spring probably reduce nesting in South Carolina. Only 50% of adult wild-caught captive females nested each year on Rockefeller Refuge (Joanen and McNease 1980).

Computation of Population Size. Population and nest data can be convered to prehatching population numbers by using the following formula (Chabreck 1967):

$$P = N / A F E$$

where, P = Total alligator population in the area
N = Total number of alligator nests on the area
A = Percent of adult alligators in the population
F = Percent of adult females among adult alligators
E = Percent of adult females nesting

To calculate population estimates for Lacassine NWR, the population attributes from this study were inserted into the formula as follows: total number of alligator nests (N) extrapolated for the entire refuge in 1986 was 332, calculated proportion of adults in the population (A) was 0.267, proportion of adult females (F) was 0.293, and (E) the annual average proportion of females that nested was 0.536. From these calculations the total population on Lacassine NWR in 1986 was 7,918 alligators. Average density was 1 alligator/1.63 ha with 1 nest/24 alligators in the population. The 1986 population in Lacassine Pool (A = 28.8%) was 6,626 alligators. Average densities were 1 alligator/0.98 ha with 1 nest/22 alligators in the population.

In 1987 the total number of nests on Lacassine NWR was 744. Using the same values for 'A', 'F' and 'E' the total alligator population on Lacassine NWR was estimated to be 17,743. Average densities were 1 alligator/0.73 ha with 1 nest/24 alligators in the population. The 1987 population in Lacassine pool (A = 28.8%) was 15,549 alligators, and average densities were 1 alligator/0.42 ha with 1 nest/22 alligators in the population.

The sex ratio data from Lacassine NWR was obtained by examining alligators harvested in the fall; however, Kinler et al. (1987:17) demonstrated that the method produced a biased sex ratio because fewer adult females are harvested at that time. Also, information on the percent of adult females nesting each year (Kinler et al. 1987:16) suggested that nesting rates may have been over-estimated, and as a result total populations may have been under-estimated in the past. Additional information on the percentage of females nesting each year and the adult sex ratio is needed for the Lacassine alligator population.

McNease and Joanen (1978) determined that the average fresh marsh habitat in Louisiana supports 1 alligator/5.67 ha. Lacassine Pool supported 1 alligator/0.98 ha in 1986 and 1 alligator/0.42 ha in 1987. The remainder of the marsh on the refuge (outside of Lacassine Pool) supported 1 alligator/4.95 ha in 1986 and 1 alligator/2.91 ha in 1987.

Population Composition

The alligator population composition outside of Lacassine Pool as determined by night counts more closely resembled the population composition reported by Taylor and Neal 1984 than did the population composition in Lacassine Pool. The most obvious difference at Lacassine NWR and that reported by Taylor and Neal (1984) was the apparent under-representation of the 2 smallest size classes. Alligators remain in pods during their first 2 years and that behavior may have caused considerable variation in night counts of those size classes (Woodward and Marion 1978). Young alligators usually remain for the first two years of life in the vicinity of their mother's nest, which is often in remote sections of a marsh (Chabreck 1965) and in areas not normally sampled by night count transects.

The population composition in Lacassine Pool was unusual in that the number of animals in the 0.6-1.5 m size classes was very small compared to the population composition reported by Taylor and Neal 1984. One possible explanation is that alligators in those size classes were more likely to submerge to avoid the airboat during the night counts than other size classes. Lacassine NWR personnel attempted to capture and tag 500 alligators/year, and alligators in the 0.6-1.5 m size classes made up the bulk of the captures, hence their avoidance of the airboat. Another reason those size classes may have been under-represented was that larger alligators may have driven the smaller alligators from the deep water habitat where night counts were mostly conducted. That possibility becomes especially likely when the high density of alligators of all size classes in the pool is taken into consideration.

Recruitment

In 1987, 9.02% of the alligator eggs laid in nests monitored in the intensive study area on Lacassine NWR failed to hatch. Assuming that no further mortality occurred between the time the eggs were inspected and hatching, the 63 active nests produced 1,875 young ($\bar{x}$ = 29.8). The aerial inventory of nests disclosed that 704 nests were present in the pool. By applying this nest production value, we estimated that 20,979 young were produced in the pool. The 40 nests outside the pool contributed another 1,192 young for a total of 22,171 young produced on the refuge in 1987. The computed population before hatching was 17,743; therefore hatchlings would have comprised 55.5% of the after hatching population if no mortality occurred.

Although fewer nests were present on the refuge in 1986, no eggs were lost to flooding. Assuming that the same percentage of faulty eggs (4.8) existed in 1986 as in 1987, then the nests in 1986 ($\bar{x}$ = 33.2 eggs) should have produced an average of 31.6 young. Total production of young on the refuge in 1986 was computed at 10,491. The computed population of alligators before hatching in 1986 was 7,918; therefore, hatchlings would have comprised 57.0% of the after-hatching population if no mortality occurred.

Alligator hatchlings range in size from 0.3 to 0.6 m at age 1 (Chabreck and Joanen 1979). Night counts on Lacassine NWR indicated that this size class (including those $<$ 0.3 m) comprised 24.1% of the before hatching population. However, after hatching this group made up only 10.4% of the total population in 1986 and 10.7% in 1987. The average of these values for both years indicates a loss of 83.6% of the hatchlings during the first year on Lacassine NWR.

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Summary of Venezuela's new law for commercial trading of wildlife and its products.

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On 23 March 1990 the Ministry of the Environment and Natural Renewable Resources in Venezuela issued a Ministerial Despatch with new regulations pertaining to wildlife trade. The new regulations are summarized here.

INTRODUCTION

- Legal basis:
  - CITES International Law
  - Venezuelan Wildlife Law (Article 87)
  - Central Administration Law (Article 36)

SECTION 1

- Purpose:

To regulate wildlife trade and industry in Venezuela and the international export of wildlife products.

- Institutions with jurisdiction to apply and enforce the law.:

- National Guard
- PROFAUNA (National Wildlife Office).

SECTION 2, Licences.

- Eligibility to establish wildlife industry or trade in products:

- Personal commercial firms fulfilling previous requirements for licences.
- Legal firms (Companies, Corporations etc.) that previously fulfill requirements for licenses.

License applications require a description of the proposed activities and verification of approval by PROFAUNA.

SECTION 3

- Transportation of wildlife or products within the country:
  - Regulations and documentation required for movement
    - from sites of origin (e.g.ranches) to local PROFAUNA centers and
    - from sites of origin to the rest of the country.

SECTION 4.

- Registration of traders and industries required.

SECTION 5

- Warehouses and commercial storage and activity regulated.

SECTION 6

- Import and Export activities:
  - Approval of PROFAUNA required.
  - Licensing and documentation described.

Analysis:

The new law has considerable advantage for wildlife conservation and sustainable use. It imposes controls on wildlife trade and is restrictive enough to discourage adventurers. Licensing and documentation are under the centralized jurisdiction of PROFAUNA. At the same time it provides a firm basis on which to build sustainable industries and commercial businesses based on wildlife. The mechanisms and climate are established to encourage investment in sustainable wildlife industry by both foreign and local investors.

PRELIMINARY STUDIES ON THE HOME RANGE OF THE CHINESE ALLIGATOR.

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Abstract:

Movements of Chinese alligators away from their dens are described and home ranges calculated. The area used for foraging by individual alligators may vary by up to 10 times from 447 meters square to 5876 meters square. Causes of this variation are thought to be as follows:

1) Available space; Alligators with access to larger foraging areas have larger home ranges.

2) Richness of food resources; Alligators with access to concentrated food supplies used smaller home ranges.

3) Age; Adult alligators used more of the available habitat than juveniles living in the same waters.

4) Size; larger alligators occupied areas of more abundant food and used a smaller foraging area than smaller individuals in the same waters.

No differences in home range were observed between males and females.

Introduction

The number of living Chinese alligators in the field is small. Surviving alligators are distributed in a discontinuous manner rather than a continuum following the destruction of much of their habitat and the reduction of their populations. In this study we enquired into the size of home range of alligators in their present dispersed locations . We also examined differences in home range size between alluvial plain and upland hilly regions. Studies were conducted in the alluvial plain in August 1988 and in the hill region in August 1989.

Materials and methods.

Investigation of the home range in the riverside plain was done at Donghe Village, Nanling county, Anhui province, a low lying area of the Yangtse alluvial plain that is intensively cultivated and has a dense human population. At this location five alligators live in a pond of 3600 m^2. One is an adult female and four are juveniles 0.6 - 0.8 m length. They may all be one family but presently live in different burrows. A swamp of 8000 m^2 lies adjacent to the NE side of the pond and SW of the pond is a mound on which are 13 farm houses. The alligator burrows are under this mound. This village and the pond is surrounded by paddy field sprinkled with ditches.

A second study site in the Yangtse alluvial plain was located at Shihpu village, Nanling county. Adjacent to this village is a pond of about 400 m^2 connected to a canal. The village people wash vegetables and clean fish at this pond and discard fish offal into the pond, therefore there is a rich food supply for the single female alligator that occupies this pond.

The investigation of the alligator home range in the hilly region was done in Xintian village, Xuancheng county, Anhui province in the foothills of the Wannan mountain chain. The area is partially cultivated in wheat, rice and vegetables but is primarily a tree farm. Two adult female alligators reside in a reservoir that covers an area of about 3600 m^2. The reservoir is formed by an embankment in the valley and two ditches discharge into it from above. Paddy fields lie below the embankment in the valley. Two female alligators have their burrows near where the where the reservoir adjoins the ditch. The burrows are only 13.5 m apart.

In another side of the hill about 2 km distant from the reservoir is a small pond of 260 m^2 area with an adjoining ditch winding around the hill. A male alligator lives in this pond, which is surrounded by vegetable and paddy rice cultivation.

Preliminary observations on the nightly movements of these alligators were made using a head lamp. Prominent land marks such as trees, paths and canals were accurately mapped and formed the reference points for a grid of X and Y axes. Then alligators were located by their eyeshine and their position relative to the X/Y axis determined accurately.

Because juvenile alligators of about the same size could not be differentiated by their eyeshine we combined observations for the four juveniles at Donghe. The adult female could be distinguished and was labelled alligator "A". Observations were made on 15 occasions, on two of which only four alligators could be seen, giving a total of 73 sightings at this location. At Shihpu the alligator, termed "B" was observed 15 times, always within or on the bank of the pond and never going out.

The two alligators at Xintian reservoir could be distinguished by size as "C" (the larger one) and "D" (the smaller one) and the male alligator in the nearby pond was called "E". Each of these were observed 15 times each.

Sighting locations of each alligator were expressed as an X_i and Y_i dimension on the axes and the parameters X_i^2, Y_i^2 and X_iY_i calculated and summed for each animal. Because the distribution of sighting locations was roughly elliptical we adopted the equation used by Jennrich and Turner (1969) in calculating range areas of lizards:

$$\text{AREA:} \quad A = 6 \text{ pi } |S|^{1/2}$$

$$\text{where } |S| = S_{xx} \cdot S_{yy} - S^2_{xy}$$

$$\text{X Variance:} \quad Sxx = 1/(n-2)[SUMX^2-(SUMX)^2/n]$$

$$\text{Y Variance:} \quad Syy = 1/(n-2)[SUMY^2-(SUMY)^2/n]$$

$$\text{X Y covariance:} \quad Sxy = 1/(n-2)[SUMXY-(SUMX)(SUMY)/n]$$

Results and discussion

The data obtained from the four sites are presented in Table 1. Observations from Donghe are shown as the combination of all sightings (adult and juveniles) and the adult "A" alone.

Long term observations have shown that Chinese alligators remain occupants of their resident burrows except when they leave during the mating season. The time of our study (August) is period of active feeding for alligators. All the alligators came out from their burrows to feed and our measurements are for the feeding area but cannot address the activity range during breeding. Table 1 indicates that the area used for foraging by alligators may vary by a factor of 10 between different alligators. The range of female "A" in the riverside plains, covered 5876 m^2, but female "B" only 447 m^2. The reasons for this difference are thought to be three respects:

(1) The structural nature of the habitat. In the residence of "A" is a large pond and its neighboring swamp. Alligator "A" searches for food both in the pond and in the swamp where there is a plentiful supply of food. The residence of "B" is surrounded by paddy fields and villages and, due to the use of chemical fertilizers and pesticides, there is little food in the paddy fields, therefore "B" did not forage there.

(2) Although the pond occupied by "A" is also near a village and the villagers sometimes discard animal offal such as fish innards into the pond, the village is so small that little food is provided from this source. In contrast the village adjacent to the home of "B" is larger and lot of animal matter is thrown into the pond. Alligator "B" did not appear to need to forage elsewhere.
(3) Four juveniles remained in the pond of "A" while "B" occupied its pond alone.

In 1969 Turner et al. analyzed data from 13 species of terrestrial lizard and found a positive correlation between area of home range and body size. They suggested that larger lizards have a greater daily energy expenditure than small lizards. Our data are insufficient to support this conclusion. We observed that females "C" and "D" lived in the same reservoir and while "C" is larger its home range is smaller. It may be that the larger "C" is able to forage in the richest portion of the pond. The home range of the male "E" is larger than "B", "C" and "D" but smaller than "A". The size of home range may be more affected by habitat structure than by differences between males and females. "E" lives in a smaller pond and usually crawled into the shallow sides of the nearby canal to take food. "C" and "D" live in a large reservoir and usually searched for food in the shallows. "B" lives in small pond but takes advantage of supplementary food thrown in by people and does not need to leave this pond to seek food. The home range of the male "E" is smaller than that of female "A" because "A" lives in a larger pond and also uses the swamp to seek food. Additionally "A" is sharing the pond with four juveniles. The activity range of the four juveniles is smaller than that of the female "A" and so the apparently smaller home range of the "family" is a statistical artifact of combining the data.

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Table 1 Comparation of the home ranges in the different place

place	name & number of alligator	number of times appeared alligator (n)	ΣX	ΣY	ΣX^2	ΣY^2	ΣXY	area of home range ($100m^2$)
riverside plain								
Donghe village	1 A♀	15	57.4	61.8	364.04	384.18	367.12	58.76
Donghe	1 A & 4 juvenile	73	188.5	172.1	890.87	832.21	820.47	46.58
Shihpu	1 B♀	15	27.4	16	58.46	19.8	23.01	4.47
hilly region								
reservoir	1 C♀	15	27.4	20	60.9	29.46	36.78	7.98
reservoir	1 D♀	15	28.4	17.8	69.28	25.2	35.56	11.23
small pond	1 E♂	15	54.6	15.01	261.78	20.77	67.37	18.15

OBSERVATION ON THE BURROW OF CHINESE ALLIGATOR *

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China.

Abstract

This paper deals with the burrow construction of the Chinese Alligator, selection of the burrow site, biological significance of the burrow and behavior of digging the burrow. A typical burrow consists 1 or 2 openings, 1 or 2 tunnels, 1 - 3 chambers, a sleeping platform and a pool. The tunnels twist and turn effectively maintaining an even temperature and avoiding enemies. Each burrow contains a pool that holds water all year and supplies the alligator with water in the burrow even when the weather is cool or very dry. The complex environmental factors of the burrow may be involved in the developmental needs of the gonad. More burrow openings face south than face north because the south facing orientation is warmer in winter and cooler in summer. The site of construction is carefully selected by the alligator with respect to topography, vegetation and soil. Alligators construct the burrow with the snout, four limbs, body and tail and burrows are usually constructed in mid to late September.

* This project is supported by the Chinese Science Fund.

Introduction

A vast majority of crocodilians living in the world are distributed in the tropics and subtropics. An exception is the Chinese Alligator which is distributed up to 31° North Latitude. Because winter temperatures in this range may fall to 13.7 C° the Chinese alligator shows a number of adaptations to this climate and the digging of a burrow is one of the more important adaptations. We have studied alligator burrows for several years to understand their biological significance. The project was initiated in 1982 as part of the study of the Chinese alligator conducted by Dr. Myrna Watanabe with Chen Bihui and Huang Chuchien. After Dr. Watanabe returned to the U.S.A the study was continued by the present authors.

Methods

Structure of Alligator burrows was studied by excavating them by hand. When each section of burrow was dug out its length, width, height and depth (distance from its bottom to the ground surface above) was measured. The length of each section was measured in the midline along the bottom and the section lengths added to give the total. After each burrow was excavated a diagram of the whole burrow was drawn. Burrow temperatures were measured in eleven burrows. Four were 1.5 - 2 m deep and located in the alluvial plain region. Four were 1.5 - 2 m deep and four of 2.5 - 2.74 m depth were located in a hilly region. Each burrow temperature was measured at the beginning, middle and end of each month and a few were measured monthly for 4-5 times. Temperature differences between the alluvial plains and hills are less than 0.5 C° and so the mean value of measurement data was adopted for the ground temperature each month. A thermometer equipped within a hollow hand drill (a geothermometer) was used to take ground and burrow temperatures. Location and depth of each burrow was probed from the surface with a thin bamboo pole and then the geothermometer inserted through the soil into the burrow. With very deep burrows it was necessary to remove part of the overlying earth above the burrow in order to insert the geothermometer but in every case the burrow remained intact and covered with earth.

Results and Discussion

Basic construction of the burrow. A typical burrow is shown in Figs 1 - 3 and is constructed as follows:
i] Openings; the burrow openings are approximately round or elliptic with the bottom wall somewhat flat. Hole size is positively correlated with the size of the occupant alligator. The openings of an adult alligator burrow are 33-35 cm high, 35-55 cm wide, and are usually located in the vertical wall of an embankment, pond bank or ditch or located at the foot of a hill. When water levels are full the opening is submersed but it may be exposed as water levels fall. Over the opening there are usually high arbors, dense bushes or grasses and holes are often located between the forks of the roots of waterside trees.

The Air Hole, first named by Chu Cheng-kuan (1957), is a vertical cylindrical entrance to the burrow of 42-56 cm diameter with the apparent function of air supply to the burrow. The opening of the air hole is at the ground surface above the burrow. The function of this aperture may be to allow an air supply, and as an exit for the alligator, in times of floods in the rainy season. Air holes are a regular feature of burrows on the flat alluvial plain where flooding is common and few air holes are seen in hill region burrows.

ii] The tunnel: The bottom of the tunnel is smooth while the top is arciform so that the tunnel in section is a semicircle. The adult alligators tunnel is 33-36 cm high, 39-60 cm wide, with a very smooth inner surface which becomes highly compacted by the passage of the alligator to a depth of 4-5 cm into the burrow wall, with a completely different texture to the loose soil external to this rampart.

The length of a tunnel is correlated with the alligators age. Adult alligator burrows may be 10 - 25 m length while those of young alligators may be about 3 - 10 m. The tunnel has twists and turns functioning to maintain stable temperatures and to discourage enemies.

3] The Chamber: The chamber is a widened part of the tunnel, roughly round or elliptical and usually located at the confluence of two forks. It is probably the place where the alligator can turn around within the tunnel. Chamber size varies with a diameter of 48 - 60 cm and a height of 42 - 50 cm.

4] The sleeping platform: A flat platform is usually located at or near the end of a tunnel that curves upward. The platform is elliptic and 90 - 150 cm long and 40 - 70 cm wide. Alligators we have investigated during their hibernation period are always found in this section of the burrow.

5] The pool: A pool of water is usually found in the deepest part of the burrow. The shape and size of the pool varies but it is usually larger than the sleeping platform. In some short simple burrows there is no pool but in larger burrows with two branches it is usually found at the end of the downward sloping branch and some pools have a short canal connected. The pools hold water all year.

The construction of the burrow relates to the age, sex and habitat of the alligator. Hatchlings have a tendency towards using natural holes and, as they grow, they rebuild and expand and deepen the hole. The burrow at one year of age is relatively simple with a single opening, 1-2 m of tunnel and no chamber, pool or platform. As the alligator grows the burrow is made more complex. Two branches with a chamber are first built, additional openings and a platform added and finally a pool constructed. The tunnel of females is more complex than that of males because within the female tunnel there are small forks to serve as the habitat of juveniles.

Temperatures measured within alligator burrows are shown in table 1 with the associated air temperatures outside the burrow. Seasonal changes of air temperature in the range of the alligator is very distinct with a minimum in January and a maximum in July. The variation between day and night air temperatures is also distinct. The mean difference between maximum and minimum air temperature can be 7.5 C° in January, 8.6 C° in April, 7.6 C° in July and 8.4 C° in October. Extreme minimum temperatures recorded were air = 13.7 C°, earth surface = - 23.3 C° and extreme maxima were Air = 40.7 C° and earth surface 72.6 C°.

Seasonal changes within the burrow are much less extreme (Table 1). There is no change from day to night and seasonal extremes are less. The Chinese Alligator can effectively thermoregulate within its burrow. The burrow shape prevents rapid access of outside air and the deeper burrow levels provide a summer resort from heat and a safe hibernaculum in winter. The Chinese Alligator spends approximately six months restricted to its burrow but only the period December to mid February is spent in deep slumber. In late February the alligator begins to arouse. Experiments have shown that the alligator needs to drink at this time but the outside air temperature is still very low (Mean air temperature about 5.9 C°). The alligator is able to obtain water from the pool in its burrow rather than crawl outside to drink. During very hot weather when outside water supplies dry up the alligator again has water in its burrow pool and can thus tide over an adverse season. A lot of experiments have shown that normal gonad development does not take place in Chinese Alligators moved from their burrows and settled in an artificial environment to hibernate. The burrow is therefore seen to be very important for the alligators life. Alligators dwell in their burrow their whole life and will only leave if the burrow is destroyed.

Selection of a burrow site. Tables 2 and 3 present information on a large number of alligator burrows with respect to the location and orientation chosen for burrow location. Burrow location is seen to be closely influenced by topography, vegetation and soil. Burrows are preferentially located against hills and banks, or on islands rather than on banks bounded by open fields. In the hill locality burrows where a reservoir is bounded on three sides by hills, the burrows are placed near a ditch that flows into the reservoir. On the alluvial plains, where ponds are often surrounded by fields, burrows are placed wherever there is a higher bank or at the base of mounds. Locations with loose soil and luxuriant vegetation are preferred. The vegetation around alligator burrows appears particularly lush. Coulson and Hernadez (1983) reported lush vegetation growth around American Alligator holes related to NH_4HCO_3 excreted by the alligator. The orientation of burrow openings is not distinctly related to burrow location but Tables 2 and 3 both indicate south facing orientations are more common. South facing orientations are warmer in winter and cooler in summer.

Burrow digging behavior. Burrow construction appears to be instinctive. Hatchlings show an unlearned tendency to associate with natural holes in the hollow of banks and squeeze and rub the holes. Such natural locations are selected and the hole expanded and deepened. Burrow construction behavior has been observed in young alligators 10 months old raised in captivity and then released into nature. After 2-3 weeks most of the young can dig a tunnel 30 -40 cm long. Burrows are mostly constructed in the middle and late September each year when cold air from the North is first experienced. The mean air temperature at this time is about 20C. From this time until the onset of hibernation alligators can be seen rebuilding and expanding their burrows.

When building burrows alligators dig the snout and four limbs deep into the soil and push back and forth with the back of its head and neck and anterior body. The cristae scutum in these parts function as a spade to shovel a tunnel through the soil. The head is used like a bulldozer to push soil outside the burrow. Flogging with the tail and pressing with the body play a role in compacting the tunnel walls. Cave ins of the burrow may be fatal to alligators within as we have found an alligator trapped between two collapsed rocks and killed by asphyxiation, at that time it had made two openings.

References

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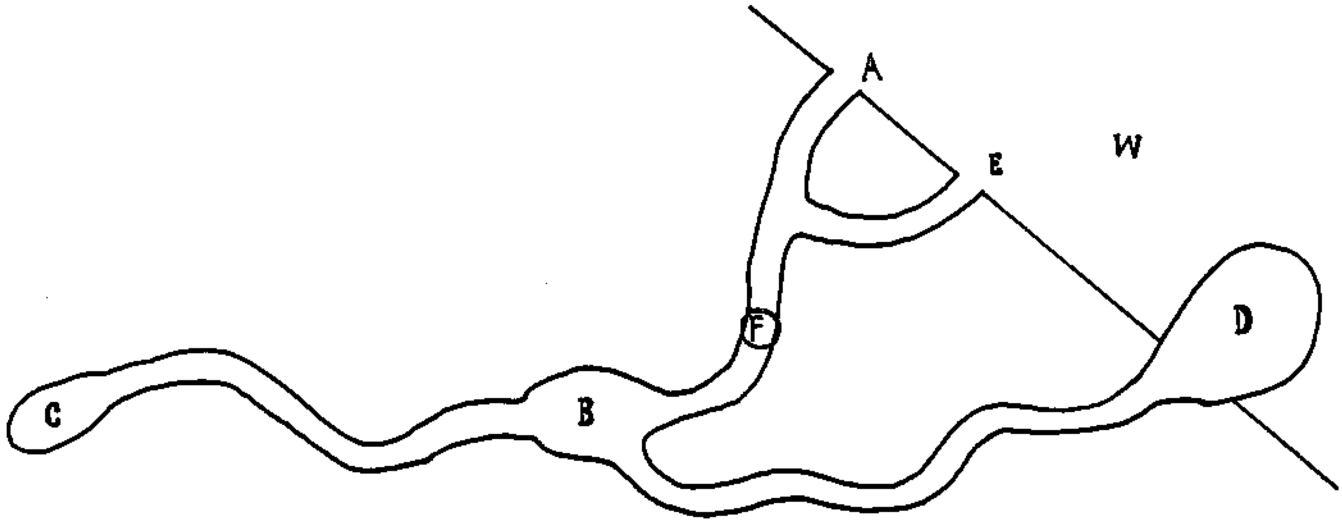

Fig. 1 An aerial view of a burrow
Fig. 2 Asectional drawing of a burrow
Fig. 3 A cross section of tunnel;
A,E=opening; B=chamber;
C=sleeping platform; D=pool;
F=air hole; W=waters
BC=upward tunnel;
BD=downward tunnel;
1.7→ ← It shows that the distance from the bottom of tunnel to the earth surface is 1.7m

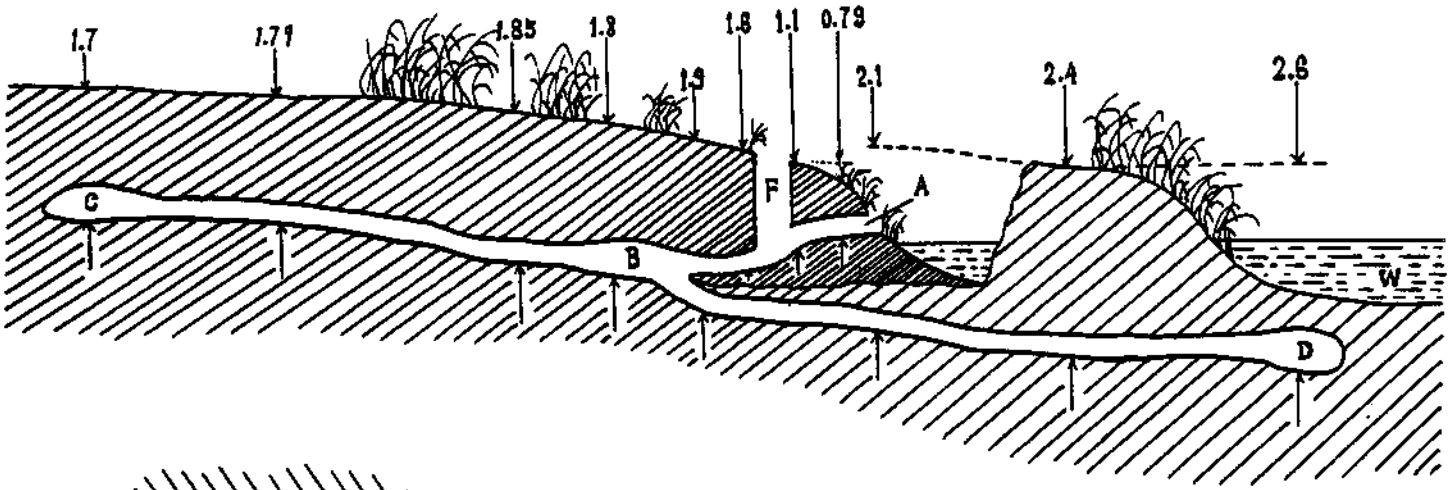

Fig.2

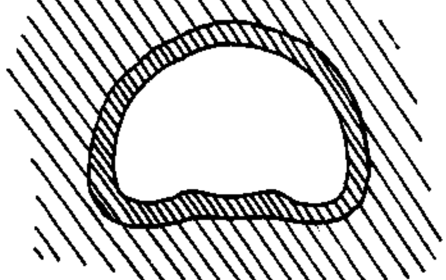

Fig.3

Table 1. The comparison between the temperature within tunnel of chinese alligator and air temperature

month	mean air temperature ℃	mean earth surface temperature ℃	1.5-2m deepth mean burrow temperature ℃	2.5-2.7m mean burrow temperature ℃
1	2.7	3.5	13.1	16.2
2	4.4	5.5	11.8	14.6
3	9.3	10.6	12.3	13.6
4	15.6	17.5	14.3	13.6
5	21	23.6	16.8	14.3
6	24.8	28.2	19.4	16.7
7	28.4	32.6	21.9	18.2
8	28.1	32.5	23.8	19.8
9	22.9	26.0	24.1	20.4
10	17.3	19.5	22.5	21.0
11	11	12.0	20.1	20.1
12	4.9	5.6	16.9	18.4

Table 2. The relation of the burrow to topography, vegetation and soil

area	number of alligator burrow		site to construct burrow				vegetation		opening's orientation
	A	B	C	D	E	F	G	H	
alluvial plain	9	15	10	—	9	5	6	18	S3:N2; SE9; NE7; SW3
hill	31	34	5	59	1	—	7	58	E4; W3; NE11; SW47

Note: A=to have alligator;
B=to have not;
C=on the island;
D=alongside a hill;
E=below the bank;
F=at the foot of the hill;
G=below the tree root of arbor;
H=below the dense bushes or grasses;
I=sandy soil
J=sandy soil to contain pebbles

E4=4 openings facing East
S=South
W=West
N=North

Table3. The fundamental state regarding burrows in the Research Centre of Chinese Alligator Reproduction

area	number of alligator burrow	site to construct burrow		vegetation		opening's orientation	soil	
		C	D	G	H		I	J
breeding area	56	37	19	6	50	E21; S14; W2; N1; SE4; NE9; SW2; WN3;	24	32
raising area one year of age	48	48		7	41	S20; W14; N3; SW11	48	
two years age	52	52			52	E17; S17; W8; SW10	36	16
three years age	37	37			37	E21; S3; N4; WN9	37	
four years age	46	46		10	36	E14; S20; N3; SE5; WN4	26	20
seven years age	46	46		8	38	E6; S24; W7; N4; SE2; NE2; SW1	45	1

Note: A=to have alligator;
B=to have not;
C=on the island;
D=alongside a hill;
E=below the bank;
F=at the foot of the hill;
G=below the tree root of arbor;
H=below the dense bushes or grasses;
I=sandy soil
J=sandy soil to contain pebbles

E4=4 openings facing East
S=South
W=West
N=North

Summary of Alligator Farming Records in Florida

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Presented at the
10th Working Meeting
of the
IUCN/SSC Crocodile Specialist Group

23-27 April 1990
Gainesville, Florida U.S.A.

Introduction

The Florida Game and Fresh Water Fish Commission (Commission) has maintained records of alligator farm stock and annual production since the inception of alligator farming in the state. Between 1969 and 1977, Commission enforcement personnel recorded inventory and production figures for some farm facilities. Permitting of alligator farms for commercial hide and meat production began in 1978 following the federal reclassification of alligators from endangered to threatened, which allowed the sale of hides where it could be demonstrated that the animals were legally acquired and produced from captive stock (Neal 1977). Since 1978, farms have been required by the Commission to report changes in inventories. These records were used to develop a profile of Florida's alligator farming industry to evaluate trends in alligator farming from 1969 to 1989. For the purpose of this paper, a farm is considered a facility which maintained captive stock between 1969 and 1978 and was subsequently authorized to commercially harvest alligators or was permitted as an alligator farm since 1978. Changes in the number of farms, inventory of stock maintained on farms, egg and hatchling production, reproductive efficiency of female breeders, and hide and meat production were evaluated. Interpretation of trends provided an opportunity to make short term projections on hide and meat production. Additionally, gross estimates of the value of farm-reared alligators were made based on Commission records and price levels provided by the industry.

Farm Levels

Only four farm facilities that maintained alligators for captive propagation subsequently began to commercially market alligators after 1978 (Figure 1). However, during the 1980's, the number of alligator farms increased nearly nine fold. The majority of the growth occurred between 1982 and 1988, when permitting of new farms reflected an 18% annual rate of increase (Figure 1). The rapid growth may be explained by the increasing availability of wild eggs and hatchlings and the perceived profitability of farming by entrepreneurs. The 1989 annual inventory of licensed and permitted farms indicated 35 farms maintained breeding stock (Figure 2); 11 farms reared only wild stock or had not yet obtained stock. Using the number of female breeders as an indicator of the relative size and annual production potential of a farm, these records indicate that the relative proportion of small, medium, and large farms remained relatively stable during the 1980's (Figure 2) and that average farm size did not increase substantially over that time.

The total alligator inventory on farms between 1982 and 1989 increased from 10,800 to 92,750. The greatest increase occurred between 1987 and 1989. The total annual inventory of all farms increased an average of 13,750 alligators each year or 32% annually during this period. This increase is a result of the expansion of breeding stock, an increase in breeder efficiency, and the development of the alligator management program which permitted expanded collection of hatchlings and eggs

Captive Production

Hatch rates of captively produced eggs are based on farmer reports prior to 1981 and on-site inspections of egg and hatchling production by Commission personnel since 1981. Reported egg production includes all eggs for some farms or years and only incubated eggs on other farms. Records available from 1 to 3 farms annually between 1969 and 1981 reflect an average hatch rate of approximately 50%. Hatch rates of the 8 to 35 farms reporting annually between 1982 and 1989 averaged 33% with no apparent trend (Figure 3).

Reported annual hatchling production on farms between 1969 and 1981 varied between 0 and 1,000; however, the number of farms reporting each year was low (1 to 3). The number of farms increased through the 1980's with annual captive hatchling production between 1984 and 1989 averaging 280 hatchlings per farm.

The number of hatchlings produced per female breeder, called Annual Reproductive Efficiency (ARE) by Godwin and Cardeilhac (1981), can be used as an index to captive propagation success. Farms must maintain a minimum annual ARE of 7 hatchlings per female to be successful (Cardeilhac 1988). ARE was evaluated between 1983 and 1989 for: (1) all farms, (2) the 5 farms with the highest annual ARE and (3) remaining farms less the top 5. Between 1983 and 1989, the average ARE for all farms was 2.51 hatchlings per female breeder. The ARE remained unchanged between 1982 and 1985 at

2.0 and increased to 3.4 through 1989. Although the ARE dropped in 1988, there appears to be a slight increasing trend since 1985 (Figure 4).

The ARE for the top five farms averaged 6.33 hatchlings per female between 1983 and 1989, whereas the remaining farms averaged only 1.42. The ARE for the top 5 farms decreased from 6.6 to 4.8 between 1984 and 1985 but steadily increased thereafter to 11.5 in 1989 (Figure 4). This increasing trend is a result of 13 individual farms occupying the top-5 category during the 7 year period. Three individual farms were in the top category 5 of the 7 years, which demonstrates maintaining a high ARE is attainable but that individual farms are not consistently attaining high ARE'S. The size of the 13 farms (based on the number of breeders) occurring in the top category were distributed in proportion to their overall occurrence. Therefore, the size of a farm is not correlated with a high ARE. Over the 7 year period, the top-5 farm category maintained only 23% of the breeding females, but accounted for 58% of the captive hatchling production. By comparison, in 1989, 30 of the 35 farms with breeders maintained 85% of the females but accounted for only 49% of the hatchlings produced in captivity.

The increase in the number of farms, expansion of breeding stock, and improved breeder efficiency has resulted in a substantial increase in the number of captively propagated hatchlings. Captive hatchling production increased from 1,031 in 1981 to 15,074 in 1989. A further increase in the number of captive hatchlings on farms can also be attributed to hatchling stock obtained from experimental research projects and expansion of ranching programs initiated by the Commission in 1987. Between 1981 and 1986, 15,464 hatchlings were placed on farms from the wild as a result of research programs. Starting in 1987, new egg and hatchling harvests from the wild were implemented. Egg and hatchling collections and a continued supply of hatchlings provided from research projects resulted in 35,088 Florida ranched hatchlings being placed on farms between 1987 and 1989. An additional 14,130 ranched hatchlings were imported from Louisiana and Texas between 1988 and 1989. As a result 49,218 wild hatchlings were placed on Florida alligator farms since September 1987 (Figure 5).

Farm Harvest

The increased production of alligators propagated on farms and the increased availability of wild hatchlings to farms has resulted in an increased number of alligator hides being tagged and sold in the hide market. Approximately 200 hides per year were tagged and sold between 1978 and 1983. The number of hides tagged each year increased steadily from 738 in 1984 to 16,385 in 1981 (Figure 6).

Hide prices fluctuated near $20 per linear foot between 1980 and 1986 and increased above $30 per linear foot following 1987 (Figure 7). However, the average value of a farm produced alligator decreased from approximately $225.00 in 1985 to approximately $200.00 from 1986 through 1988. Total carcass value decreased only 12.5%, despite a 25% decrease in hide size and a 50% decline in meat yield from each carcass. Higher hide prices diminished the relative value of meat from a carcass, providing an incentive to harvest smaller alligators at an earlier age. Industry sources reported that this harvest strategy increased cash flow, while maintaining an acceptable overall return for each animal slaughtered. Based on farmer reports, increases in hide prices returned the average animal value to approximately $225 in 1989.

The increased harvest of farm-reared animals was reflected in the overall increase in total meat production from farms. Meat production increased from 27,962 pounds in 1985 to approximately 128,379 pounds in 1989, despite a decline in average meat yield from 20 pounds per alligator in 1985 to 6.7 pounds in 1989 (Figure 8).

The ability to project future farm harvest levels is valuable to regulatory agencies and the industry. Estimated production levels allow regulators to anticipate the manpower and tag allotment needed to monitor production and permit the industry to plan for facility development and initiate marketing strategies aimed at maintaining a steady market.

Because the inventory of rearing stock presently maintained on Florida farms is known, 2 year production projections can be made relatively safely provided market conditions remain stable. These projections can be made based on the number and age of rearing stock and recent trends in the rate of harvest. Harvest rates of 2-year old alligators, calculated as the percentage of hatchlings placed on farms 2 years before, increased from approximately 25% to 50% prior to 1986, to approximately 80% during the past 3 years (1987-89). Projections based on the slaughter of 80% of the 2 year age class indicate hide production figures of 24,350 hides in 1990 and 28,100 hides in 1991 (Figure 9). This production would represent a 72% increase over the next 2 years.

Longer term estimates, although more speculative, can be made for harvest levels beyond 1991 based on trends in captive production and anticipated expansion of ranching programs that would provide more wild eggs and hatchlings for captive rearing. Assuming a continued annual improvement in captive production of the 0.2 hatchlings per female observed since 1983 and a diminished expansion of ranching stock to 7% per year as fewer suitable collection areas are available, farm hide production would increase to approximately 32,172 hides by 1993 (Figure 9). Based on these projections, and assuming current product values, the gross value of alligator production on farms could double to over $7.2 million by 1993 (Table 1).

<u>Summary</u>

There has been a substantial increase in the number of captively produced hatchlings on Florida alligator farms over the last decade. That increase is largely attributable to increases in the number of breeders and farms, as well as moderate improvement in the number of hatchlings produced per female. It is clear that substantial improvements are needed to increase captive production to a profitable ARE, but until those improvements are achieved, Florida's alligator management programs that make wild stock available for rearing on farms will continue to account for the major increase in farm inventory. Further increases in farm production are possible, assuming improvements in captive propagation and expansion of ranched alligators from management of wild populations.

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Table 1. Estimated gross value of farm-reared alligators from 1984 through 1993.

Farm-Reared Alligators

ESTIMATED GROSS VALUE

Year	Harvest	Average Length (feet)	Hide Value	Meat Value (@$5.50/lb.)	Total Value
1984	738	6.0	$ 84,600	$ 81,800	$ 166,400
1985	1,339	6.0	$ 166,500	$ 153,600	$ 320,100
1986	3,921	5.0	$ 443,300	$ 319,600	$ 762,900
1987	6,479	4.5	$ 919,000	$ 385,000	$1,304,000
1988	7,572	4.5	$1,107,400	$ 450,000	$1,557,400
1989	16,385	4.5	$2,621,800	$1,064,800	$3,686,600
1990	23,686				$5,329,400*
1991	27,029				$6,081,500*
1992	29,829				$6,711,500*
1993	32,172				$7,238,700*

* Projected figures based on alligator carcass value of $225.

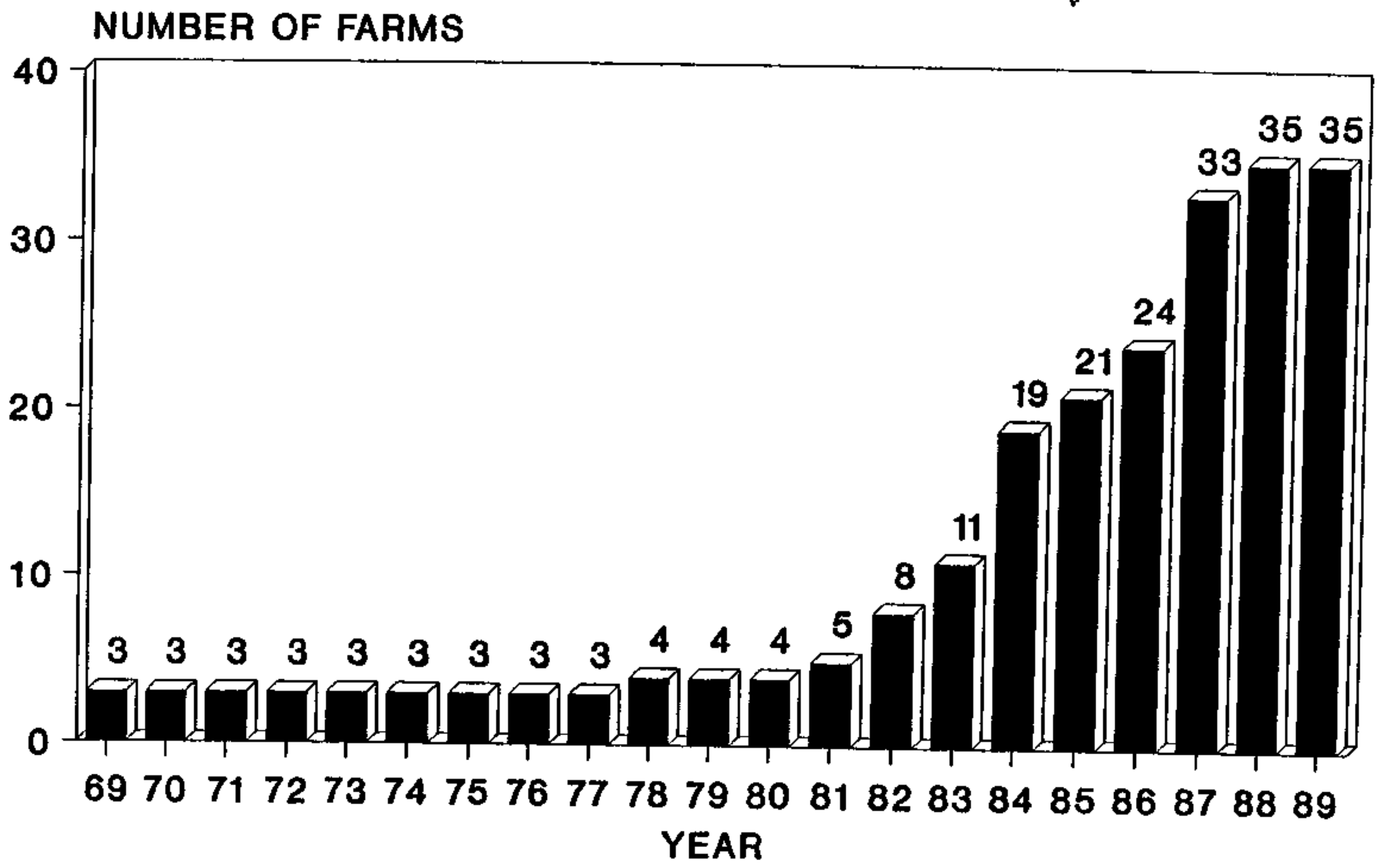

Figure 1. Number of Florida alligator farms that maintained female breeders, 1969 to 1989.

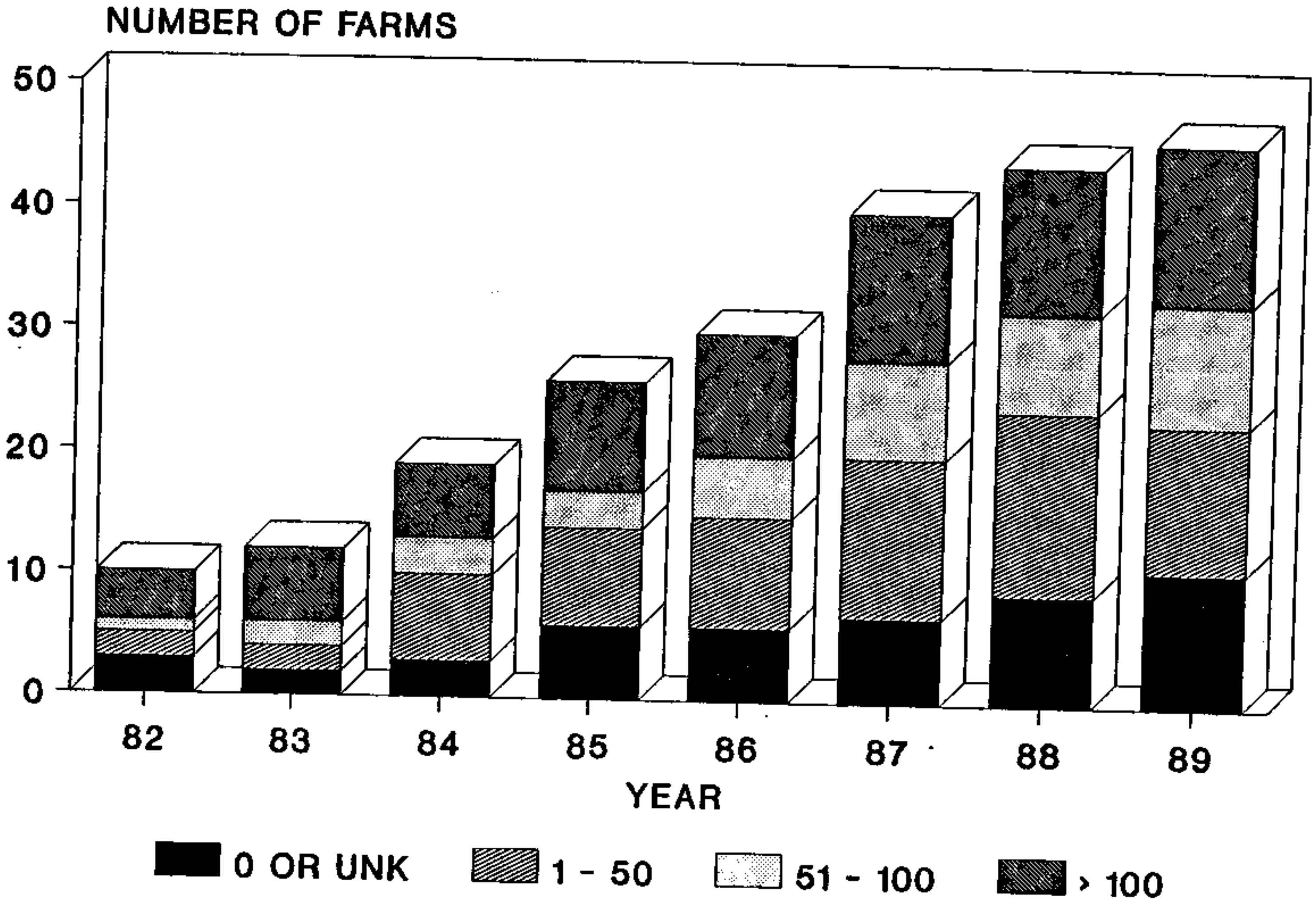

Figure 2. Numbers of Florida alligator farms categorized by number of female breeders maintained, 1982 to 1989.

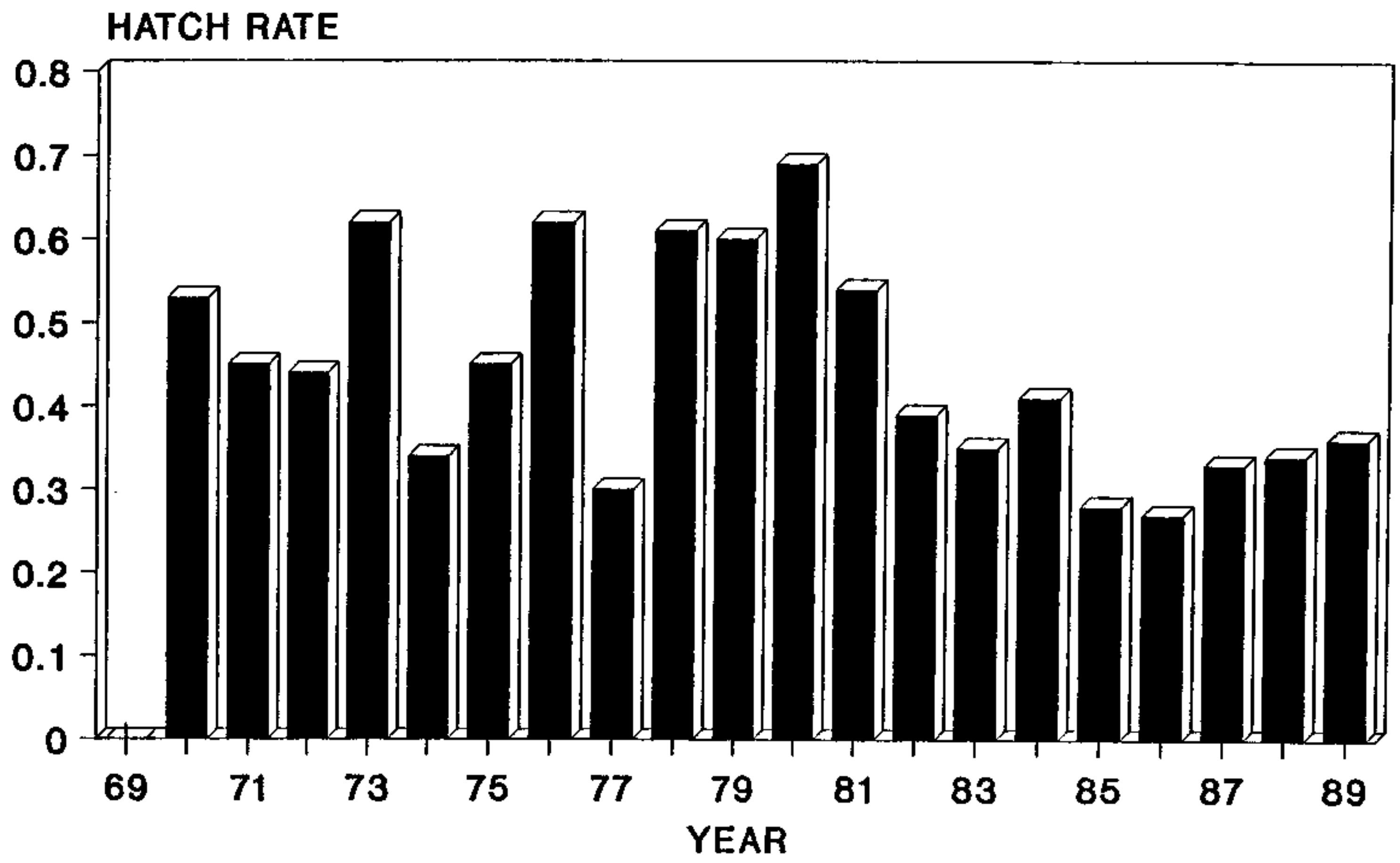

Figure 3. Reported hatch rates of alligator eggs captively produced on Florida alligator farms 1969 to 1989.

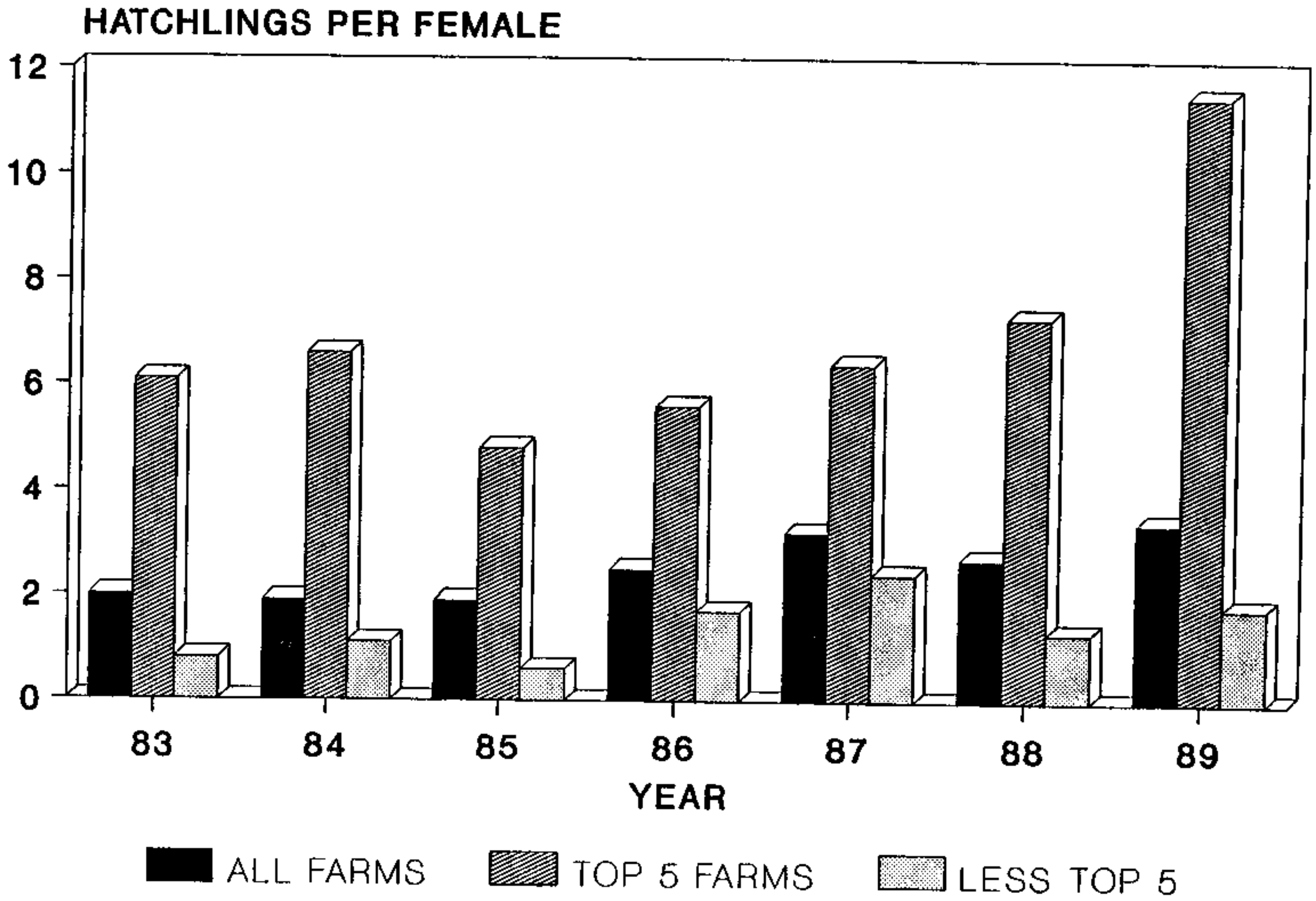

Figure 4. Number of hatchling alligators produced per female breeder on all Florida alligator farms, the five most productive farms, and all farms less the most productive five farms 1983 to 1989.

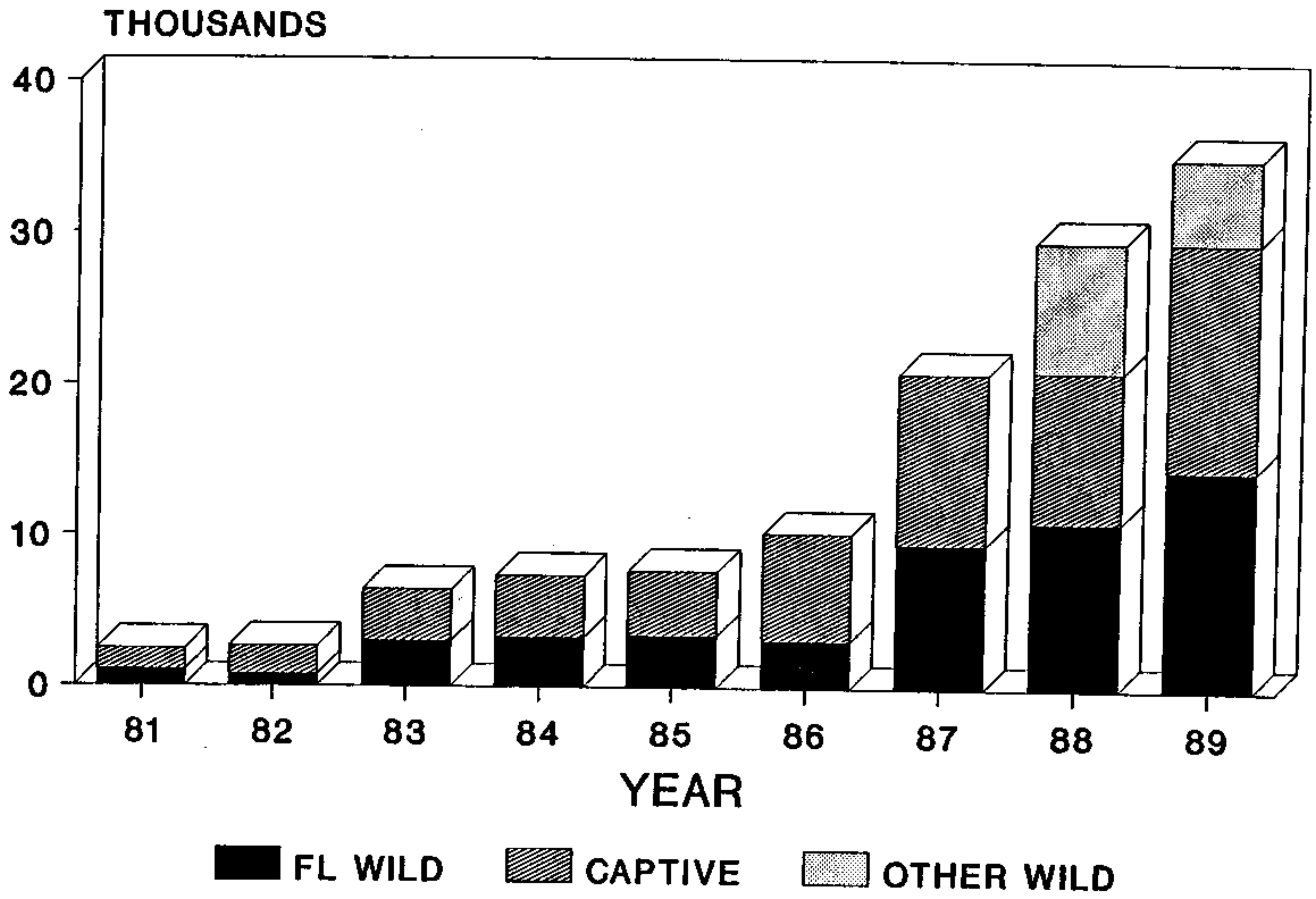

Figure 5. Source of alligator hatchlings reported on farm inventories in Florida from 1981 to 1989.

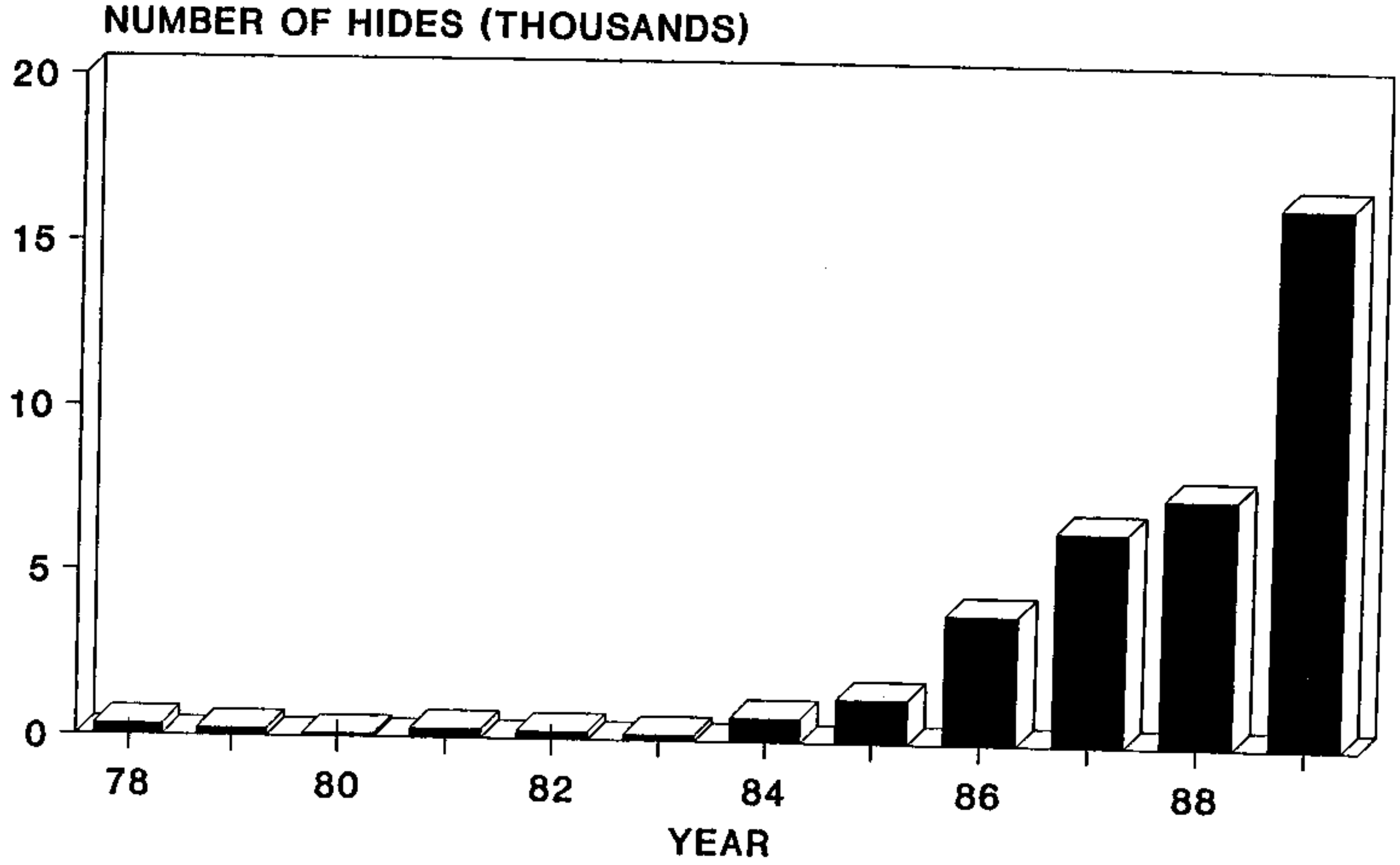

Figure 6. Number of Florida alligator farm hides produced from 1978 to 1989.

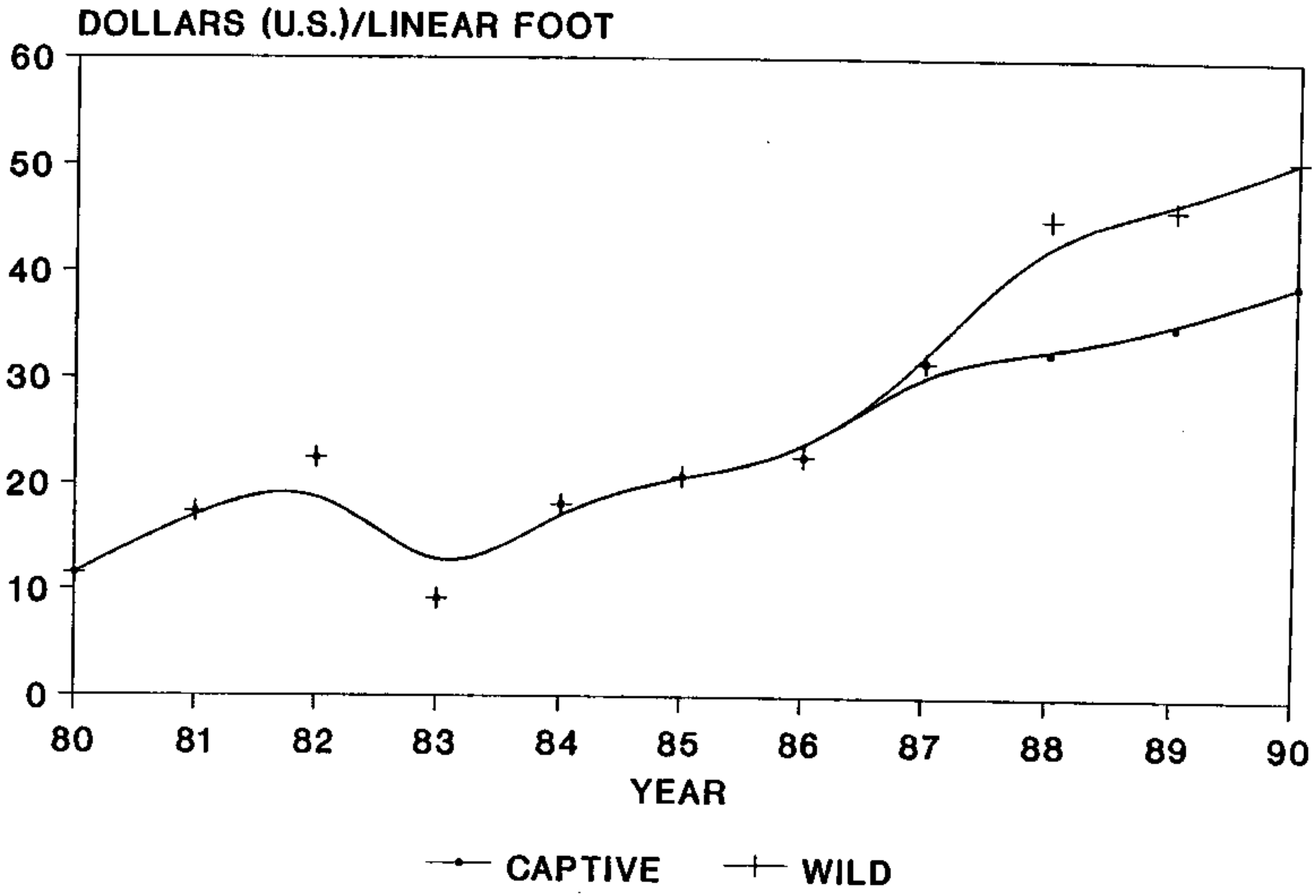

Figure 7. Alligator hide sale price per linear foot for wild and farm hides based on receipts from hides sold by the Commission and industry reports from 1980 to 1990.

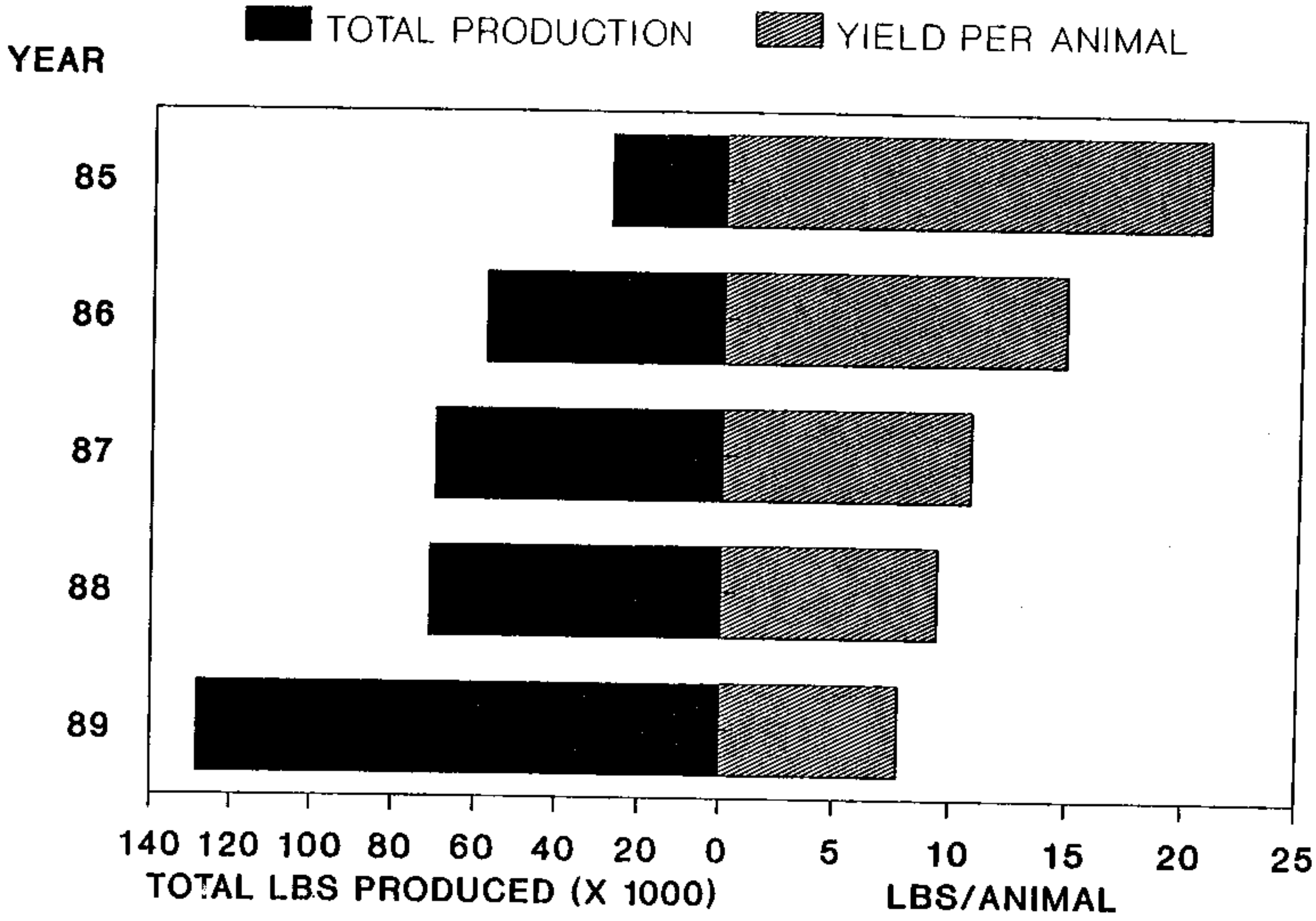

Figure 8. Number of alligators slaughtered and average meat yield per carcass on Florida farms from 1985 to 1989.

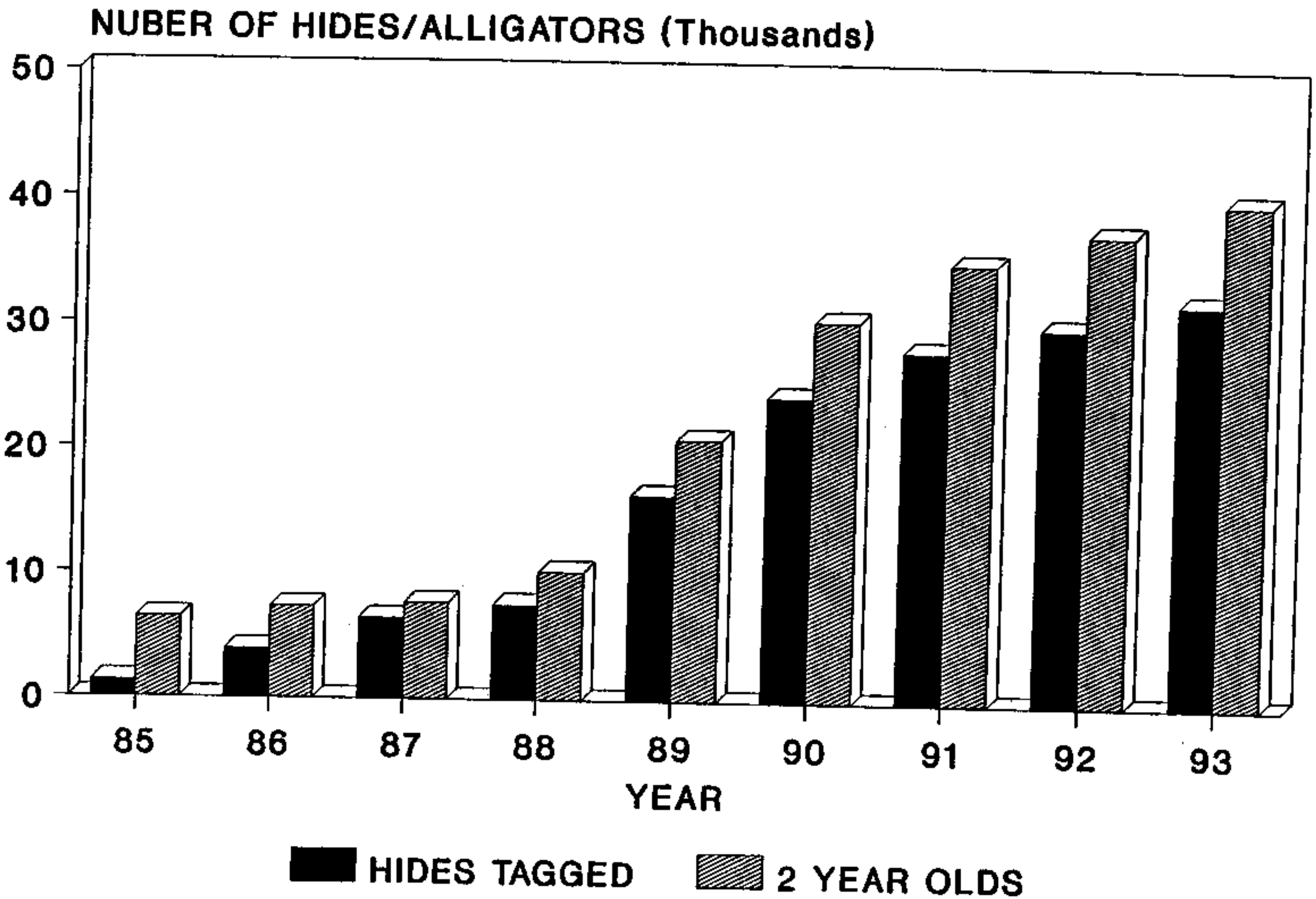

Figure 9. Florida alligator farm hide production from 1985 to 1989 and projections of future harvests based on anticipated slaughter of 80% of 2 year olds and stock increases from expanded captive production and ranching programs.

GFC Form 1000AF

ALLIGATOR FARM ANNUAL REPORT

For the Report Year Ending

December 31, ____

Farm Name ______________________________

Farm Licensee Name ______________________________

Address ______________________________

____

Telephone Numbers (   ) ______________ (   ) ______________

1. Number of live alligators on my farm as of December 31 last report year ______

2. Total number of clutches produced from nests on my farm this report year ______

3. Grand total of alligator eggs produced by breeders on my farm this report year (include eggs culled prior to incubation) ______

4. Number of eggs reported in No. 3 that were incubated on my farm this report year ______

5. Number of hatchling alligators produced from eggs reported in No. 4 that were retained and were surviving on my farm as of December 31 this report year. ______

6. Number of wild alligator eggs that were transferred from the egg collection coordinator under the public lands egg collection program, and incubated on my farm this report year ______

7. Number of hatchlings produced from public lands eggs reported in No. 6 that were retained and surviving on my farm as of December 31 of this report year ______

8. Number of eggs that were transferred to me from private lands alligator management program permittees and incubated on my farm this report year ______

9. Number of hatchlings produced from private lands eggs reported in No. 8 that were retained and surviving on my farm as of December 31 this report year ______

10. Number of "orphaned" eggs transferred to me from nuisance alligator program trappers serving as my alligator farming agent(s) this report year ______

11. Number of hatchlings produced from nuisance alligator program "orphaned" eggs reported in No. 10 that were retained and surviving on my farm as of December 31 of this report year ______

12. Number of "supplement" hatchlings received from U. of F. Co-op Unit this report year ______

13. Number of "supplement" hatchlings from U. of F. Co-op Unit that were retained and were surviving on my farm as of December 31 of this report year ______

14. Number of wild hatchlings collected from counties assigned to me under the statewide hatchling collection program this report year ______

15. Number of wild hatchlings reported in No. 14 that were retained and surviving on my farm as of December 31 of this report year ______

16. Total number of live, <u>hatchling</u> alligators bought or transferred to my farm this report year (Does not include hatchlings reported in No. 12 and 13 above.) ______

    Itemize (List each transaction):

    <u>Date</u> <u>Number</u> <u>Source</u>

17. Number of hatchlings reported in No. 16 that were retained and surviving on my farm as of December 31 of this report year ______

18. Total number of live, <u>non</u>-hatchling alligators bought or transferred to my farm this report year ______

    Itemize (List each transaction):

    <u>Date</u> <u>Number</u> <u>Size</u> <u>Source</u>

19. Total number of live hatchling alligators sold or transferred from my farm this report year ______

Itemize (List each transaction):

Date	Number	Size	Destination

20. Total number of live non-hatchling alligators sold or transferred from my farm this report year ______

Itemize (List each transaction):

Date	Number	Size	Destination

21. Number of alligator hide tags used this report year ______

22. Number of unused alligator hide tags returned with this report ______

23. Number of dead, non-hatchling alligators to be disposed of by burial and not hide tagged this year. (Do not include dead hatchlings of the year, as they must be deducted to calculate figures reported as surviving hatchlings as of December 31.) ______

24. Total number of breeding alligators in ponds on my farm at beginning of breeding season

male ______

female ______

25. Total number of breeding alligators in ponds on my farm as of December 31 of this report year

male ______

female ______

26. Grand total number of live alligators on my farm as of December 31 of this report year

SIZE CLASS

	0'-2'	2'-4'	4'-6'	6'-8'	8'+		
No. of Alligators	____	____	____	____	____	=	____ GRAND TOTAL

27. Number of pounds of farm meat produced from alligators that were tagged with a harvest tag issued to me, and reported as used in No. 19 this report year. (Do not include meat produced from alligator carcasses tagged with wild harvest tags, or harvest tags issued to another farm.) ____

28. Number of pounds of meat reported in No. 26 that was sold this report year. (Do not include meat from wild alligator carcasses you may have purchased and processed.) ____

I certify that this record is accurate to the best of my knowledge.

______________________ Signed

__________ Date

DD/gs
rev. 3-19-90
FN: 1000AF90.FRM

Appendix I (continued)

1989 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	FARM ADULT MALES	FARM ADULT FEMALES	FARM TOTAL BREEDERS	FARM NUMBER OF NESTS	FARM TOTAL EGGS	FARM VIABLE EGGS	FARM HATCHLINGS PRODUCED	FARM HATCH PER ADULT FEM	FARM HATCH RATES	PUBLIC WET. EGG COLL.	PUBLIC WET. HATCHLINGS	PRIVATE WET. EGG COLL.	PRIVATE WET. HATCHLINGS	FSP HATCHLINGS	PUBLIC WET. HATCH. COLL.
ASHLEY ASSOCIATES	DON ASHLEY	TALLAHASSEE	0	0	0	0	0	0	0			0	0	0	0	0	0
BABCOCK FLORIDA CO.	PETER ARNOLD	PUNTA GORDA	0	0	0	0	0	0	0			0	0	798	597	0	0
BECK, WAYNE H.	WAYNE BECK	MOOREHAVEN	25	75	100	24	842	431	405	5.40	0.48	332	315	0	0	0	450
BJO GATOR RANCH	RON NELSON	INVERNESS	32	33	65	17	766	499	493	14.94	0.64	332	323	0	0	0	443
BONNY FARMS	JOE TILLMAN	LAKE PLACID	96	318	414	122	3300	3303	1504	4.73	0.46	0	0	0	0	274	281
BUSCH GARDENS	RON REYNOLDS	TAMPA	11	26	37	11	375	95	14	0.54	0.04	0	0	0	0	0	0
CIRCLE M FARMS	DONALD NELSON	BUSHNELL	19	56	75	30	1179	806	530	9.46	0.45	0	0	0	0	220	0
CLAYBROOK FARMS	TIM KEAGAN	CHRISTMAS	62	191	253	33	1062	192	90	0.47	0.08	332	261	0	0	227	180
COLSON GATOR FARM	FLYNN COLSON	BROOKSVILLE	0	0	0	0	0	0	0			0	0	0	0	0	0
CYPRESS CREEK FARMS	SCOTT ANDERSON	STARKE	0	0	0	0	0	0	0			0	0	0	0	280	66
C.S.T. GATOR FARM	DON MORGAN	KEYSTONE HTS	97	238	335	24	673	404	200	0.84	0.30	700	530	0	0	275	0
DAVID A EVANS	DAVID EVANS	HOMERVILLE GA.	0	0	0	0	0	0	0			0	0	0	0	0	0
DAVID DRYSDALE	DAVID DRYSDALE	ANTHONY	81	82	163	30	832	205	190	2.32	0.23	0	0	0	0	0	0
DUNNELLON GATOR FARM	ARCHIE SMITH	DUNNELLON	6	15	21	4	116	67	36	2.40	0.31	280	214	0	0	198	84
EVERGLADES TOURS INC.	JOHN HUDSON	HOMESTEAD	25	50	75	30	1512	1063	985	19.70	0.65	332	125	0	0	272	490
EVERGLADES WONDER GAR.	LESTER PIPER	BONITA SPRINGS	46	65	111	8	120	85	5	0.09	0.04	0	0	0	0	0	0
FLORIDA'S CYPRESS GAR.	ANDY KOUSKOULIS	CYPRESS GAR.	3	2	5	0	0	0	0	0.00		0	0	0	0	0	0
FLYING P RANCH	G.O. PARROTT	BUSHNELL	23	88	111	1	30	24	1	0.00	0.03	0	0	233	209	809	383
FOSTER FARMS INC.	KEVIN FOSTER	OKEECHOBEE	166	443	609	180	5974	2066	1325	2.99	0.22	1934	1567	125	120	856	23
FRANKS GATOR FARM	PATRICIA FRANKS	OSTEEN	5	19	24	5	156	121	101	5.32	0.65	0	0	0	0	0	0
FROEHLICH'S GATOR FARM	EDWIN FROEHLICH	CHRISTMAS	0	0	0	0	0	0	0		0.00	0	0	0	0	0	0
GATOR ACRES, INC.	CRAIG LYONS	GAINESVILLE	31	95	125	40	1340	689	575	6.05	0.43	332	232	0	0	279	390
GATOR JAWS INC.	JAY WILDER	DELAND	30	47	77	6	227	57	29	0.62	0.13	333	255	0	0	220	198
GATOR JUNGLE OF PLANT	TRACY HOWELL	DOVER	55	119	174	9	331	331	127	1.07	0.38	0	0	0	0	330	351
GATORAMA	DAVID THIELEN	PALMDALE	120	147	267	18	365	120	82	0.56	0.22	333	260	0	0	0	493
GATORLAND ZOO	FRANK GODWIN	ORLANDO	241	376	617	14	443	35	25	0.07	0.06	0	0	0	0	270	135
GOMES GATOR FARM	FRANK GOMES	TAMPA	7	7	14	1	45	30	0	0.00	0.00	0	0	0	0	0	0
HERPETOFAUNA	TOM CRUTCHFIELD	N.FT. MYERS	4	5	9	1	0	0	0	0.00		0	0	0	0	0	0
HILLTOP FARMS	LAWLER WELLS	AVON PARK	156	495	650	321	10779	6830	5375	10.86	0.50	0	0	0	0	0	0
HINES, TOMMY	TOMMY HINES	NEWBERRY	0	0	0	0	0	0	0			0	0	0	0	0	0
HOWELL ALLIGATOR FARM	JOHN HOWELL	DOVER	30	97	127	0	0	0	0	0.00	0.00	654	563	0	0	22	38
HUNTS ALLIGATOR BR	CLYDE HUNT	BUSHNELL	130	203	333	66	2502	1405	1067	5.26	0.43	332	297	0	0	163	309
J&M GAME FARM	JAMES POSEY	PALMDALE	32	45	77	0	266	49	41	0.91	0.15	0	0	0	0	0	0
J&M GATOR FARM	NAUDINE POSEY	PALMDALE	74	74	148	0	0	0	0	0.00		300	289	0	0	169	0
KACKLEY GATOR FARM	STEVE KACKLEY	SEBRING	33	76	109	4	139	66	59	0.78	0.42	332	280	0	0	0	0
LEE, DRENNAN CRAWFORD	D.C. LEE	WILDWOOD	0	0	0	0	0	0	0			0	0	0	0	0	0
LIMESTONE FARMS	LOIS HOWELL	ARCADIA	14	32	46	1	62	0	0	0.00	0.00	0	0	0	0	0	0
N.A. OSTRICH	GARY LEVINE	LIVE OAK	0	0	0	0	0	0	0			0	0	0	0	0	0
PARKER ISLAND GATOR	WILLIAM TILLMAN	LAKE PLACID	0	0	0	0	0	0	0			0	0	0	0	275	0
PELLA'S GATOR FARM 1	EUGENE PELLA	SEBRING	0	0	0	0	0	0	0			0	0	0	0	0	0
PELLA'S GATOR FARM 2	EUGENE PELLA	SEBRING	191	414	605	55	1665	330	309	0.75	0.19	332	263	0	0	272	441
PELTS AND SKINS	PETER BISGARD	LOUISIANA	0	0	0	0	0	0	0			0	0	0	0	0	0
RAYFIELD GROVES	JACK RAYFIELD	NESBITT ISLAND	10	32	42	21	835	280	267	8.34	0.32	0	0	0	0	0	0
RUSSELL GATOR FARM	TOMMY RUSSELL	OSTEEN	38	112	150	46	1569	1176	736	6.57	0.47	333	315	0	0	0	0
ST.AUGUSTINE ALL.FARM	MARK WISE	ST. AUGUSTINE	238	120	358	3	32	16	0	0.00	0.00	0	0	9	0	0	0
SWAMPY ACRES	LEN GEIGER	SEBRING	85	170	255	126	4581	2220	472	2.78	0.10	332	278	0	0	0	0
TYSON, JAY	TYSON, JAY	FINETTA	0	0	0	0	0	0	0			0	0	0	0	0	0
WOOTEN, RAYMOND	RAYMOND WOOTEN	OCHOPEE	87	86	173	4	200	25	25	0.29	0.13	0	0	0	0	0	0
SUBTOTAL			2312	4443	6755	1260	42314	22036	15074	N/A	N/A	7835	6374	1165	926	5169	4859
MEANS PER FARM			48	93	141	26	882	459	314	3.39	0.36	163	133	24	19	108	101
# OF FARMS			48	48	48	48	48	48	48	35	33	48	48	48	48	48	48

Appendix I (continued)

1989 ALLIGATOR FARM INVENTORY SUMMARY

ALLIGATOR FARM	OWNER	CITY	PRIVATE WET. HATCH COLL.	ORPHANED EGGS	ORPHANED HATCHLINGS	OUT OF STATE HATCHLINGS	GRAND TOTAL HATCHLINGS	REPORTED MORTALITY	LIVE GATORS ACQUIRED(+)	LIVE GATORS DISPOSED(-)	TOTAL GATORS	HIDES TAGGED	LBS MEAT PRODUCED	LBS MEAT SOLD
ASHLEY ASSOCIATES	DON ASHLEY	TALLAHASSEE	0	0	0	0	0	0	0	0	0	0	0	0
BABCOCK FLORIDA CO.	PETER ARNOLD	PUNTA GORDA	0	0	0	0	597	242	97	0	601	97	0	0
WAYNE H. BECK	WAYNE BECK	HOCREHAVEN	0	0	0	0	1170	0	100	0	1524	0	0	0
BIG GATOR RANCH	RON NELSON	INVERNESS	0	0	0	0	1069	0	0	293	1994	0	0	0
BONNY FARMS	JOE TILLMAN	LAKE PLACID	0	0	0	0	3136	127	1076	1900	3841	50	0	0
BUSCH GARDENS	DON REYNOLDS	TAMPA	0	0	0	0	54	3	44	1	151	4	0	0
CIRCLE N FARMS	DONALD NELSON	BUSHNELL	0	0	0	0	750	18	0	271	1216	0	0	0
CLABROOK FARMS	TIM KEAGAN	CHRISTMAS	0	0	0	2661	3419	151	389	0	9345	1979	13556	13556
COLSON GATOR FARM	FLYNN COLSON	BROOKSVILLE	0	0	0	0	100	0	104	0	104	0	0	0
CYPRESS CREEK FARMS	SCOTT ANDERSON	STARKE	0	0	0	0	696	3	350	0	846	0	0	0
C.S.T. GATOR FARM	DON MORGAN	KEYSTONE HTS	0	0	0	0	746	15	1	286	3251	300	3402	2594
DAVID & EVANS	DAVID EVANS	HOMERVILLE' GA.	0	0	0	0	0	0	0	0	0	0	0	0
ARTHUR JONES ENTER.	KEN EARNEST	ANTHONY	0	0	0	0	156	33	0	0	1772	4	0	0
DUNNELLON GATOR FARM	ARCHIE SMITH	DUNNELLON	0	0	0	0	532	31	0	0	1299	22	113	0
EVERGLADES TOURS INC.	JOHN HUDSON	HOMESTEAD	0	0	0	0	947	0	79	1004	2915	76	1140	1140
EVERGLADES WONDER GAR.	LESTER PIPER	BONITA SPRINGS	0	0	0	0	5	2	0	0	116	0	0	0
FLORIDA'S CYPRESS GAR.	ANDY KOUKOULIS	CYPRESS GAR.	0	0	0	0	0	11	65	41	60	0	0	0
FLYING P RANCH	B.O. PARROT	BUSHNELL	0	172	43	0	1377	175	3580	574	3381	4400	28237	18120
FOSTER FARMS INC.	KEVIN FOSTER	OKEECHOBEE	0	0	0	1000	2030	26	111	3819	6228	0	0	0
FRANKS GATOR FARM	PATRICIA FRANKS	OSTEEN	0	0	0	0	201	0	100	0	226	0	0	0
FROEHLICH'S GATOR FARM	EDWIN FROEHLICH	CHRISTMAS	0	0	0	1586	1586	0	1601	59	4011	3300	25251	18034
GATOR ACRES, INC.	CRAIG LYONS	GAINESVILLE	0	0	0	0	1465	29	457	62	4607	1150	12588	9107
GATOR JAWS INC.	JAY MILDER	DELAND	0	0	0	0	710	1	0	457	787	151	1720	1720
GATOR JUNGLE OF PLANT	TRACY HOWELL	DOVER	0	0	0	0	776	4	60	186	1861	84	2144	1717
GATORAMA	DAVID THIELEN	PALMDALE	0	0	0	0	836	200	240	46	2166	600	8920	3464
GATORLAND ZOO	FRANK GODWIN	ORLANDO	0	0	0	287	1183	0	796	0	3976	1122	11679	10224
GOMES GATOR FARM	FRANK GOMES	TAMPA	0	0	0	0	0	0	0	0	12	1	0	0
HERPETOFAUNA	TOM CRUTCHFIELD	N.FT. MYERS	0	0	0	0	0	0	20	0	28	1	0	0
HILLTOP FARMS	LAWLER WELLS	AVON PARK	160	0	0	0	6375	41	1	2651	11490	1314	6157	4220
HINES, TOMMY	TOMMY HINES	NEWBERRY	0	0	0	0	0	0	0	160	0	0	0	0
HOWELL ALLIGATOR FARM	JOHN HOWELL	DOVER	0	0	0	0	623	1	50	20	1628	0	0	0
HUNTS ALLIGATOR GR	CLYDE HUNT	BUSHNELL	0	0	0	0	1926	841	0	707	4890	411	5180	3745
JAN GAE FARM	JAMES POSEY	PALMDALE	0	0	0	0	41	2	0	0	283	0	0	0
JIM GATOR FARM	MAUDINE POSEY	PALMDALE	0	0	0	0	450	12	0	6	1650	76	613	311
KACKLEY GATOR FARM	STEVE KACKLEY	SEBRING	0	0	0	0	494	0	247	0	907	0	0	0
LEE, ORDWAN CRAWFORD	B.C. LEE	WILDWOOD	0	0	0	0	0	2	0	0	144	0	0	0
LIMESTONE FARMS	LOIS HOWELL	ARCADIA	0	0	0	0	0	0	0	6	56	0	0	0
N.A. OSTRICH	GARY LEVINE	LIVE OAK	0	0	0	0	0	0	0	0	0	0	0	0
PARKER ISLAND GATOR	WILLIAM TILLMAN	LAKE PLACID	0	0	0	0	0	45	505	1039	4680	466	6319	6319
PELLA'S GATOR FARM 1	EUGENE PELLA	SEBRING	0	0	0	0	0	36	0	0	1972	0	0	0
PELLA'S GATOR FARM 2	EUGENE PELLA	SEBRING	0	0	0	0	1125	0	0	260	2157	0	0	0
PELTS AND SKINS	PETER BISSARO	LOUISIANA	0	0	0	0	0	0	0	0	0	0	0	0
RAYFIELD GROVES	JACK RAYFIELD	MERRITT ISLAND	0	0	0	0	267	22	0	0	651	0	0	0
RUSSELL GATOR FARM	TOMMY RUSSELL	OSTEEN	0	0	0	0	1051	0	100	244	3211	391	2175	0
ST.AUGUSTINE ALL FARM	MARK WISE	ST. AUGUSTINE	0	0	0	0	0	10	6	10	360	0	0	0
SWAMPY ACRES	KEN GEIGER	SEBRING	0	0	0	0	750	0	0	0	2728	85	1165	628
TYSON, JAY	TYSON, JAY	PINETTA	0	0	0	0	0	0	0	0	0	0	0	0
WOOTEN, RAYMOND	RAYMOND WOOTEN	OCHOPEE	0	0	0	0	25	0	0	0	216	0	0	0
SUBTOTAL			160	172	43	5534	35693	2034	10267	14093	93135	16462	128379	96105
MEANS PER FARM			3	4	1	115	744	43	214	294	1940	343	2675	2002
# OF FARMS			48	49	43	43	48	49	43	48	43	43	43	48

Appendix I (continued)

1989 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	FARM ADULT MALES	FARM ADULT FEMALES	FARM TOTAL BREEDERS	FARM NUMBER OF NESTS	FARM TOTAL EGGS	FARM VIABLE EGGS	FARM HATCHLINGS PRODUCED	FARM HATCH PER ADULT FEM	FARM HATCH RATES	PUBLIC WET. EGG COLL.	PUBLIC WET. HATCHLINGS	PRIVATE WET. EGG COLL.	PRIVATE WET. HATCHLINGS	PSP HATCHLINGS	PUBLIC WET. HATCH. COLL.
ARTHUR JONES ENTER.	KEN EARNEST	ANTHONY	133	62	195		1821	646	612	9.87	0.34	0	0	0	0	0	0
ASHLEY ASSOCIATES	DON ASHLEY	TALLAHASSEE	0	0	0	0	0	0	0			0	0	0	0	0	0
BABCOCK FLORIDA CO.	PETER AROLA	PUNTA GORDA	0	0	0	0	0	0	0			0	0	265	220	117	0
BILLY KEMPFER	BILLY KEMPFER	MELBOURNE	0	0	0	0	0	0	0			0	0	0	0	0	0
BONAY FARMS	JOE TILLMAN	LAKE PLACID	146	368	514		3410	725	396	1.07	0.12	0	0	0	0	155	350
BUSCH GARDENS	RON REYNOLDS	TAMPA	11	28	39		230	11	9	0.32	0.04	0	0	0	0	0	0
CLABROOK FARMS	BILOXI ABBOT	CHRISTMAS	62	198	260		1466	79	67	0.34	0.05	251	127	0	0	156	52
CLAUDE B.REESE JR	CLAUDE REESE	PALM BEACH	3	2	5	2	47	30	10	5.00	0.21	0	0	0	0	0	0
CYPRESS CREEK FARMS	SCOTT ANDERSON	STARKE	0	0	0	0	0	0	0			0	0	0	0	156	0
C.S.T. GATOR FARM	RON MORGAN	KEYSTONE HTS	97	238	335		1800	606	260	1.09	0.14	218	196	0	0	156	52
DAVID A EVANS	DAVID EVANS	OKEECHOBEE	0	0	0	0	0	0	0			0	0	210	170	0	0
DONALD NELSON FARMS	DONALD NELSON	BUSHNELL	19	56	75		861	430	249	4.46	0.29	0	0	0	0	360	0
DRENNAN CRAWFORD LEE	D.C. LEE	WILDWOOD	0	0	0	0	0	0	0			0	0	0	0	156	0
DUNNELLON GATOR FARM	ARCHIE SMITH	DUNNELLON	6	15	21		113	36	5	0.33	0.04	94	82	0	0	156	360
EVERGLADES TOURS INC.	JOHN HUDSON	HOMESTEAD	25	50	75		239	94	78	1.56	0.33	211	194	0	0	156	600
EVERGLADES WONDER GAR.	LESTER PIPER	BONITA SPRINGS	30	32	102		56	37	0	0.00	0.00	0	0	0	0	0	0
FLORIDA'S CYPRESS GAR.	ANDY KOUKOULIS	CYPRESS GAR.	3	3	6	0	0	0	0	0.00	0.00	0	0	0	0	0	0
FLYING P RANCH	G.O. PARROTT	BUSHNELL	23	88	111		77	39	25	0.28	0.32	0	0	0	0	246	200
FOSTER FARMS INC.	KEVIN FOSTER	OKEECHOBEE	56	160	216		2760	615	363	2.28	0.13	1260	1108	0	0	196	12
FRANKS GATOR FARM	PATRICIA FRANKS	OSTEEN	6	18	24	0	0	0	0	0.00	0.00	0	0	0	0	0	0
FROEHLICH'S GATOR FARM	EDWIN FROEHLICH	CHRISTMAS	0	0	0	0	0	0	0			0	0	0	0	0	0
GATOR ACRES, INC.	CRAIG LYONS	GAINESVILLE	31	98	129		611	236	232	2.37	0.38	219	227	322	224	156	269
GATOR JAWS INC.	JAY WILDEN	DELAND	30	47	77		152	100	69	1.47	0.45	219	143	0	0	156	0
GATOR JUNGLE OF PLANT	TRACY HOWELL	DOVER	57	30	87		107	63	24	0.80	0.22	176	102	0	0	102	254
GATORAMA	DAVID THIELEN	PALMDALE	120	127	247		304	93	87	0.69	0.29	159	115	0	0	117	306
GATORLAND ZOO	FRANK GODWIN	ORLANDO	676	126	802		805	172	65	0.52	0.08	378	268	0	0	155	348
GEIGER'S GATOR FARM	KEN GEIGER	SEBRING	86	172	258		2980	1701	1072	6.23	0.36	219	207	0	0	156	15
GOMES GATOR FARM	FRANK GOMES	TAMPA	6	8	14	0	0	0	0	0.00	0.00	0	0	0	0	0	0
HEMP HUT INC.	CHRIS McQUADE	FT. MYERS	0	0	0	0	0	0	0			0	0	0	0	0	0
HERPETOFAUNA	TOM CRUTCHFIELD	N.FT. MYERS	1	1	2	0	0	0	0	0.00	0.00	0	0	0	0	0	0
HILLTOP FARMS	LAWLER WELLS	AVON PARK	165	496	661		4531	4512	3378	6.81	0.75	0	0	0	0	156	0
HOWELL ALLIGATOR FARM	JOHN HOWELL	DOVER	17	52	69		326	242	130	2.50	0.40	218	198	0	0	155	46
HUNTS ALLIGATOR GR	CLYDE HUNT	BUSHNELL	131	203	334		1877	1410	1052	5.18	0.56	219	105	0	0	117	284
JIM GAME FARM	JAMES POSEY	PALMDALE	32	45	77		364	200	75	1.67	0.21	0	0	0	0	0	0
JUG GATOR FARM	NADINE POSEY	PALMDALE	76	76	152	0	0	0	0	0.00	0.00	0	0	0	0	117	50
KACKLEY GATOR FARM	STEVE KACKLEY	SEBRING	33	76	109	0	0	0	0	0.00	0.00	0	0	0	0	0	0
LIMESTONE FARMS	LARRY HOWELL	ARCADIA	22	18	40		340	42	0	0.00	0.00	0	0	0	0	0	0
MURPHY FERNERY	SHELDON MURPHY	DELAND	0	0	0	0	0	0	0			0	0	0	0	0	0
NELSON AND BUSBY	RON NELSON	INVERNESS	32	33	65		468	468	408	12.36	0.87	0	0	0	0	0	0
N A OSTRICH	GARY LEVINE	LIVE OAK	0	0	0	0	0	0	0			0	0	0	0	0	0
PARKER ISLAND GATOR	WILLIAM TILLMAN	LAKE PLACID	0	0	0	0	0	0	0			0	0	0	0	156	185
PELLA'S GATOR FARM 1	EUGENE PELLA	SEBRING	191	414	605		990	288	204	0.49	0.21	0	0	0	0	0	0
PELLA'S GATOR FARM 2	EUGENE PELLA	SEBRING	0	0	0	0	0	0	0			214	179	0	0	160	650
PELTS AND SKINS	PETER BISGARD	LOUISIANA	0	0	0	0	0	0	0			0	0	0	0	0	0
RAYFIELD GROVES	JACK RAYFIELD	MERRITT ISLAND	12	30	42		656	233	148	4.93	0.23	0	0	0	0	0	0
RUSSELL GATOR FARM	TOMMY RUSSELL	OSTEEN	35	115	150		2140	1365	944	8.21	0.44	218	136	0	0	156	0
ST.AUGUSTINE ALL. FARM	MARK WISE	ST AUGUSTINE	230	128	358	0	0	0	0	0.00	0.00	0	0	0	0	0	0
WAYNE H BECK	WAYNE BECK	WEWAHITCHKA	25	75	100	0	0	0	0	0.00	0.00	0	0	0	0	155	0
SUBTOTAL			2564	3673	6232	2	29423	14411	5963	N/A	N/A	4272	3403	817	614	3954	4133
MEANS PER FARM			53	77	130	0	613	300	208	2.31	0.22	89	71	17	13	82	86
# OF FARMS			48	48	48	22	48	48	48	35	35	48	48	48	48	48	48

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ALLIGATOR FARM	OWNER	CITY	PRIVATE WET. HATCH COLL.	OUT OF STATE HATCHLING	GRAND TOTAL HATCHLINGS	REPORTED MORTALITY	LIVE GATORS ACQUIRED(+)	LIVE GATORS DISPOSED(-)	TOTAL GATORS	HIDES TAGGED	LBS MEAT PRODUCED	LBS MEAT SOLD
ARTHUR JONES ENTER.	KEN EARNEST	ANTHONY	0	0	612	11	1	0	1615	0	0	0
ASHLEY ASSOCIATES	DON ASHLEY	TALLAHASSEE	0	0	0	0	0	0	0	0	0	0
BABCOCK FLORIDA CO.	PETER ARNOLD	PUNTA GORDA	0	0	337	153	0	349	246	108	0	0
BILLY KEMPNER	BILLY KEMPNER	MELBOURNE	72	0	72	0	0	72	0	0	0	0
BEANY FARMS	JOE TILLMAN	LAKE PLACID	0	0	340	97	0	3571	2793	25	0	0
BUSCH GARDENS	RON REYNOLDS	TAMPA	0	0	9	3	40	1	97	0	0	0
CLABROOK FARMS	SHLOMI RANDT	CHRISTMAS	0	5000	6402	206	0	28	7667	1234	8674	8670
CLAUDE D.REESE JR	CLAUDE REESE	PALM BEACH	0	0	10	2	0	13	0	0	0	0
CYPRESS CREEK FARMS	SCOTT ANDERSON	STARKE	0	0	166	3	0	0	153	0	0	0
C.S.T. GATOR FARM	DON MORGAN	KEYSTONE HTS	0	0	654	3	157	186	2836	360	5120	5120
DAVID A EVANS	DAVID EVANS	OKEECHOBEE	0	0	170	0	0	170	0	0	0	0
DONALD NELSON FARMS	DONALD NELSON	BUSHNELL	0	0	417	79	0	0	739	0	0	0
DRENNAN CRAWFORD LEE	D.C. LEE	WILDWOOD	0	0	166	10	0	0	146	0	0	0
DUNNELLON GATOR FARM	ARCHIE SMITH	DUNNELLON	0	0	603	56	0	0	820	0	0	0
EVERGLADES TOURS INC.	JOHN HUDSON	HOMESTEAD	0	0	1025	41	13	13	2043	17	132	132
EVERGLADES WONDER GAR.	LESTER PIPER	BONITA SPRINGS	0	0	0	6	0	0	112	0	0	0
FLORIDA'S CYPRESS GAR.	ANDY KOUKOULIS	CYPRESS GAR.	0	0	0	2	0	0	47	0	0	0
FLYING P RANCH	G.D. PARROT	BUSHNELL	0	998	1549	71	998	4	3806	1429	10370	3075
FOSTER FARMS INC.	KEVIN FOSTER	OKEECHOBEE	0	641	2331	28	1382	1109	4870	18	0	0
FRANKS GATOR FARM	PATRICIA FRANKS	OSTEEN	0	0	0	0	0	0	24	0	0	0
FROEHLICH'S GATOR FARM	EDWIN FROEHLICH	CHRISTMAS	0	1400	1400	5	1737	60	4174	1716	18050	12388
GATOR ACRES, INC.	CRAIG LYCAN	GAINESVILLE	0	0	1110	31	0	0	3877	622	6668	6000
GATOR JAWS INC.	JAY WILDER	DELAND	0	0	394	33	466	0	730	130	2212	331
GATOR JUNGLE OF PLANT	TRACY HOWELL	DOVER	0	0	962	3	218	167	1266	72	2150	1845
GATORAMA	DAVID THIELEN	PALMDALE	0	0	626	36	53	225	1741	90	2727	1904
GATORLAND ZOO	FRANK GODWIN	ORLANDO	0	257	1094	372	0	9	3787	1041	8890	8890
GEIGER'S GATOR FARM	KEN GEIGER	SEBRING	0	0	1450	243	27	0	2063	67	644	624
GOMES GATOR FARM	FRANK GOMES	TAMPA	0	0	0	3	0	0	21	1	0	0
HERP HUT INC.	CHRIS McQUADE	FT. MYERS	0	0	0	2	4	2	0	0	0	0
HERPETOFAUNA	TOM CRUTCHFIELD	N.FT. MYERS	0	0	0	1	6	2	9	0	0	0
HILLTOP FARMS	LAWLER WELLS	AVON PARK	0	0	3534	34	0	1619	10122	116	734	734
HOWELL ALLIGATOR FARM	JOHN HOWELL	DOVER	0	0	523	226	149	22	967	0	0	0
HUNTS ALLIGATOR GR	CLYDE HUNT	BUSHNELL	0	0	1558	2	0	204	6331	475	4190	5409
J&M GAME FARM	JAMES POSEY	PALMDALE	0	0	75	4	0	136	244	3	240	198
J&M GATOR FARM	MAUDINE POSEY	PALMDALE	0	0	167	9	136	13	1285	19	207	207
KACKLEY GATOR FARM	STEVE KACKLEY	SEBRING	0	0	0	0	321	3	313	12	136	136
LIMESTONE FARMS	LARRY HOWELL	ARCADIA	0	0	0	0	0	26	62	0	0	0
MURPHY FERNERY	SHELDON MURPHY	DELAND	0	0	0	0	0	9	0	0	0	0
NELSON AND BUSBY	RON NELSON	INVERNESS	0	0	408	2	0	0	1024	0	0	0
N.A. OSTRICH	GARY LEVINE	LIVE OAK	0	0	0	0	0	0	0	0	0	0
PARKER ISLAND GATOR	WILLIAM TILLMAN	LAKE PLACID	0	0	348	92	3470	796	3295	0	0	0
PELLA'S GATOR FARM 1	EUGENE PELLA	SEBRING	0	0	204	42	1499	0	2013	0	0	0
PELLA'S GATOR FARM 2	EUGENE PELLA	SEBRING	0	0	983	63	204	0	1130	0	0	0
PELTS AND SKINS	PETER BISSARD	LOUSIANA	0	0	0	0	0	0	0	0	0	0
RAYFIELD GROVES	JACK RAYFIELD	MERRITT ISLAND	0	0	148	0	0	0	406	0	0	0
RUSSELL GATOR FARM	TOMMY RUSSELL	OSTEEN	0	0	1235	10	0	24	2675	0	0	0
ST.AUGUSTINE ALL.FARM	MARK WISE	ST. AUGUSTINE	0	0	0	4	13	10	374	0	0	0
WAYNE H. BECK	WAYNE BECK	MOOREHAVEN	0	0	156	2	100	0	254	0	0	0
SUBTOTAL			72	8236	30435	1990	10952	8841	75175	7529	71699	60773
MEANS PER FARM			2	173	634	41	228	184	1566	157	1481	1266
# OF FARMS			48	48	48	48	49	48	48	48	48	40

Appendix I (continued)

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ALLIGATOR FARM	OWNER	CITY	ADULT MALES	ADULT FEMALES	TOTAL BREEDERS	NUMBER OF NESTS	TOTAL EGGS	VIABLE EGGS	HATCHLINGS PRODUCED	HATCH PER ADULT FEM	HATCH RATES	PUBLIC WET. EGG COLL.	PUBLIC WET. HATCH RATE	PRIVATE WET. EGG COLL.	PRIVATE WET. HATCH RATE	FSP HATCHLINGS	PUBLIC WET. HATCH. COLL.
ARTHUR JONES ENTER.	KEN EARNEST	ANTHONY	100	100	200		1694	636	424	4.24	0.25					0	
BABCOCK FLORIDA CO.	PETER ARNOLD	PUNTA GORDA			0		0	0	0								
BONNY FARMS	JOE TILLMAN	LAKE PLACID	148	369	517		4061	2919	2072	5.62	0.51			869	590	301	
BUSCH GARDENS	RON REYNOLDS	TAMPA	7	8	15		0	0	0	0.00						0	
CLABROOK FARMS	SHLOMI RANOT	CHRISTMAS	67	199	266		1657	696	493	2.48	0.30					301	
C.S.T. GATOR FARM	DON MORGAN	KEYSTONE HTS	100	245	345		691	444	9	0.04	0.01					258	
DONALD NELSON FARMS	DONALD NELSON	BUSHNELL	19	56	75		631	269	121	2.16	0.19					301	
DUNNELLON GATOR FARM	ARCHIE SMITH	DUNNELLON	6	16	21		3	0	0	0.00	0.00					129	
EVERGLADES TOURS INC.	JOHN HUDSON	HOMESTEAD	25	46	71		102	46	0	0.00	0.00					301	
EVERGLADES WONDER GAR.	LESTER PIPER	BONITA SPRINGS	70	32	102		63	10	0	0.00	0.00					0	
FLORIDA'S CYPRESS GAR.	ANDY KOUKOULIS	CYPRESS GAR.			0												
FLYING P RANCH	G.O. PARROT	BUSHNELL	23	88	111		783	65	27	0.31	0.03					404	
FOSTER FARMS INC.	KEVIN FOSTER	OKEECHOBEE	64	160	224		1309	430	324	2.03	0.25					903	
FRANKS GATOR FARM	PATRICIA FRANKS	OSTEEN	0	0	0		0	0	0							0	
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS	0	0	0		0	0	0							0	
GATOR ACRES, INC.	CRAIG LYCAN	GAINESVILLE	31	88	119		1632	680	520	5.91	0.32					301	
GATOR JAWS INC.	JAY HILDEN	DELAND	2	4	6		0	0	0	0.00						0	
GATOR JUNGLE OF PLANT	TRACY HOWELL	DOVER	60	30	90		273	126	42	1.40	0.15					129	
GATORAMA	DAVID THIELEN	PALMDALE	100	134	234		511	259	176	1.31	0.34					0	
GATORLAND ZOO	FRANK GODWIN	ORLANDO	600	124	724		1079	159	99	0.80	0.09					301	
GEIGER'S GATOR FARM &	KEN GEIGER	SEBRING	87	175	262		2681	1600	671	3.83	0.25					0	
GOMES GATOR FARM	FRANK GOMES	TAMPA	3	5	8		136	49	18	2.00	0.07					0	
HERP HUT INC.	CHRIS McQUADE	FT. MYERS	0	0	0		0	0	0							0	
HERPETOFAUNA	TOM CRUTCHFIELD	N.FT. MYERS	0	1	1		0	0	0	0.00						0	
HILLTOP FARMS	LAWLER WELLS	AVON PARK	156	510	666		6747	4586	3140	6.16	0.47					0	
HOWELL ALLIGATOR FARM	JOHN HOWELL	DOVER	32	60	92		775	277	69	1.15	0.09					129	
HUNTS ALLIGATOR BR	CLYDE HUNT	BUSHNELL	146	238	384		2776	981	715	3.00	0.26					129	
JOEL SMITH ALL. FARM	JOEL SMITH	BELL	0	0	0		0	0	0							0	
J&M GAME FARM	JAMES POSEY	PALMDALE	38	47	85		912	300	221	4.70	0.24					172	
J&M GATOR FARM	MAUDINE POSEY	PALMDALE	91	80	171		29	28	26	0.33	0.90					172	
KACKLEY GATOR FARM	STEVE KACKLEY	SEBRING	52	64	116		935	363	305	4.77	0.33					0	
LIMESTONE FARMS	JOHN EVANS	ARCADIA	13	25	38		0	0	0	0.00						0	
MURPHY FERNERY	SHELDON MURPHY	DELAND	5	4	9		168	92	37	9.25	0.22					0	
NELSON AND BUSBY	RON NELSON	INVERNESS	25	26	61		489	435	379	14.58	0.78					0	
PARKER ISLAND GATOR	WILLIAM TILLMAN	LAKE PLACID	0	0	0		0	0	0							0	
PELLA'S GATOR FARM	EUGENE PELLA	SEBRING	50	150	200		0	0	0	0.00						0	
RAYFIELD GROVES	JACK RAYFIELD	MERRITT ISLAND	12	30	42		724	235	184	6.13	0.25					0	
RUSSELL GATOR FARM	TOMMY RUSSELL	O'STEEN	44	130	174		1822	981	671	5.16	0.37					172	
SEMINOLE CULTURAL CEN	LESLIE STEVENS	TAMPA	7	3	10		0	0	0	0.00						0	
ST. AUGUSTINE ALL.F.	MARK WISE	ST. AUGUSTINE	240	125	365		102	2	2	0.02	0.02					0	
SUBTOTAL		40	2423	3371	5794		32766	16666	10737	N/A	N/A			869	590	4403	
MEANS PER FARM			64	89	145		840	427	275	3.19	0.33					116	
# OF FARMS			38	38	40		39	39	39	33	27					38	

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ALLIGATOR FARM	OWNER	CITY	PRIVATE WET. HATCH COLL.	OUT OF STATE HATCHLING	TOTAL HATCH	REPORTED MORTALITY	LIVE GATORS ACQUIRED(+)	LIVE GATORS DISPOSED(-)	TOTAL GATORS	HIDES TAGGED	LBS MEAT PRODUCED	LBS MEAT SOLD
ARTHUR JONES ENTER.	KEN EARNEST	ANTHONY	0		424				1013	0	0	4
BABCOCK FLORIDA CO.	PETER ARNOLD	PUNTA GORDA	121		711			200	511			
BONNY FARMS	JOE TILLMAN	LAKE PLACID	0		2776				5286	63	0	0
BUSCH GARDENS	RON REYNOLDS	TAMPA	0		0				52	0	0	0
CLABROOK FARMS	SHLOMI RANDT	CHRISTMAS	0		1013				4060	1314	14315	2026
C.S.T. GATOR FARM	DON MORGAN	KEYSTONE HTS	0		267				2578	735	3270	475
DONALD NELSON FARMS	DONALD NELSON	BUSHNELL	0		422				401	0	0	0
DUNNELLON GATOR FARM	ARCHIE SMITH	DUNNELLON	0		226				299	0	0	0
EVERGLADES TOURS INC.	JOHN HUDSON	HOMESTEAD	0		752				1076	1	0	0
EVERGLADES WONDER GAR.	LESTER PIPER	BONITA SPRINGS	0		0				102	0	0	0
FLORIDA'S CYPRESS GAR.	ANDY KOUKOULIS	CYPRESS GAR.			0				43	1		
FLYING P RANCH	G.O. PARROT	BUSHNELL	200		998				2686	898	11696	9628
FOSTER FARMS INC.	KEVIN FOSTER	OKEECHOBEE	0		1344				2279	56	0	0
FRANKS GATOR FARM	PATRICIA FRANKS	OSTEEN	0		0				0	0	0	0
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS	0		0				2768	1449	18603	17564
GATOR ACRES, INC.	CRAIG LYCAN	GAINESVILLE	0		969				3412	130	1675	525
GATOR JAWS INC.	JAY WILDEN	DELAND	0		0				42	1	0	0
GATOR JUNGLE OF PLANT	TRACY HOWELL	DOVER	0		430				762	113	2594	1768
GATORAMA	DAVID THIELEN	PALMDALE	0		658				1412	7	0	0
GATORLAND ZOO	FRANK GODWIN	ORLANDO	0		715				4115	859	7104	8608
GEIGER'S GATOR FARM &	KEN GEIGER	SEBRING	0		784				927	3	0	0
GOMES GATOR FARM	FRANK GOMES	TAMPA	0		10				25	2	0	0
HERP HUT INC.	CHRIS McQUADE	FT. MYERS	0		0				0	0	0	0
HERPETOFAUNA	TOM CRUTCHFIELD	N.FT. MYERS	0		0				6	0	0	0
HILLTOP FARMS	LAWLER WELLS	AVON PARK	0		3140				8358	28	1125	3865
HOWELL ALLIGATOR FARM	JOHN HOWELL	DOVER	0		348				543	0	0	0
HUNTS ALLIGATOR BR	CLYDE HUNT	BUSHNELL	0		1108				4755	803	9522	8163
JOEL SMITH ALL. FARM	JOEL SMITH	BELL	0		0				0	0	0	4540
J&M GAME FARM	JAMES POSEY	PALMDALE	0		393				312	14	95	95
J&M GATOR FARM	MAXINE POSEY	PALMDALE	0		198				1025	0	0	460
KACKLEY GATOR FARM	STEVE KACKLEY	SEBRING	0		305				2276	0	0	0
LIMESTONE FARMS	JOHN EVANS	ARCADIA	0		0				86	2	0	0
MURPHY FERNERY	SHELDON MURPHY	DELAND	0		37				9	0	0	0
NELSON AND BUSBY	RON NELSON	INVERNESS	0		379				618	0	0	0
PARKER ISLAND GATOR	WILLIAM TILLMAN	LAKE PLACID	0		300				372	0	0	0
PELLA'S GATOR FARM	EUGENE PELLA	SEBRING	0		364				564	0	0	0
RAYFIELD GROVES	JACK RAYFIELD	MERRITT ISLAND	0		184				258	0	0	0
RUSSELL GATOR FARM	TOMMY RUSSELL	O'STEEN	0		904				1526	0	0	0
SEMINOLE CULTURAL CEN	LESLIE STEVENS	TAMPA	0		25				46	0	0	0
ST AUGUSTINE ALL.F.	MARK WISE	ST. AUGUSTINE	0		2				375	0	0	0
SUBTOTAL		40	321		20266				54974	6479	69937	57740
MEANS PER FARM			8		507				1374	166	1842	1519
# OF FARMS			39		40				40	39	38	33

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ALLIGATOR FARM	OWNER	CITY	ADULT MALES	ADULT FEMALES	TOTAL BREEDERS	NUMBER OF NESTS	TOTAL EGGS	VIABLE EGGS	HATCHLINGS PRODUCED	HATCH PER ADULT FEM	HATCH RATES	PUBLIC WET. EGG COLL.	PUBLIC WET. HATCH RATE	PRIVATE WET. EGG COLL.	PRIVATE WET. HATCH RATE	FSP HATCHLINGS	PUBLIC WET. HATCH. COLL.
ARTHUR JONES ENTER	ARTHUR JONES	OCALA	130	90	220		1147	1147	332	3.69	0.29					0	
BONNY FARMS	JOE TILLMAN	LAKE PLACID	26	105	131		1269	1219	539	5.13	0.42					1116	
CIRCLE G GATOR RANCH	JOHN GALVIN	BUSHNELL	0	0	0		0	0	0							0	
C.S.T. GATOR FARM	MORGAN/EDGERTON	KEYSTONE HTS.	70	156	226		1600	1489	150	0.96	0.09					0	
CLAYBROOK FARMS	SHLOMI RANDT	CHRISTMAS	70	200	270		1511	1172	524	2.62	0.35					583	
DONALD NELSON FARMS	DONALD NELSON	BUSHNELL	19	56	75		0	0	0	0.00						0	
DUNNELLON GATOR FARM	ARCHIE SMITH	DUNNELLON	0	0	0		0	0	0							0	
EVERGLADES TOURS INC.	JOHN HUDSON	HOMESTEAD	6	14	20		0	0	0	0.00						0	
EXOTIC BREEDERS	RON NELSON	INVERNESS	45	100	145	5	139	139	136	1.36	0.98					0	
GATOR JUNGLE(PLANT CITY)	TRACY HOWELL	DOVER	25	24	49		552	552	74	3.08	0.13					0	
GATORAMA	DAVID THIELEN	PALMDALE	100	200	300		0	0	0	0.00						0	
GATORLAND ZOO	FRANK GODWIN	KISSIMMEE	502	263	765		889	485	220	0.84	0.25					582	
GIGERS GATOR FARM	KEN GIGER	AVON PARK	70	130	200		2818	2818	410	3.15	0.15					0	
GOMES GATOR FARM	FRANK GOMES	RIVERVIEW	10	9	19		20	0	0	0.00	0.00					0	
HOWELL ALLIGATOR FARM	JOHN HOWELL	PLANT CITY	12	23	35		0	0	0	0.00						0	
HUNTS ALLIGATOR BRS	CLYDE HUNT	BUSHNELL	146	238	384		1935	1935	438	1.84	0.23					0	
FOSTER FARMS INC.	KEVIN FOSTER	OKEECHOBEE	0	0	0		0	0	0							0	
FLYING P RANCH	G.O. PARROTT	BUSHNELL	55	169	224		1337	1337	469	2.78	0.35					579	
FROELICHS GATOR FARM	EDWIN FROELICH	CHRISTMAS	0	0	0		0	0	0							0	
J&M GAME FARM	JAMES POSEY	PALMDALE	29	37	66		579	544	375	10.14	0.65					0	
J&M GATOR FARM	JAMES POSEY	PALMDALE	0	0	0		0	0	0							0	
KACKLEY GATOR FARM	STEVE KACKLEY	SEBRING	52	64	116		1054	814	307	4.80	0.29					0	
LIMESTONE FARMS	EVANS/DAVIS	BRANDON	13	25	38		0	0	0	0.00						0	
LYCANS GATOR FARM	CRAIG LYCAN	GAINESVILLE	27	83	110		1151	1151	76	0.92	0.07					0	
MURPHYS FERNERY	SHELDON MURPHY	DELEON SPGS	5	10	15		0	0	0	0.00						0	
PELLAS GATOR FARM	EDWARD PELLA	SEBRING	0	0	0		0	0	0							0	
RAYFIELD GROVES	JACK RAYFIELD	MERRITT ISL.	15	27	42	7	199	110	31	1.15	0.16					0	
RUSSEL GATOR FARM	TOMMY RUSSEL	SANFORD	17	50	67	14	598	568	278	5.56	0.46					0	
HILLTOP FARMS	LAWLER WELLS	AVON PARK	131	370	501		6560	6560	2153	5.82	0.33					1165	
SMITHS GATOR FARM	JOEL SMITH	BELL	185	356	541		3014	3014	577	1.62	0.19					0	
SUBTOTAL		30	1760	2799	4559	26	26372	25053	7089	N/A	N/A	0	0	0	0	4025	0
MEANS PER FARM			59	93	152	9	879	835	236	2.53	0.27	ERR	ERR	ERR	ERR	134	ERR
# OF FARMS			30	30	30	3	30	30	30	24	18	0	0	0	0	30	0

Appendix I (continued)

1986 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	PRIVATE WET. HATCH COLL.	CONS/HAR HATCHLING	TOTAL HATCH	REPORTED MORTALITY	LIVE GATORS ACQUIRED(+)	LIVE GATORS DISPOSED(-)	TOTAL GATORS	HIDES TAGGED	LBS MEAT PRODUCED	LBS MEAT SOLD
ARTHUR JONES ENTER	ARTHUR JONES	OCALA			332				599	0	0	0
SONNY FARMS	JOE TILLMAN	LAKE PLACID			1655				3303	704	270	270
CIRCLE G GATOR RANCH	JOHN GALVIN	BUSHNELL			0				0	1	155	155
C.S.T. GATOR FARM	MORGAN/EDGERTON	KEYSTONE HTS.			150				3084	204	1665	255
CLAYBROOK FARMS	SHLOMI RANDT	CHRISTMAS			1107				4923	147	2950	165
DONALD NELSON FARMS	DONALD NELSON	BUSHNELL			0				75	0	0	0
DUNNELLON GATOR FARM	ARCHIE SMITH	DUNNELLON			0				99	0	0	0
EVERG/'DES TOURS INC.	JOHN HUDSON	HOMESTEAD			0				122	0	0	0
EXOTIC BREEDERS	RON NELSON	INVERNESS			136				281	0	0	0
GATOR JUNGLE(PLANT CITY)	TRACY HOWELL	DOVER			74				511	72	3543	2461
GATORAMA	DAVID THIELEN	PALMDALE			0				925	0	0	0
GATORLAND ZOO	FRANK GODWIN	KISSIMMEE			802				4457	686	9225	6323
GIGERS GATOR FARM	KEN GIGER	AVON PARK			410				258	0	0	0
GOMES GATOR FARM	FRANK GOMES	RIVERVIEW			0				27	10	0	0
HOWELL ALLIGATOR FARM	JOHN HOWELL	PLANT CITY			0				140	0	0	0
HUNTS ALLIGATOR BRS	CLYDE HUNT	BUSHNELL			438				4530	454	10488	4132
FOSTER FARMS INC.	KEVIN FOSTER	OKEECHOBEE			0				0	0	0	0
FLYING P RANCH	G.O. PARROTT	BUSHNELL	94		1142				2624	183	1975	775
FROELICHS GATOR FARM	EDWIN FROELICH	CHRISTMAS			0				3360	452	6190	5490
J&M GAME FARM	JAMES POSEY	PALMDALE			375				177	7	85	95
J&M GATOR FARM	JAMES POSEY	PALMDALE			0				697	0	0	0
KACKLEY GATOR FARM	STEVE KACKLEY	SEBRING			307				1978	0	0	0
LIMESTONE FARMS	EVANS/DAVIS	BRANDON			0				88	0	0	0
LYCANS GATOR FARM	CRAIG LYCAN	GAINESVILLE			76				2894	10	0	0
MURPHYS FERNERY	SHELDON MURPHY	DELEON SPGS			0				15	0	0	0
PELLAS GATOR FARM	EDWARD PELLA	SEBRING			0				200	0	0	0
RAYFIELD GROVES	JACK RAYFIELD	MERRITT ISL.			31				79	0	0	0
RUSSEL GATOR FARM	TOMMY RUSSEL	SANFORD			278				400	0	0	0
HILLTOP FARMS	LAWLER WELLS	AVON PARK			3318				6348	780	17481	10614
SMITHS GATOR FARM	JOEL SMITH	BELL			577				25	211	4080	12059
SUBTOTAL		30	94	0	11208	0	0	0	42219	3921	58107	42803
MEANS PER FARM			94	ERR	374	ERR	ERR	ERR	1407	131	1937	1427
# OF FARMS			1	0	30	0	0	0	30	30	30	30

Appendix I (continued)

1985 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	ADULT MALES	ADULT FEMALES	TOTAL BREEDERS	NUMBER OF NESTS	TOTAL EGGS	VIABLE EGGS	HATCHLINGS PRODUCED	HATCH PER ADULT FEM	HATCH RATES	PUBLIC WET. EGG COLL.	PUBLIC WET. HATCH RATE	PRIVATE WET. EGG COLL.	PRIVATE WET. HATCH RATE	FSP HATCHLINGS	PUBLIC WET. HATCH. COLL.
BONNY FARMS	JOE TILLMAN	LAKE PLACID	26	105	131		410	410	21	0.20	0.05					863	
CIRCLE G GATOR RANCH	JOHN GALVIN	BUSHNELL	10	19	29		142	0	0	0.00	0.00					0	
DONALD NELSON FARMS	DONALD NELSON	BUSHNELL	0	0	0		0	0	0							0	
C.S.T. GATOR FARM	MORGAN/EDGERTON	KEYSTONE HTS.	72	158	230		441	441	47	0.30	0.11					900	
EVERGLADES TOURS INC.	JOHN HUDSON	HOMESTEAD	6	14	20		0	0	0	0.00						0	
GATOR JUNGLE	HERMAN BROOKS	CHRISTMAS	220	210	430		1058	1019	138	0.66	0.13					500	
GATOR JUNGLE(PLANT CITY)	TRACY HOWELL	DOVER	25	25	50		641	541	71	2.84	0.11					0	
GATORLAND ZOO	FRANK GODWIN	KISSIMMEE	500	263	763		829	268	184	0.70	0.22					816	
GIGERS GATOR FARM	KEN GIGER	AVON PARK	70	130	200		462	462	119	0.92	0.26					0	
GOMES GATOR FARM	FRANK GOMES	RIVERVIEW	6	9	15		0	0	0	0.00						0	
HOWELL ALLIGATOR FARM	JOHN HOWELL	PLANT CITY	12	23	35		0	0	0	0.00						0	
HUNTS ALLIGATOR BRS	CLYDE HUNT	BUSHNELL	118	178	296		2114	2020	942	5.29	0.45					0	
FOSTER FARMS INC.	KEVIN FOSTER	OKEECHOBEE	0	0	0		0	0	0							0	
FLYING P RANCH	G.O. PARROTT	BUSHNELL	55	169	224		1751	1267	574	3.40	0.33					0	
FROELICHS GATOR FARM	EDWIN FROELICH	CHRISTMAS	0	0	0		0	0	0							334	
J&M GAME FARM	JAMES POSEY	PALMDALE	4	12	16		350	310	143	11.92	0.41					0	
J&M GATOR FARM	JAMES POSEY	PALMDALE	0	0	0		0	0	0							0	
KACKLEY GATOR FARM	STEVE KACKLEY	SEBRING	52	64	116		1377	1207	660	10.31	0.48					0	
LIMESTONE FARMS	EVANS/DAVIS	BRANDON	0	0	0		0	0	0							0	
LYCANS GATOR FARM	CRAIG LYCAN	GAINESVILLE	27	83	110		615	615	66	0.80	0.11					0	
MURPHYS FERNERY	SHELDON MURPHY	DELEON SPGS	5	10	15		0	0	0							0	
PELLAS GATOR FARM	EDWARD PELLA	SEBRING	0	0	0		0	0	0							0	
RAYFIELD GROVES	JACK RAYFIELD	MERRITT ISL.	19	60	79		0	0	0							0	
RUSSEL GATOR FARM	TOMMY RUSSEL	SANFORD	8	24	32		0	0	0							0	
HILLTOP FARMS	LAWLER WELLS	AVON PARK	146	285	431		4208	4208	1115	3.91	0.26					0	
SMITHS GATOR FARM	JOEL SMITH	BELL	185	356	541		625	625	192	0.54	0.31					0	
SUBTOTAL		26	1566	2197	3763	0	15023	13393	4272	N/A	N/A	0	0	0	0	3413	0
MEANS PER FARM			60	85	145	ERR	578	515	164	1.94	0.28	ERR	ERR	ERR	ERR	131	ERR
# OF FARMS			26	26	26	0	26	26	26	17	14	0	0	0	0	26	0

Appendix I (continued)

1985 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	PRIVATE WET. HATCH COLL.	CONS/HAR HATCHLING	TOTAL HATCH	REPORTED MORTALITY	LIVE GATORS ACQUIRED(+)	LIVE GATORS DISPOSED(-)	TOTAL GATORS	HIDES TAGGED	LBS MEAT PRODUCED	LBS MEAT SOLD
BONNY FARMS	JOE TILLMAN	LAKE PLACID			884				2435	0	0	0
CIRCLE G GATOR RANCH	JOHN GALVIN	BUSHNELL			0				29	0	0	0
DONALD NELSON FARMS	DONALD NELSON	BUSHNELL			0				0	0	0	0
C.S.T. GATOR FARM	MORGAN/EDGERTON	KEYSTONE HTS.			947				3175	175	1929	1065
EVERGLADES TOURS INC.	JOHN HUDSON	HOMESTEAD			0				20	0	0	0
GATOR JUNGLE	HERMAN BROOKS	CHRISTMAS			638				4370	13	200	185
GATOR JUNGLE(PLANT CITY)	TRACY HOWELL	DOVER			71				463	37	1506	675
GATORLAND ZOO	FRANK GODWIN	KISSIMMEE			1000				5014	106	2134	1150
GIGERS GATOR FARM	KEN GIGER	AVON PARK			119				262	0	0	0
GOMES GATOR FARM	FRANK GOMES	RIVERVIEW			0				38	2	0	0
HOWELL ALLIGATOR FARM	JOHN HOWELL	PLANT CITY			0				186	0	0	0
HUNTS ALLIGATOR GRS	CLYDE HUNT	BUSHNELL			942				4515	427	10056	4277
FOSTER FARMS INC.	KEVIN FOSTER	OKEECHOBEE			0				0	0	0	0
FLYING P RANCH	G.O. PARROTT	BUSHNELL			908				2144	7	0	0
FROELICHS GATOR FARM	EDWIN FROELICH	CHRISTMAS			0				4028	133	2335	115
J&M GAME FARM	JAMES POSEY	PALMDALE			143				366	2	102	50
J&M GATOR FARM	JAMES POSEY	PALMDALE			0				140	0	0	0
KACKLEY GATOR FARM	STEVE KACKLEY	SEBRING			660				1715	0	0	0
LIMESTONE FARMS	EVANS/DAVIS	BRANDON			0				121	0	0	0
LYCANS GATOR FARM	CRAIG LYCAN	GAINESVILLE			66				1163	1	0	0
MURPHYS FERNERY	SHELDON MURPHY	DELEON SPGS			0				15	0	0	0
PELLAS GATOR FARM	EDWARD PELLA	SEBRING			0				200	0	0	0
RAYFIELD GROVES	JACK RAYFIELD	MERRITT ISL.			0				79	0	0	0
RUSSEL GATOR FARM	TOMMY RUSSEL	SANFORD			0				32	0	0	0
HILLTOP FARMS	LAWLER WELLS	AVON PARK			1115				3832	32	1150	250
SMITHS GATOR FARM	JOEL SMITH	BELL			192				2896	404	8550	11196
SUBTOTAL		26	0	0	7685	0	0	0	37238	1339	27962	18963
MEANS PER FARM			ERR	ERR	296	ERR	ERR	ERR	1432	52	1075	729
# OF FARMS			0	0	26	0	0	0	26	26	26	26

Appendix I (continued)

1984 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	ADULT MALES	ADULT FEMALES	TOTAL BREEDERS	NUMBER OF NESTS	TOTAL EGGS	VIABLE EGGS	HATCHLINGS PRODUCED	HATCH PER ADULT FEM	HATCH RATES	PUBLIC WET. EGG COLL.	PUBLIC WET. HATCH RATE	PRIVATE WET. EGG COLL.	PRIVATE WET. HATCH RATE	FSP HATCHLINGS	PUBLIC WET. HATCH. COLL.
BONNY FARMS	JOE TILLMAN	LAKE PLACID	12	22	34	16	410	410	213	9.68	0.52					879	
CIRCLE G GATOR RANCH	JOHN GALVIN	BUSHNELL	10	20	30		128	128	0	0.00	0.00						
C.S.T. GATOR FARM	MORGAN/EDGERTON	KEYSTONE HTS.	72	159	231		1105	1105	122	0.77	0.11					506	
GATOR JUNGLE	HERMAN BROOKS	CHRISTMAS	240	240	480		726	657	147	0.61	0.20					500	
GATOR JUNGLE(PLANT CITY)	TRACY HOWELL	DOVER	25	24	49		101	101	56	2.33	0.55					0	
GATORLAND ZOO	FRANK GODWIN	KISSIMMEE	350	350	700		1074	325	238	0.68	0.22					788	
GIGERS GATOR FARM	KEN GIGER	AVON PARK	25	50	75		34	34	0	0.00	0.00					0	
GOMES GATOR FARM	FRANK GOMES	RIVERVIEW	6	9	15		26	26	0	0.00	0.00					0	
HOWELL ALLIGATOR FARM	JOHN HOWELL	PLANT CITY	12	23	35		0	0	0	0.00						0	
HUNTS ALLIGATOR BRS	CLYDE HUNT	BUSHNELL	120	178	298			2121	717	4.03						0	
FLYING P RANCH	G.O. PARROTT	BUSHNELL	19	51	70		1092	1092	292	5.73	0.27					544	
FROELICHS GATOR FARM	EDWIN FROELICH	CHRISTMAS	0	0	0		0	0	0							0	
J&M GAME FARM	JAMES POSEY	PALMDALE	4	7	11		277	277	224	32.00	0.81					0	
KACKLEY GATOR FARM	STEVE KACKLEY	SEBRING	53	64	117	41	1145	1145	666	10.41	0.58					0	
LIMESTONE FARMS	EVANS/DAVIS	BRANDON	0	0	0		0	0	0							0	
LYCANS GATOR FARM	CRAIG LYCAN	GAINESVILLE	27	83	110		0	0	0	0.00						0	
PELLAS GATOR FARM	EDWARD PELLA	SEBRING	0	0	0		0	0	0							0	
SWAMPY FARMS	LAWLER WELLS	AVON PARK	100	295	395	31	1066	736	377	1.28	0.35					36	
SMITHS GATOR FARM	JOEL SMITH	BELL	158	498	656		2777	2777	1023	2.05	0.37					0	
SUBTOTAL		19	1233	2073	3306	88	9961	10934	4075	N/A	N/A	0	0	0	0	3253	0
MEANS PER FARM			65	109	174	29	553	575	214	1.97	0.41	ERR	ERR	ERR	ERR	181	ERR
# OF FARMS			19	19	19	3	18	19	19	16	13	0	0	0	0	18	0

Appendix I (continued)

1984 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	PRIVATE WET. HATCH COLL.	CONS/HAR HATCHLING	TOTAL HATCH	REPORTED MORTALITY	LIVE GATORS ACQUIRED(+)	LIVE GATORS DISPOSED(-)	TOTAL GATORS	HIDES TAGGED	LBS MEAT PRODUCED	LBS MEAT SOLD
BONNY FARMS	JOE TILLMAN	LAKE PLACID			1092				1581	0		
CIRCLE 6 GATOR RANCH	JOHN GALVIN	BUSHNELL			0				59	0		
C.S.T. GATOR FARM	MORGAN/EDGERTON	KEYSTONE HTS.			628				2406	42		
GATOR JUNGLE	HERMAN BROOKS	CHRISTMAS			647				3947	0		
GATOR JUNGLE(PLANT CITY)	TRACY HOWELL	DOVER			56				365	0		
GATORLAND ZOO	FRANK GODWIN	KISSIMMEE			1026				4181	78		
GIGERS GATOR FARM	KEN GIGER	AVON PARK			0				200	0		
GOMES GATOR FARM	FRANK GOMES	RIVERVIEW			0				53	0		
HOWELL ALLIGATOR FARM	JOHN HOWELL	PLANT CITY			0				158	0		
HUNTS ALLIGATOR BRS	CLYDE HUNT	BUSHNELL			717				4026	78		
FLYING P RANCH	G.O. PARROTT	BUSHNELL			836				1526	0		
FROELICHS GATOR FARM	EDWIN FROELICH	CHRISTMAS			0				3845	0		
JIM GAME FARM	JAMES POSEY	PALMDALE			224				367	0		
KACKLEY GATOR FARM	STEVE KACKLEY	SEBRING			666				1076	0		
LIMESTONE FARMS	EVANS/DAVIS	BRANDON			0				124	0		
LYCANS GATOR FARM	CRAIG LYCAN	GAINESVILLE			0				110	0		
PELLAS GATOR FARM	EDWARD PELLA	SEBRING			0				200	0		
SWAMPY FARMS	LAWLER WELLS	AVON PARK			413				2689	0		
SMITHS GATOR FARM	JOEL SMITH	BELL			1023				4282	540		
SUBTOTAL		19	0	0	7328	0	0	0	31195	738	0	0
MEANS PER FARM			ERR	ERR	386	ERR	ERR	ERR	1642	39	ERR	ERR
# OF FARMS			0	0	19	0	0	0	19	19	0	0

Appendix I (continued)

1983 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	ADULT MALES	ADULT FEMALES	TOTAL BREEDERS	NUMBER OF NESTS	TOTAL EGGS	VIABLE EGGS	HATCHLINGS PRODUCED	HATCH PER ADULT FEM	HATCH RATES	PUBLIC WET. EGG COLL.	PUBLIC WET. HATCH RATE	PRIVATE WET. EGG COLL.	PRIVATE WET. HATCH RATE	FSP. HATCHLINGS	PUBLIC WET. HATCH. COLL.
HUNTS ALLIGATOR FARM	CLYDE HUNT	BUSHNELL	118	178	296	65	2545		768	4.31	0.30						
FLYING P RANCH	G.O. PARROT	BUSHNELL	19	51	70	8	299		114	2.24	0.38						
C.S.T. GATOR FARM	DON MORGAN	KEYSTONE HTS.	72	157	229	13	205		1	0.01	0.00					561	
JOEL SMITH ALL. FARM	JOEL SMITH	BELL	158	494	652	57	2104		670	1.36	0.32					1084	
FROELICHS GATOR FARM	EDWIN FROELICH	CHRISTMAS	68	122	190	46	1389		1053	8.63	0.76						
GATORLAND ZOO	FRANK GODWIN	ORLANDO	350	350	700	47	1241		55	0.16	0.04						
CLAYBROOK FARMS	SHLOMI RANOT	CHRISTMAS	240	240	480	21	840		191	0.80	0.23					952	
J&M GAME FARM	JAMES POSEY	PALMDALE	5	10	15	2	70		58	5.80	0.83					216	
GEIGERS GATOR FARM	KEN GIGER	SEBRING	0	0	0	0	0		0								
PARKER ISLAND GATOR	WILLIAM TILLMAN	LAKE PLACID	12	22	34	9	264		144	6.55	0.55						
HILLTOP FARMS	LAWLER WELLS	AVON PARK	0	0	0	0	0		0							175	
KACKLEY GATOR FARM	STEVE KACKLEY	SEBRING	64	53	117	19	613		307	5.79	0.50						
CIRCLE G GATOR RANCH	JOHN GALVIN	BUSHNELL	10	20	30	4	105		66	3.30	0.63						
SUBTOTAL		13	1116	1697	2813	291	9675		3427	N/A	N/A					2988	
MEANS PER FARM			86	131	216	22	744		264	2.02	0.35					598	
# OF FARMS			13	13	13	13	13		13	11	11					5	

Appendix I (continued)

1983 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	PRIVATE WET. HATCH COLL.	CONS/HAR HATCHLING	TOTAL HATCH	REPORTED MORTALITY	LIVE GATORS ACQUIRED(+)	LIVE GATORS DISPOSED(-)	TOTAL GATORS	HIDES TAGGED	LBS MEAT PRODUCED	LBS MEAT SOLD
HUNTS ALLIGATOR FARM	CLYDE HUNT	BUSHNELL							3635	66		
FLYING P RANCH	G.O. PARROT	BUSHNELL										
C.S.T. GATOR FARM	DON MORGAN	KEYSTONE HTS.				533	154					
JOEL SMITH ALL. FARM	JOEL SMITH	BELL				164		1		118		
FROELICHS GATOR FARM	EDWIN FROELICH	CHRISTMAS						1059	6743	0		
GATORLAND ZOO	FRANK GODWIN	ORLANDO										
CLAYBROOK FARMS	SHLOMI RANOT	CHRISTMAS				22						
J&M GAME FARM	JAMES POSEY	PALMDALE							143			
GEIGERS GATOR FARM	KEN GIGER	SEBRING							50			
PARKER ISLAND GATOR	WILLIAM TILLMAN	LAKE PLACID					79		538			
HILLTOP FARMS	LAWLER WELLS	AVON PARK					1024		1404			
KACKLEY GATOR FARM	STEVE KACKLEY	SEBRING										
CIRCLE 6 GATOR RANCH	JOHN GALVIN	BUSHNELL										
SUBTOTAL			13			719	1257	1060	12513	184	0	
MEANS PER FARM						240	419	530	2086	61	ERR	
# OF FARMS						3	3	2	6	3	0	

Appendix I (continued)

1981 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	ADULT MALES	ADULT FEMALES	TOTAL BREEDERS	NUMBER OF NESTS	TOTAL EGGS	VIABLE EGGS	HATCHLINGS PRODUCED	HATCH PER ADULT FEM	HATCH RATES	PUBLIC WET. EGG COLL.	PUBLIC WET. HATCH RATE	PRIVATE WET. EGG COLL.	PRIVATE WET. HATCH RATE	FSP HATCHLINGS	PUBLIC WET. HATCH. COLL.
HUNTS ALLIGATOR BR	CLYDE HUNT	BUSHNELL	120	178	298	48	1773		854	4.80	0.48						
C.S.T. GATOR FARM	DON MORGAN	KEYSTONE HTS	78	160	238	1	4		0	0.00	0.00						
JOEL SMITH ALL FARM	JOEL SMITH	BELL	97	340	437	23	827		549	1.61	0.66					1031	
FROELICHS GATOR FARM	EDWIN FROELICH	CHRISTMAS															
CLAYBROOK FARMS	SHLOMI RANOT	CHRISTMAS															
PARKER ISLAND GATOR	WILLIAM TILLMAN	LAKE PLACID															
SUBTOTAL		6	295	678	973	72	2604	0	1403	N/A	N/A	0	0	0	0	1031	0
MEANS PER FARM			98	226	324	24	868	ERR	468	2.07	0.54	ERR	ERR	ERR	ERR	1031	ERR
# OF FARMS			3	3	3	3	3	0	3	3	3	0	0	0	0	1	0

1982 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	ADULT MALES	ADULT FEMALES	TOTAL BREEDERS	NUMBER OF NESTS	TOTAL EGGS	VIABLE EGGS	HATCHLINGS PRODUCED	HATCH PER ADULT FEM	HATCH RATES	PUBLIC WET. EGG COLL.	PUBLIC WET. HATCH RATE	PRIVATE WET. EGG COLL.	PRIVATE WET. HATCH RATE	FSP HATCHLINGS	PUBLIC WET. HATCH. COLL.
HUNTS ALLIGATOR FARM	CLYDE HUNT	BUSHNELL	120	178	298	34	1381		372	2.09	0.27						
FLYING P RANCH	G.O. PARROT	BUSHNELL	19	51	70	0	0		0								
C.S.T. GATOR FARM	DON MORGAN	KEYSTONE HTS.	72	157	229	9	178		5	0.03	0.03						
JOEL SMITH ALL. FARM	JOEL SMITH	BELL	159	496	655	42	1538		461	0.93	0.30					745	
FROELICHS GATOR FARM	EDWIN FROELICH	CHRISTMAS	32	120	152	45	1664		1033	8.61	0.62						
CLAYBROOK FARMS	SHLOMI RANOT	CHRISTMAS															
J&M GAME FARM	JAMES POSEY	PALMDALE	5	10	15	0	0		0								
PARKER ISLAND GATOR	WILLIAM TILLMAN	LAKE PLACID															
HILLTOP FARMS	LAWLER WELLS	AVON PARK															
CIRCLE G GATOR RANCH	JOHN GALVIN	BUSHNELL	10	20	30												
SUBTOTAL		10	417	1032	1449	130	4761		1871	N/A	N/A					745	
MEANS PER FARM			60	147	207	22	794		312	1.81	0.39					745	
# OF FARMS			7	7	7	6	6		6	4	4					1	

Appendix I (continued)

1981 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	PRIVATE WET. HATCH COLL.	CONS/HAR HATCHLING	TOTAL HATCH	REPORTED MORTALITY	LIVE GATORS ACQUIRED(+)	LIVE GATORS DISPOSED(-)	TOTAL GATORS	HIDES TAGGED	LBS MEAT PRODUCED	LBS MEAT SOLD
HUNTS ALLIGATOR BR	CLYDE HUNT	BUSHNELL			854		0			30		
C.S.T. GATOR FARM	DON MORGAN	KEYSTONE HTS			0			72				
JOEL SMITH ALL FARM	JOEL SMITH	BELL			549	43	800		3282	254		
FROELICHS GATOR FARM	EDWIN FROELICH	CHRISTMAS										
CLAYBROOK FARMS	SHLOMI RANOT	CHRISTMAS										
PARKER ISLAND GATOR	WILLIAM TILLMAN	LAKE PLACID							131			
SUBTOTAL		6	0	0	1403	43	800	72	3413	284	0	
MEANS PER FARM			ERR	ERR	468	43	400	72	1707	142	ERR	
# OF FARMS			0	0	3	1	2	1	2	2	0	

1982 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	PRIVATE WET. HATCH COLL.	CONS/HAR HATCHLING	TOTAL HATCH	REPORTED MORTALITY	LIVE GATORS ACQUIRED(+)	LIVE GATORS DISPOSED(-)	TOTAL GATORS	HIDES TAGGED	LBS MEAT PRODUCED	LBS MEAT SOLD
HUNTS ALLIGATOR FARM	CLYDE HUNT	BUSHNELL						1100		0		
FLYING P RANCH	G.O. PARROT	BUSHNELL					70		70			
C.S.T. GATOR FARM	DON MORGAN	KEYSTONE HTS.				409						
JOEL SMITH ALL. FARM	JOEL SMITH	BELL				197			3401	53		
FROELICHS GATOR FARM	EDWIN FROELICH	CHRISTMAS							6802	191		
CLAYBROOK FARMS	SHLOMI RANOT	CHRISTMAS										
J&M GAME FARM	JAMES FOSEY	PALMDALE					0					
PARKER ISLAND GATOR	WILLIAM TILLMAN	LAKE PLACID							131			
HILLTOP FARMS	LAWLER WELLS	AVON PARK							404			
CIRCLE 6 GATOR RANCH	JOHN GALVIN	BUSHNELL							30			
SUBTOTAL		10				606	70	1100	10638	244	0	
MEANS PER FARM						303	35	1100	1806	81	ERR	
# OF FARMS						2	2	1	6	3	0	

Appendix I (continued)

1979 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	ADULT MALES	ADULT FEMALES	TOTAL BREEDERS	NUMBER OF NESTS	TOTAL EGGS	VIABLE EGGS	HATCHLINGS PRODUCED	HATCH PER ADULT FEM	HATCH RATES	PUBLIC WET. EGG COLL.	PUBLIC WET. HATCH RATE	PRIVATE WET. EGG COLL.	PRIVATE WET. HATCH RATE	FSP HATCHLINGS	PUBLIC WET. HATCH. COLL.
HUNTS ALLIGATOR BR	CLYDE HUNT	BUSHNELL															
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS	50	100	150	35	1145		850	8.50	0.74						
CLABROOK FARMS	SHLOMI RANOT	CHRISTMAS	90	90	180	16	500		142	1.58	0.28						
JOEL SMITH ALL. FARM	JOEL SMITH	BELL															
SUBTOTAL		4	140	190	330	51	1645	0	992	N/A	N/A	0	0	0	0	0	0
MEANS PER FARM			70	95	165	26	823	ERR	496	5.22	0.60	ERR	ERR	ERR	ERR	ERR	ERR
# OF FARMS			2	2	2	2	2	0	2	2	2	0	0	0	0	0	0

1980 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	ADULT MALES	ADULT FEMALES	TOTAL BREEDERS	NUMBER OF NESTS	TOTAL EGGS	VIABLE EGGS	HATCHLINGS PRODUCED	HATCH PER ADULT FEM	HATCH RATES	PUBLIC WET. EGG COLL.	PUBLIC WET. HATCH RATE	PRIVATE WET. EGG COLL.	PRIVATE WET. HATCH RATE	FSP HATCHLINGS	PUBLIC WET. HATCH. COLL.
HUNTS ALLIGATOR BR	CLYDE HUNT	BUSHNELL	120	173	293	47	1885		1187	6.86	0.63						
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS	40	100	140	36	1264		1000	10.00	0.79						
CLABROOK FARMS	SHLOMI RANOT	CHRISTMAS															
JOEL SMITH ALL. FARM	JOEL SMITH	BELL															
SUBTOTAL		4	160	273	433	83	3149	0	2187	N/A	N/A	0	0	0	0	0	0
MEANS PER FARM			80	137	217	42	1575	ERR	1094	8.01	0.69	ERR	ERR	ERR	ERR	ERR	ERR
# OF FARMS			2	2	2	2	2	0	2	2	2	0	0	0	0	0	0

Appendix I (continued)

1979 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	PRIVATE WET. HATCH COLL.	CONS/HAR HATCHLING	TOTAL HATCH	REPORTED MORTALITY	LIVE GATORS ACQUIRED(+)	LIVE GATORS DISPOSED(-)	TOTAL GATORS	HIDES TAGGED	LBS MEAT PRODUCED	LBS MEAT SOLD
HUNTS ALLIGATOR BR	CLYDE HUNT	BUSHNELL										
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS							4090	200		
CLABROOK FARMS	SHLOMI RANOT	CHRISTMAS										
JOEL SMITH ALL. FARM	JOEL SMITH	BELL				113	809			20		
SUBTOTAL		4	0	0	0	113	809	0	4090	220	0	0
MEANS PER FARM			ERR	ERR	ERR	113	809	ERR	4090	110	ERR	ERR
# OF FARMS			0	0	0	1	1	0	1	2	0	0

1980 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	PRIVATE WET. HATCH COLL.	CONS/HAR HATCHLING	TOTAL HATCH	REPORTED MORTALITY	LIVE GATORS ACQUIRED(+)	LIVE GATORS DISPOSED(-)	TOTAL GATORS	HIDES TAGGED	LBS MEAT PRODUCED	LBS MEAT SOLD
HUNTS ALLIGATOR BR	CLYDE HUNT	BUSHNELL						22		89		
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS					0	0	5470	0		
CLABROOK FARMS	SHLOMI RANOT	CHRISTMAS										
JOEL SMITH ALL. FARM	JOEL SMITH	BELL				71	302	153	2123			
SUBTOTAL		4	0	0	0	71	302	175	7593	89		
MEANS PER FARM			ERR	ERR	ERR	71	151	58	3797	45		
# OF FARMS			0	0	0	1	2	3	2	2		

Appendix I (continued)

1977 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	ADULT MALES	ADULT FEMALES	TOTAL BREEDERS	NUMBER OF NESTS	TOTAL EGGS	VIABLE EGGS	HATCHLINGS PRODUCED	HATCH PER ADULT FEM	HATCH RATES	PUBLIC WET. EGG COLL.	PUBLIC WET. HATCH RATE	PRIVATE WET. EGG COLL.	PRIVATE WET. HATCH RATE	FSP HATCHLINGS	PUBLIC WET. HATCH. COLL.
HUNTS ALLIGATOR BR	CLYDE HUNT	BUSHNELL				24	864		160		0.19						
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS				27	988		400		0.40						
CLABROOK FARMS	SHLOMI RANDT	CHRISTMAS															
JOEL SMITH ALL. FARM	JOEL SMITH	BELL				0	0		0								
SUBTOTAL		4	0	0	0	51	1852	0	560	N/A	N/A	0	0	0	0	0	0
MEANS PER FARM			ERR	ERR	ERR	17	617	ERR	187	ERR	0.30	ERR	ERR	ERR	ERR	ERR	ERR
# OF FARMS			0	0	0	3	3	0	3	0	2	0	0	0	0	0	0

1978 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	ADULT MALES	ADULT FEMALES	TOTAL BREEDERS	NUMBER OF NESTS	TOTAL EGGS	VIABLE EGGS	HATCHLINGS PRODUCED	HATCH PER ADULT FEM	HATCH RATES	PUBLIC WET. EGG COLL.	PUBLIC WET. HATCH RATE	PRIVATE WET. EGG COLL.	PRIVATE WET. HATCH RATE	FSP HATCHLINGS	PUBLIC WET. HATCH. COLL.
HUNTS ALLIGATOR BR	CLYDE HUNT	BUSHNELL	96	147	243	48	1920		1108	7.54	0.58						
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS	50	100	150	38	1412		906	9.06	0.64						
CLABROOK FARMS	SHLOMI RANDT	CHRISTMAS	90	90	180												
JOEL SMITH ALL. FARM	JOEL SMITH	BELL	75	151	226	1			5	0.03							
SUBTOTAL		4	311	488	799	87	3332	0	2019	N/A	N/A	0	0	0	0	0	0
MEANS PER FARM			78	122	200	29	1666	ERR	673	4.14	0.61	ERR	ERR	ERR	ERR	ERR	ERR
# OF FARMS			4	4	5	3	2	0	3	3	2	0	0	0	0	0	0

Appendix I (continued)

1977 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	PRIVATE WET. HATCH COLL.	CONS/HAR HATCHLING	TOTAL HATCH	REPORTED MORTALITY	LIVE GATORS ACQUIRED(+)	LIVE GATORS DISPOSED(-)	TOTAL GATORS	HIDES TAGGED	LBS MEAT PRODUCED	LBS MEAT SOLD
HUNTS ALLIGATOR GR	CLYDE HUNT	BUSHNELL										
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS										
CLABROOK FARMS	SHLOMI RANOT	CHRISTMAS										
JOEL SMITH ALL. FARM	JOEL SMITH	BELL										
									221			
SUBTOTAL		4	0	0	0	0	0	0	221	0	0	0
MEANS PER FARM			ERR	ERR	ERR	ERR	ERR	ERR	221	ERR	ERR	ERR
# OF FARMS			0	0	0	0	0	0	1	0	0	0

1978 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	PRIVATE WET. HATCH COLL.	CONS/HAR HATCHLING	TOTAL HATCH	REPORTED MORTALITY	LIVE GATORS ACQUIRED(+)	LIVE GATORS DISPOSED(-)	TOTAL GATORS	HIDES TAGGED	LBS MEAT PRODUCED	LBS MEAT SOLD
HUNTS ALLIGATOR GR	CLYDE HUNT	BUSHNELL						80		75		
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS				26			3431	200		
CLABROOK FARMS	SHLOMI RANOT	CHRISTMAS							837	60		
JOEL SMITH ALL. FARM	JOEL SMITH	BELL				59	365		654	0		
SUBTOTAL		4	0	0	0	85	365	80	4922	335	0	0
MEANS PER FARM			ERR	ERR	ERR	43	365	80	1641	84	ERR	ERR
# OF FARMS			0	0	0	2	1	1	3	4	0	0

Appendix I (continued)

1975 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY		ADULT MALES	ADULT FEMALES	TOTAL BREEDERS	NUMBER OF NESTS	TOTAL EGGS	VIABLE EGGS	HATCHLINGS PRODUCED	HATCH PER ADULT FEM	HATCH RATES	PUBLIC WET. EGG COLL.	PUBLIC WET. HATCH RATE	PRIVATE WET. EGG COLL.	PRIVATE WET. HATCH RATE	FSP HATCHLINGS	PUBLIC WET. HATCH. COLL.
HUNTS ALLIGATOR BR	CLYDE HUNT	BUSHNELL																
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS						731		331		0.45						
CLABROOK FARMS	SHLOMI RANOT	CHRISTMAS																
SUBTOTAL			3	0	0	0	0	731	0	331	N/A	N/A	0	0	0	0	0	0
MEANS PER FARM				ERR	ERR	ERR	ERR	731	ERR	331	ERR	0.45	ERR	ERR	ERR	ERR	ERR	ERR
# OF FARMS				0	0	0	0	1	0	1	0	1	0	0	0	0	0	0

1976 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY		ADULT MALES	ADULT FEMALES	TOTAL BREEDERS	NUMBER OF NESTS	TOTAL EGGS	VIABLE EGGS	HATCHLINGS PRODUCED	HATCH PER ADULT FEM	HATCH RATES	PUBLIC WET. EGG COLL.	PUBLIC WET. HATCH RATE	PRIVATE WET. EGG COLL.	PRIVATE WET. HATCH RATE	FSP HATCHLINGS	PUBLIC WET. HATCH. COLL.
HUNTS ALLIGATOR BR	CLYDE HUNT	BUSHNELL						234		107		0.46						
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS					42	1400		910		0.65						
CLABROOK FARMS	SHLOMI RANOT	CHRISTMAS																
SUBTOTAL			3	0	0	0	42	1634	0	1017	N/A	N/A	0	0	0	0	0	0
MEANS PER FARM				ERR	ERR	ERR	42	817	ERR	509	ERR	0.62	ERR	ERR	ERR	ERR	ERR	ERR
# OF FARMS				0	0	0	1	2	0	2	0	2	0	0	0	0	0	0

Appendix I (continued)

1975 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY		PRIVATE WET. HATCH COLL.	CONS/HAR HATCHLING	TOTAL HATCH	REPORTED MORTALITY	LIVE GATORS ACQUIRED(+)	LIVE GATORS DISPOSED(-)	TOTAL GATORS	HIDES TAGGED	LBS MEAT PRODUCED	LBS MEAT SOLD
HUNTS ALLIGATOR GR	CLYDE HUNT	BUSHNELL											
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS											
CLABROOK FARMS	SHLOMI RANOT	CHRISTMAS											
SUBTOTAL			3	0	0	0	0	0	0	0	0	0	0
MEANS PER FARM				ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR
# OF FARMS				0	0	0	0	0	0	0	0	0	0

1976 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY		PRIVATE WET. HATCH COLL.	CONS/HAR HATCHLING	TOTAL HATCH	REPORTED MORTALITY	LIVE GATORS ACQUIRED(+)	LIVE GATORS DISPOSED(-)	TOTAL GATORS	HIDES TAGGED	LBS MEAT PRODUCED	LBS MEAT SOLD
HUNTS ALLIGATOR GR	CLYDE HUNT	BUSHNELL								1396			
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS											
CLABROOK FARMS	SHLOMI RANOT	CHRISTMAS											
SUBTOTAL			3	0	0	0	0	0	0	1396	0	0	0
MEANS PER FARM				ERR	ERR	ERR	ERR	ERR	ERR	1396	ERR	ERR	ERR
# OF FARMS				0	0	0	0	0	0	1	0	0	0

Appendix I (continued)

1973 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	ADULT MALES	ADULT FEMALES	TOTAL BREEDERS	NUMBER OF NESTS	TOTAL EGGS	VIABLE EGGS	HATCHLINGS PRODUCED	HATCH PER ADULT FEM	HATCH RATES	PUBLIC WET. EGG COLL.	PUBLIC WET. HATCH RATE	PRIVATE WET. EGG COLL.	PRIVATE WET. HATCH RATE	FSP HATCHLINGS	PUBLIC WET. HATCH. COLL.
HUNTS ALLIGATOR BR	CLYDE HUNT	BUSHNELL	21	23	44	9	256		203	8.83	0.79						
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS				17	622		338		0.54						
CLABROOK FARMS	SHLOMI RANOT	CHRISTMAS															
SUBTOTAL		3	21	23	44	26	878	0	541	N/A	N/A	0	0	0	0	0	0
MEANS PER FARM			21	23	44	13	439	0	271	23.52	0.62	ERR	ERR	ERR	ERR	ERR	ERR
# OF FARMS			1	1	1	2	2	1	2	1	2	0	0	0	0	0	0

1974 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	ADULT MALES	ADULT FEMALES	TOTAL BREEDERS	NUMBER OF NESTS	TOTAL EGGS	VIABLE EGGS	HATCHLINGS PRODUCED	HATCH PER ADULT FEM	HATCH RATES	PUBLIC WET. EGG COLL.	PUBLIC WET. HATCH RATE	PRIVATE WET. EGG COLL.	PRIVATE WET. HATCH RATE	FSP HATCHLINGS	PUBLIC WET. HATCH. COLL.
HUNTS ALLIGATOR BR	CLYDE HUNT	BUSHNELL				4	198				0.00						
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS				31	1067		427		0.40						
CLABROOK FARMS	SHLOMI RANOT	CHRISTMAS															
SUBTOTAL		3	0	0	0	35	1265	0	427	N/A	N/A	0	0	0	0	0	0
MEANS PER FARM			ERR	ERR	ERR	18	633	ERR	427	ERR	0.34	ERR	ERR	ERR	ERR	ERR	ERR
# OF FARMS			0	0	0	2	2	0	1	0	2	0	0	0	0	0	0

Appendix I (continued)

1973 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	PRIVATE WET. HATCH COLL.	CONS/HAR HATCHLING	TOTAL HATCH	REPORTED MORTALITY	LIVE GATORS ACQUIRED(+)	LIVE GATORS DISPOSED(-)	TOTAL GATORS	HIDES TAGGED	LBS MEAT PRODUCED	LBS MEAT SOLD
HUNTS ALLIGATOR BR	CLYDE HUNT	BUSHNELL										
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS										
CLABROOK FARMS	SHLOMI RANOT	CHRISTMAS										
SUBTOTAL		3	0	0	0	0	0	0	0	0	0	0
MEANS PER FARM			ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR
# OF FARMS			0	0	0	0	0	0	0	0	0	0

1974 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	PRIVATE WET. HATCH COLL.	CONS/HAR HATCHLING	TOTAL HATCH	REPORTED MORTALITY	LIVE GATORS ACQUIRED(+)	LIVE GATORS DISPOSED(-)	TOTAL GATORS	HIDES TAGGED	LBS MEAT PRODUCED	LBS MEAT SOLD
HUNTS ALLIGATOR BR	CLYDE HUNT	BUSHNELL										
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS						5				
CLABROOK FARMS	SHLOMI RANOT	CHRISTMAS										
SUBTOTAL		3	0	0	0	0	0	5	0	0	0	0
MEANS PER FARM			ERR	ERR	ERR	ERR	ERR	5	ERR	ERR	ERR	ERR
# OF FARMS			0	0	0	0	0	1	0	0	0	0

Appendix I (continued)

1971 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	ADULT MALES	ADULT FEMALES	TOTAL BREEDERS	NUMBER OF NESTS	TOTAL EGGS	VIABLE EGGS	HATCHLINGS PRODUCED	HATCH PER ADULT FEM	HATCH RATES	PUBLIC WET. EGG COLL.	PUBLIC WET. HATCH RATE	PRIVATE WET. EGG COLL.	PRIVATE WET. HATCH RATE	FSP HATCHLINGS	PUBLIC WET. HATCH. COLL.
HUNTS ALLIGATOR BR	CLYDE HUNT	BUSHNELL	21	23	44	3	103			0.00	0.00						
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS															
CLABROOK FARMS	SHLOMI RANOT	CHRISTMAS				8	254		114		0.45						
SUBTOTAL		3	21	23	44	11	357	0	114	N/A	N/A	0	0	0	0	0	0
MEANS PER FARM			21	23	44	6	179	ERR	114	4.96	0.32	ERR	ERR	ERR	ERR	ERR	ERR
# OF FARMS			1	1	1	2	2	0	1	1	2	0	0	0	0	0	0

1972 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	ADULT MALES	ADULT FEMALES	TOTAL BREEDERS	NUMBER OF NESTS	TOTAL EGGS	VIABLE EGGS	HATCHLINGS PRODUCED	HATCH PER ADULT FEM	HATCH RATES	PUBLIC WET. EGG COLL.	PUBLIC WET. HATCH RATE	PRIVATE WET. EGG COLL.	PRIVATE WET. HATCH RATE	FSP HATCHLINGS	PUBLIC WET. HATCH. COLL.
HUNTS ALLIGATOR BR	CLYDE HUNT	BUSHNELL	21	23	44	9	297		197	8.57	0.66						
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS															
CLABROOK FARMS	SHLOMI RANOT	CHRISTMAS				16	523		110		0.21						
SUBTOTAL		3	21	23	44	25	820	0	307	N/A	N/A	0	0	0	0	0	0
MEANS PER FARM			21	23	44	13	410	ERR	154	13.35	0.37	ERR	ERR	ERR	ERR	ERR	ERR
# OF FARMS			1	1	1	2	2	0	2	1	2	0	0	0	0	0	0

Appendix I (continued)

1971 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	PRIVATE WET. HATCH COLL.	CONS/HAR HATCHLING	TOTAL HATCH	REPORTED MORTALITY	LIVE GATORS ACQUIRED(+)	LIVE GATORS DISPOSED(-)	TOTAL GATORS	HIDES TAGGED	LBS MEAT PRODUCED	LBS MEAT SOLD
HUNTS ALLIGATOR BR	CLYDE HUNT	BUSHNELL					0		363			
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS										
CLABROOK FARMS	SHLOMI RANOT	CHRISTMAS										
SUBTOTAL		3	0	0	0	0	0	0	363	0	0	0
MEANS PER FARM			ERR	ERR	ERR	ERR	0	ERR	363	ERR	ERR	ERR
# OF FARMS			0	0	0	0	1	0	1	0	0	0

1972 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	PRIVATE WET. HATCH COLL.	CONS/HAR HATCHLING	TOTAL HATCH	REPORTED MORTALITY	LIVE GATORS ACQUIRED(+)	LIVE GATORS DISPOSED(-)	TOTAL GATORS	HIDES TAGGED	LBS MEAT PRODUCED	LBS MEAT SOLD
HUNTS ALLIGATOR BR	CLYDE HUNT	BUSHNELL					0		744			
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS										
CLABROOK FARMS	SHLOMI RANOT	CHRISTMAS										
SUBTOTAL		3	0	0	0	0	0	0	744	0	0	
MEANS PER FARM			ERR	ERR	ERR	ERR	0	ERR	744	ERR	ERR	
# OF FARMS			0	0	0	0	1	0	1	0	0	

1969 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY		ADULT MALES	ADULT FEMALES	TOTAL BREEDERS	NUMBER OF NESTS	TOTAL EGGS	VIABLE EGGS	HATCHLINGS PRODUCED	HATCH PER ADULT FEM	HATCH RATES	PUBLIC WET. EGG COLL.	PUBLIC WET. HATCH RATE	PRIVATE WET. EGG COLL.	PRIVATE WET. HATCH RATE	FSP HATCHLINGS	PUBLIC WET. HATCH. COLL.
HUNTS ALLIGATOR BR	CLYDE HUNT	BUSHNELL		12	13	25	0	0		0	0.00	0.00						
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS																
ST. AUGUSTINE ALL.F.	MARK WISE	ST. AUGUSTINE																
CLABROOK FARMS	SHLOMI RANOT CLEMMONS	CHRISTMAS																
SUBTOTAL			4	12	13	25	0	0	0	0	N/A	N/A	0	0	0	0	0	0
MEANS PER FARM				12	13	25	0	0	ERR	0	0.00	ERR	ERR	ERR	ERR	ERR	ERR	ERR
# OF FARMS				1	1	1	1	1	0	1	1	1	0	0	0	0	0	0

1970 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY		ADULT MALES	ADULT FEMALES	TOTAL BREEDERS	NUMBER OF NESTS	TOTAL EGGS	VIABLE EGGS	HATCHLINGS PRODUCED	HATCH PER ADULT FEM	HATCH RATES	PUBLIC WET. EGG COLL.	PUBLIC WET. HATCH RATE	PRIVATE WET. EGG COLL.	PRIVATE WET. HATCH RATE	FSP HATCHLINGS	PUBLIC WET. HATCH. COLL.
HUNTS ALLIGATOR BR	CLYDE HUNT	BUSHNELL		21	23	44	2	92		87	3.78	0.95						
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS					7	239		89		0.37						
CLABROOK FARMS	SHLOMI RANOT	CHRISTMAS																
SUBTOTAL			3	21	23	44	9	331	0	176	N/A	N/A	0	0	0	0	0	0
MEANS PER FARM				21	23	44	5	166	ERR	88	7.65	0.53	ERR	ERR	ERR	ERR	ERR	ERR
# OF FARMS				1	1	1	2	2	0	2	1	2	0	0	0	0	0	0

Appendix I (continued)

1969 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	PRIVATE WET. HATCH COLL.	CONS/HAR HATCHLING	TOTAL HATCH	REPORTED MORTALITY	LIVE GATORS ACQUIRED(+)	LIVE GATORS DISPOSED(-)	TOTAL GATORS	HIDES TAGGED	LBS MEAT PRODUCED	LBS MEAT SOLD
HUNTS ALLIGATOR GR	CLYDE HUNT	BUSHNELL										
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS										
ST. AUGUSTINE ALL.F.	MARK WISE	ST. AUGUSTINE										
CLABROOK FARMS	SHLOMI RANOT CLEMMONS	CHRISTMAS										
SUBTOTAL		4	0	0	0	0	0	0	0	0	0	0
MEANS PER FARM			ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR
# OF FARMS			0	0	0	0	0	0	0	0	0	0

1970 REPORT
COMMERCIAL FLORIDA ALLIGATOR FARMS

ALLIGATOR FARM	OWNER	CITY	PRIVATE WET. HATCH COLL.	CONS/HAR HATCHLING	TOTAL HATCH	REPORTED MORTALITY	LIVE GATORS ACQUIRED(+)	LIVE GATORS DISPOSED(-)	TOTAL GATORS	HIDES TAGGED	LBS MEAT PRODUCED	LBS MEAT SOLD
HUNTS ALLIGATOR GR	CLYDE HUNT	BUSHNELL					150					
FROELICH'S GATOR FARM	EDWIN FROELICH	CHRISTMAS										
CLABROOK FARMS	SHLOMI RANOT	CHRISTMAS										
SUBTOTAL		3	0	0	0	0	150	0	0	0	0	0
MEANS PER FARM			ERR	ERR	ERR	ERR	150	ERR	ERR	ERR	ERR	ERR
# OF FARMS			0	0	0	0	1	0	0	0	0	0

On the Possibility of a New Undescribed Crocodilian Species from Colombia

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Abstract

Colombian crocodilian skins have been discovered which have scutes and scales of unusual form and arrangement. A comparison with the known caimans allows the conclusion that they might represent a species as yet undescribed, a possibility which is also considered by Medem (1981).

Introduction

When one of the German authors (Fuchs) on official mission in 1988 examined the stock of a German dealer in reptile skins, he found parts of skins and one complete hide of a crocodilian with unusual characteristics. Some of the characteristics of these skins deviated considerably from those which we find with all other living crocodiles. The skins have been deposited with the "Senckenberg Museum" in Frankfurt am Main. A further skin, to which the authors had no access owing to technical reasons, is now in the possession of the "Staatliche Museum für Naturkunde" in Stuttgart.

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We would particularly like to emphasize that this publication does not aim at describing a new species in accordance with the relevant established rules. At present there is no proof that the deviating characteristics are genetically fixed and inheritable without mutations within a bigger population. Furthermore, accessible material so far is scarce, and therefore the possibility cannot be excluded that this is only an individually occuring mutation. With this publication the authors intend to point out the facts and initiate further research in those regions which provide a possible habitat in the wild for the caimans in question.

Alligatoridae of Colombia

According to Medem (1981), four species of caimans can be found in Colombia: the Spectacled Caiman (Caiman crocodilus), the Black Caiman (Melanosuchus niger) and the two Smooth-fronted Caimans (Paleosuchus palpebrosus and P. trigonatus). It is characteristic of their belly skins that they do not have any integumentary sense organs (ISOs) and that the ventral scutes have two-piece ossifications. The skins discussed here also show clearly these two characteristics and therefore can be classified as belonging to the Alligatorinae.

Distribution

The person in charge of the reptile skin company in Germany said that he had had fewer than five of these unusual skins in his possession. He had bought them from a Colombian raw hide dealer from Barranquilla in 1972/73, who at that time dealt exclusively in caiman skins originating from the northern catchment-basin of the Rio Magdalena. We therefore cannot exclude that the unusual skins originated from the surroundings of Barranquilla or even from Cienaga Grande, between Barranquilla (Atlantico) and Santa Marta (Magdalena).

Description of the Skins

Length: whole skin (SMF 74138) 106 cm, tail (SMF 74139) 49 cm.

Colouration: dark brown after tanning

Ventral scales:

collar:	existent and distinctly shaped;
pores (ISO):	non existent;
transverse rows:	- scutes very big and partly irregular in the centre of the belly; only partly arranged in transverse rows; - 22-24 transverse rows between collar and last row in front of the vent area; - 2-8 scutes in each transverse row;
ossifications:	- in front of collar : 1.-6. transverse row strongly ossified; - collar: strongly ossified - after collar: 1.-12. transverse row strongly 13.-14. slightly 15.-22. (24.) not ossified; - tail: counting from the first row behind the vent area; 1.-15. transverse row strongly though decreasingly ossified; 16. transverse row - end of tail with slight or no ossifications.

...

Flank scales: not ossified and unkeeled. Only existent in distal third of flanks and grouped in 10-12 regularly arranged longitudinal rows. In between run granular scales which are also arranged in transversel rows; rest of the flanks has only individual scales in the area near the ventral scales; no development of transverse rows in this part. Size ratio between width of innermost large flank scales and adjacent belly scutes is 0,98:1, similar to that of Crocodylus porosus and completely different from all other caiman species (Caiman crocodilus 1.75-2.47:1; Melanosuchus niger 1.55-1.92:1; Paleosuchus spp. 1-1.5:1).

Tail scales: Only in the distal area are scales arranged in whorls. In the proximal area, particularly near the vent area, no lateral development of whorls.

Table 1

Discussion

Table 1 shows that in the case of our unusual skin material the form and arrangement of scales and scutes of the flanks, tail and body differ significantly from the conditions to be found with other Colombian caimans. This context suggests a comparison with a mutation which King (1989) calls a "biological sport". This refers to an unusual deviation which King discovered with a captive bred American alligator, Alligator mississipiensis. In the case of this animal, only the flanks

...

showed a mutation, however to such an extent that the characteristic big oval scales were not recognizable.

With the skin discussed here we also find granular scales but only in the proximal part of both flanks. Contrary to all other known caimans, the distal area has an additional 10-12 regularly running longitudinal rows on the flank scales. The arrangement of the ventral and tail scutes of the skin described by King did not show any such deviations from the standard which distinguishes the caiman skins described here from all other living crocodiles.

Medem, too, believed in the existence of a still unknown and not yet described crocodilian species in the Cienaga Grande area, a large lake situated in the Departamento de Magdalena on the Caribbean coast of Colombia between the cities of Barranquilla and Santa Marta. Medem based his conviction on the descriptions of local caiman hunters. He wrote on this hypothetical "Caiman liso":

> The scutes (flanks) are much smaller than those of the Caiman crocodilus; they are particularly numerous and clearly smoother (i. e. unkeeled). Because of their softness, coloration and small scales the raw hide dealers in Colombia had great interest in preserving these skins.

According to Medem, the animals reached a total length of not more than 8-9 ft (2.4-2.7 m). Sometimes they were sighted in the lower stretches of the "Rio Frio", a river rising in the Sierra Nevada de Santa Marta and emptying into a small lake east of Cienaga Grande. It seems that these caimans came from the upper part of the Rio Frio. According to Medem, already by the end of the nineteen thirties and in the early forties the "Caiman liso" was considered as very rare or extinct in its range. Hide-hunting activities were concentrated in the Cienaga Grande and surrounding region, essentially in the area where the "Caiman liso" was to have occurred.

Thus, the question still remains: Do the caiman skins which show such a considerable deviation for some characteristics really represent a still unknown species which, it seems, became rare fifty years ago, or is it nothing but a locally restricted mutation occuring in individual animals? The problem can only be solved by research activities in the animals' natural range, although it is likely,that these animals were exterminated.

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Table 1. PRINCIPAL SKIN CHARACTERISTICS OF THE CAIMANS OF COLOMBIA (Reference: Wermuth & Fuchs, 1978).

	Caiman crocodilus	Melanosuchus niger	Paleosuchus spp.	"Caiman sp. nov."
1. Transverse rows of ventral scales	20 - 24	26 - 28	17 - 19	21 - 22
2. Ventral scales per transverse row	10 - 14	12	10 - 12	2 - 8
3. Longitudinal rows of flank scales	3 - 4	5	3	10 - 12 only in distal area of flanks
4. Ossifications				
- Flank scales	Non ossified (C.c. app.) or strongly ossified (C.c.croc.)	Non ossified, keels only feeble developped.	All scales ossified and with keels.	Non ossified, no keels.
- Ventral scales	front of collar: 1.-7. C.c.croc. behind collar: 1.-13. C. c. fusc.	front of collar: 1.-7. strongly ossified. behind collar: 1.-20.; strongly ossified 1.-17.	front of collar: 1.-5. strongly ossified. behind collar: 1.-17. (19.); strongly ossified 1.-11. (14.).	front of collar: 1.-6. strongly ossified. behind collar: 1.-12. strong, 13.-14. feeble, 15.-22. non ossified.
- Tail scales	Min.: 1.-16. strongly ossified. Max.: 1.-23. strongly ossified.	Ossifications feeble; juveniles only with feeble ossifications in middle most scutes of transversal rows.	Ossifications with increasing strength towards tip of the tail.	1.-15. strong, 16.- tip of the tail with feeble or no ossifications.
5. Remarks	Number and degree of ossifications of flank, ventral and tail scales differ among the different subspecies		Both Paleosuchus species cannot be distinguished by the characteristics of their belly skins (Brazaitis, 1989, Fuchs 1974, Wermuth & Fuchs 1978).	- Ventral scales large, not arranged in regular transversal rows. - Additional inclusions of scales. - Tail scales proximal not arranged in regular whorls.

Growth Curves For The Nile Crocodile
As Estimated By Skeletochronology

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ABSTRACT

Growth curves were constructed for the Nile crocodile from the Middle Zambezi river using two different skeletochronological methods. The first method assigned ages to individual crocodiles using the dorsal osteoderms of living animals, before fitting a modified Von Bertalanffy growth curve. The second method used a calculated annual increment from femurs to derive an estimate of the rate of increase to fit the curve. The curves were similar and it is suggested that they could be useful in management. It should, however, be noted that skeletochronology is built on precarious foundations and the results must be regarded with caution.

INTRODUCTION

It is important to determine the relationship between age and body size in the Nile crocodile, as body size is directly related to sexual maturity, fecundity (in females) and survivorship (Cott, 1961; Graham, 1968; Hutton, 1984). The rate of growth is a measure of how efficiently the crocodile is utilizing its environment and will be directly affected by food availability, food quality, food intake, season and sex of the animal. This rate will slow after sexual maturity (Graham, 1968; Webb, Messel, Crawford and Yerbury, 1978; Hutton, 1984). Growth appears to be indeterminate (Chabreck and Joanen, 1979; Graham, 1968; Neill, 1971) and this may be because wild crocodiles die before reaching their asymptotic length (Brisbin, 1988).

Skeletochronolgy or the ageing of animals from annual growth laminae in the skeleton and hard parts has been used for fish many times (Beamish and McFarlane, 1983) but has only recently been applied to crocodilians (Ferguson, 1984; Hutton, 1987a,b). In this study two independent skeletochronological methods were used to construct growth curves for the Nile crocodile from the Middle Zambezi River in Mozambique and Zimbabwe. The first method assigned ages to individual crocodiles while the second used annual increments to derive an estimate of the rate of increase.

STUDY AREA

The Middle Zambezi river stretches from the Victoria Falls to the Cahora Bassa dam (Figure 1). Climatically the area is sub-arid to arid (Phillips, 1959) and there are three distinct seasons (hot wet, cool and hot dry). Mean air temperatures are always above 20°C with a peak in October/ November (mean maximum 33 - 38°C, absolute maximum 41°C). They decrease gradually to a low in June/July (mean minimum 26°C, absolute minimum 2.8°C; Coche, 1974). Surface water temperatures vary from a low of 22°C to a high of 30°C. There is a single rainy season which begins in October with sporadic storms. These increase through November and approximately 90% of the precipitation occurs between

December and February (Figure 2). Rainfall often occurs as localized heavy showers associated with thunderstorms and the annual average is 600 mm (range 350 mm - 1015 mm). Daily hours of sunshine vary from a mid rainy season low of 6.4 h to a cool season high of 10.1 h (20 year mean from Department of Meteorological Services records, Harare).

The river has been dammed at two sites and the subsequent lakes of Kariba (5 500 km^2) and Cahora Bassa (2 665 km^2) now support substantial crocodile populations.

METHODS

Material (either a dorsal osteoderm section or a femur) was collected from Lakes Kariba and Cahora Bassa. The method of data collection and its subsequent analysis was different in each area. The growth curve for female crocodiles from Lake Cahora Bassa was derived from the same material by Craig, Gibson and Hutton (1989) and their method was applied to a sample of male femurs.

Lake Kariba

Whenever possible, for all captured crocodiles > 1.2 m total length (TL), an osteoderm section was removed from the neck, following the method of Hutton (1986). Briefly, the area was injected with a local anaesthetic (Lignocaine hydrochloride) prior to an osteoderm section (± 5 mm thick) being removed with a fine-toothed amputation saw. The resulting wounds were packed with antibiotic powder and infection was never recorded, even when some crocodiles were penned for several weeks before release. Wounds were almost unnoticeable a year later. Twenty one osteoderm sections were collected and stored in 95 % alcohol. In addition, femurs were collected and sun-dried from shot sample of 24 sub-adult crocodiles (1.2 - 2.5 m TL).

For analysis a thin sliver was removed with a hacksaw, from the osteoderm or central diaphysis of the femur, and ground by hand on silicon carbide paper to approximately 100_u. This was viewed under a dissection microscope in transmitted light and minor adjustments made to the thickness until the annuli were clearly visible. Five variables were recorded from the osteoderms (Figure 3) and the age estimated with the following formula:

$$AGE = (((TD/2) - LD) / MS) + VL$$

where:

TD = Total depth of the osteoderm
LD = Depth of the visible laminae
MS = Mean separation of the three innermost laminae
VL = Number of visible laminae

Counting only the visible laminae will give an underestimate of age because the inner laminae disappear with age (Buffrenil, 1982). The above formula estimates age by calculting the number of missing laminae and adding them to the visible ones.

It was assumed that laminae resorption in the sub-adult femurs had not begun (Hutton, 1984) and annuli counted directly from the sections were used as uncorrected age estimates.

The estimated ages were tested with a nonlinear regression against total length, using a derivative of the Von Bertalanffy (1938) growth curve defined by Craig, *et al.* (1989). The equation was

$$Y = (K + at)(1 - be^{rt}) \qquad (1)$$

where :

K = The intercept for the positive asymptote
a = Slope
b = Intercept
r = Exponent for rate of increase
t = Age in years

This gives the asymptote a positive slope, rather than conventional horizontal line. Initial parameter values were chosen arbitrarily and the final values were calculated by iteration on a computer. The only known parameter in the equation was age (t).

Lake Cahora Bassa

A femur was removed, cleaned, and sun-dried from 230 crocodiles, which were shot as part of a cropping exercise in accordance with CITES regulations (*Res. Conf.* 5.25). In the laboratory sections were cut from the central diaphysis of 55 of these and prepared in the same manner as the Kariba sample. It proved to be impossible to assign an age to the femurs owing to the obliteration of the inner annuli by resorption and reworking of the center of the bone (Griffiths, 1962). Therefore a different technique to that used for the Kariba sample, developed by Craig (Craig *et al.*, 1989), was adopted for the analysis. For each femur the outside diameter and the diameters of two successive annuli were recorded (Figure 4) using a graticuled eyepiece in a dissection microscope. Total length was regressed against femur diameter to establish theoretical total lengths for the annuli diameters (Y). The calculated length increment from the innermost recorded annulus to the next successive annulus (ΔY) was plotted against Y. If Y is given by equation (1) then ΔY, for an increment of one year, can be calculated by

$$\Delta Y = (K + at - Y)(1 - e^{r}) + a(1 - be^{rt} e^{r}) \qquad (2)$$

where :

K = The intercept for the positive asymptote
Y = Calculated total length
a = Slope
b = Intercept
r = Exponent for rate of increase
t = Time

A trial value was then chosen for r and for each Y in the data set equation (1) was solved iteratively to find t. This value for t was then substituted into equation (2) to find ΔY. Y and $\hat{\Delta Y}$ were solved for all values of Y and the residuals expressed as $\sum(\Delta Y - \hat{\Delta Y})^2$. This process was repeated using different values of r until one showed residuals achieving their minimum value. The curve was then fitted using Marquardt's least squares method (1963), constrained through a hatching size of 0.31 m TL.

RESULTS

The relationship between femur diameter and total length for male crocodiles from Lake Cahora Bassa was linear ($Y=13.26\ X + 5.96$; $r=0.96$; $p<0.001$; Figure 5). A plot of calculated total length (Y) against the annual increment ($\triangle Y$) gives a wide scatter but suggests decreased growth with increased age (Figure 6).

The computed growth curves for males and females in both Lake Kariba (Figure 7) and Lake Cahora Bassa (Figure 8) are remarkably similar. This was expected, given that both populations are subject to almost identical climatic conditions. Males appear to grow faster than females and this has been established for other Nile crocodile populations (Graham, 1968; Hutton, 1984). They also appear to have more variable growth than the females. Predictions of total length at a hypothetical 100 years of age are 5 m TL for males and 3.6 m TL for females.

DISCUSSION

Ageing animals using skeletochronolgy is a controversial technique and doubts will be expressed as to the validity of the results. A number of assumptions need to be made before these curves can be accepted as real, the most important of which is that laminae are deposited annually. There may be a number of other factors which could inhibit feeding and hence growth, such as a fluctuating food supply or behaviour during breeding. These may or may not be on an annual basis. In temperate climates the laminae were considered to be in response to seasons but this may be obscured in the tropics which often have ill-defined and short cool periods (approximately two months in the study area). Growth rates are also notoriously variable even within discrete populations (Hutton, 1987b) and this could lead to incorrect age estimation and erroneous growth curves.

It was not possible, after the first few years of life, to assign ages to osteoderms soley by counting the laminae. This was because laminae are removed and broken up by resorption and accretion (Buffrenil, 1982). It was necessary to estimate the number of missing laminae and this could lead to addittional errors in age estimation.

A further problem, especially for long lived animals such as crocodilians, is validation of the technique. In the case of the Nile crocodile there is only one known age free living speciman. This animal had an age estimation error of 15 % at 46 years (Hutton, 1987a,b). Clearly much more data are needed before the technique can stand up to serious critisism.

However, if we accept the limitations of the method and assume that the laminae are deposited on an annual basis, then it is possible to discuss some of the implications of the present growth curves.

The age at which a crocodile is capable of breeding is an important parameter which can be used to enhance the exploitation of a wild population (Craig, *et al.* 1989). Current knowledge suggests that a female Nile crocodile becomes sexually mature between 2.4 and 2.6 m TL (Cott, 1961; Hutton, 1984; Games, Zohlo and Chande, 1989). The growth curves indicate that females mature between 12 and 20 years of age in the study area.

When the female growth curves for the study area and Lake Ngezi (Hutton, 1987a) are compared there is one striking difference (Figure 9). Females from Lake Ngezi take between 25 and 35 years to attain sexual maturity. They will, however, reach a similar maximum size. Lake Ngezi is close to Harare on the cool central plateau of Zimbabwe and air and water temperatures are substantially lower than the Middle Zambezi valley (summer maximum temperatures are seldom over 30°C). It is hypothesized that the lower temperatures contribute to their slower growth rate (Hutton, 1987a).

The similarity of the independently derived curves is remarkable and it is possible that they approximate the growth of wild crocodiles in the study area. It could be argued, in the case of the Cahora Bassa sample, that this is a result of mathematical manipulation of "soft" data. The choice of the asymptotic length through which the calculated annual increments have been constrained is one major weakness in the method and is largely subjective.

The "traditional" Von Bertalanffy curve asymptotes to a horizontal line. However, if curves are fitted to the Lake Kariba data by eye it appears that there is a continued slow increase in length throughout life. This was also true for data from Lake Ngezi (Hutton, 1984). In view of this and data and opinions of other authors (Chabreck and Joanen, 1979; Graham, 1968; Neill, 1971) it was felt that the use of a modified form of the Von Bertalanffy equation was justified (Craig *et al.*).

In this study it was much more difficult to count laminae in the femur sections than in the osteoderm sections. This was contrary to what was expected and it is unfortunate that both sections were not collected from the shot sample.

Finally it should be mentioned that there is at least one documented case of poor management of fish populations because of non-validation of the ageing technique (Beamish and McFarlane, 1983). This should remind wildlife managers to treat these growth curves with caution until better data is available.

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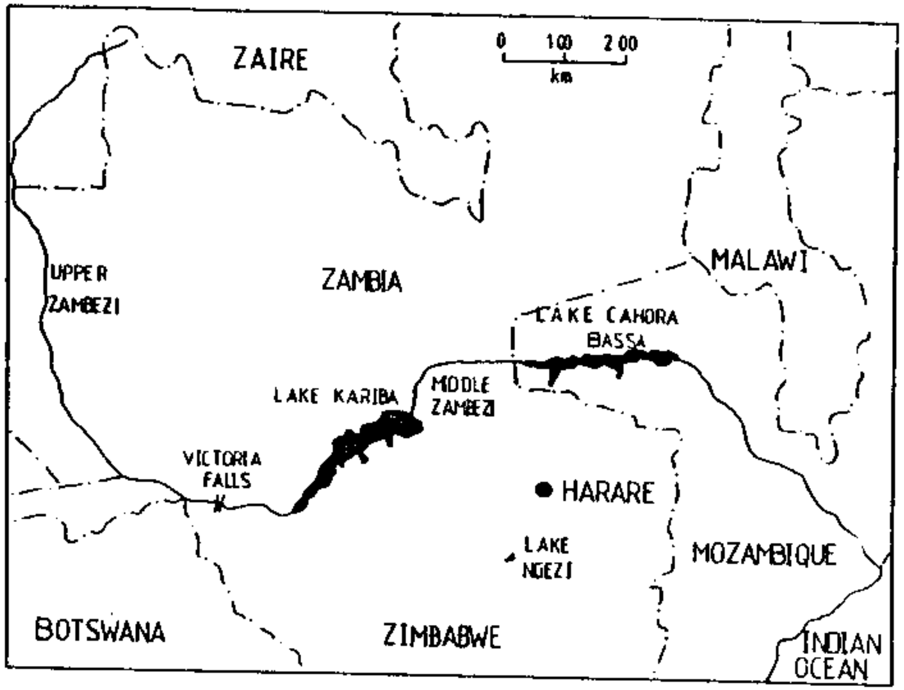

Figure 1. South Central Africa showing the Zambezi River and Lakes Kariba and Cahora Bassa.

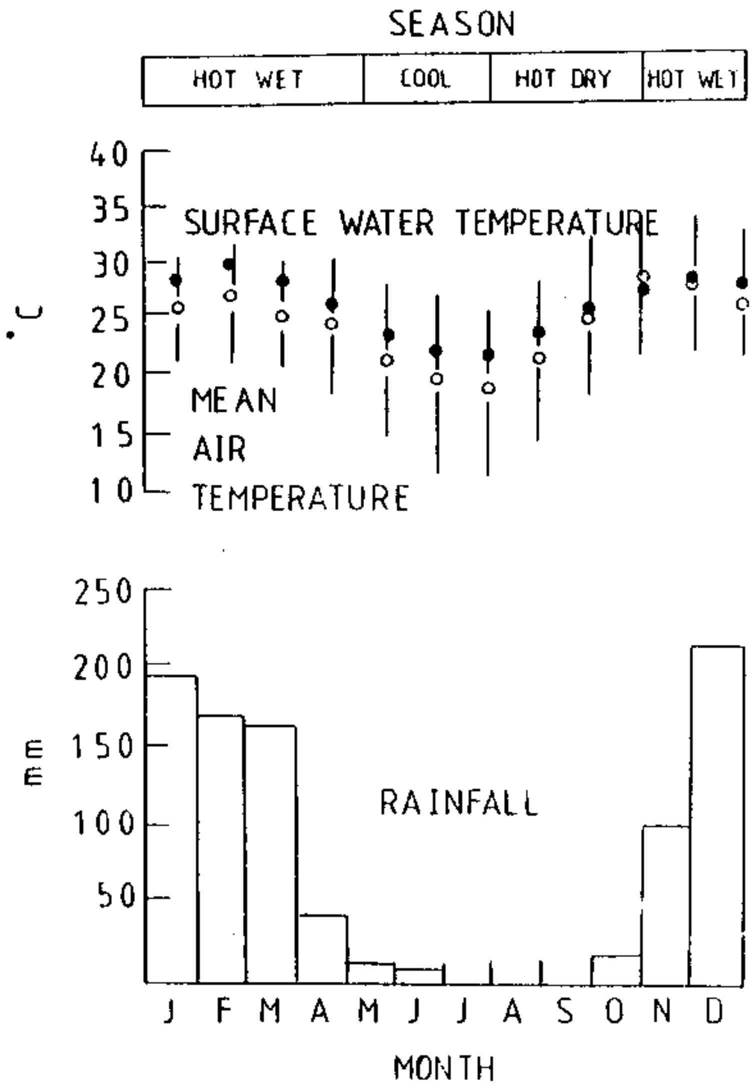

Figure 2. Mean air temperatures (0), surface water temperatures (●) and rainfall for the study area (Data from Lake Kariba). Broad seasonal divisions are also indicated.

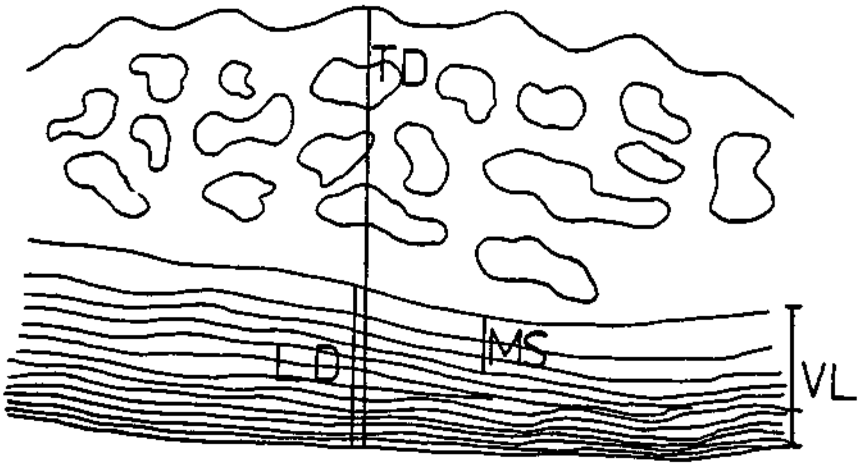

Figure 3. Measurements taken from osteoderm sections to estimate age. TD = Total osteoderm depth; LD = Depth of visible laminae; VL = Number of visible laminae; MS = Three innermost laminae averaged for the mean separation.

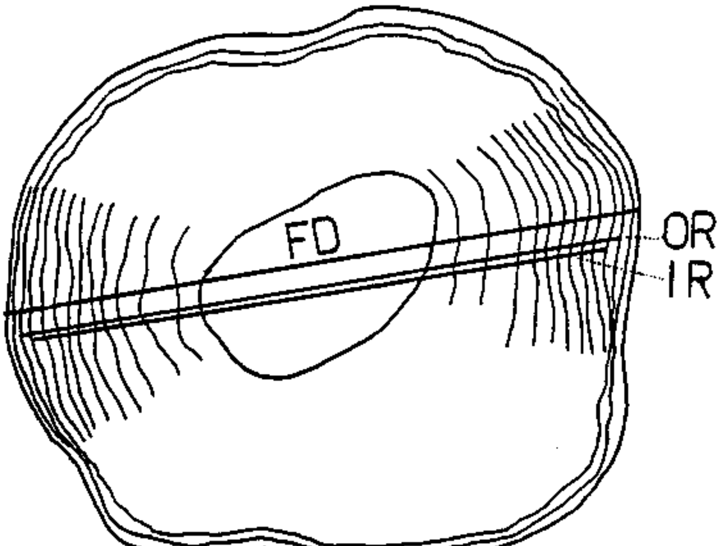

Figure 4. Measurements taken from femur sections to estimate age.
FD = Femur diameter along the longest axis;
OR = Diameter of a lamina;
IR = Diameter of the next inner lamina.

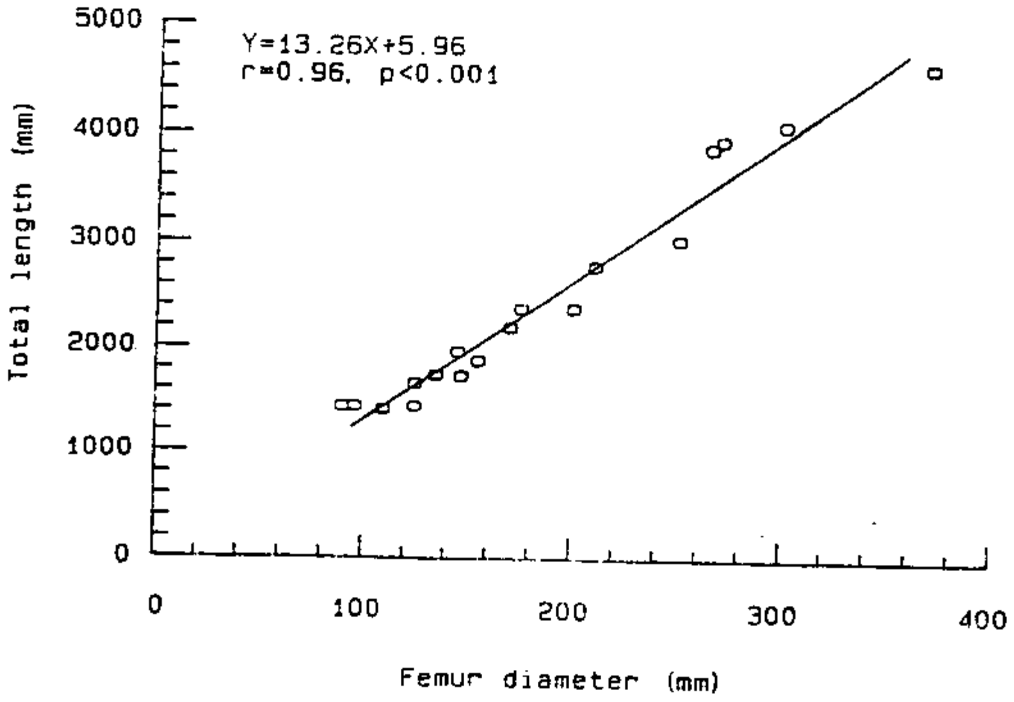

Figure 5. The relationship between femur diameter and total length for a sample of male femurs from Lake Cahora Bassa.

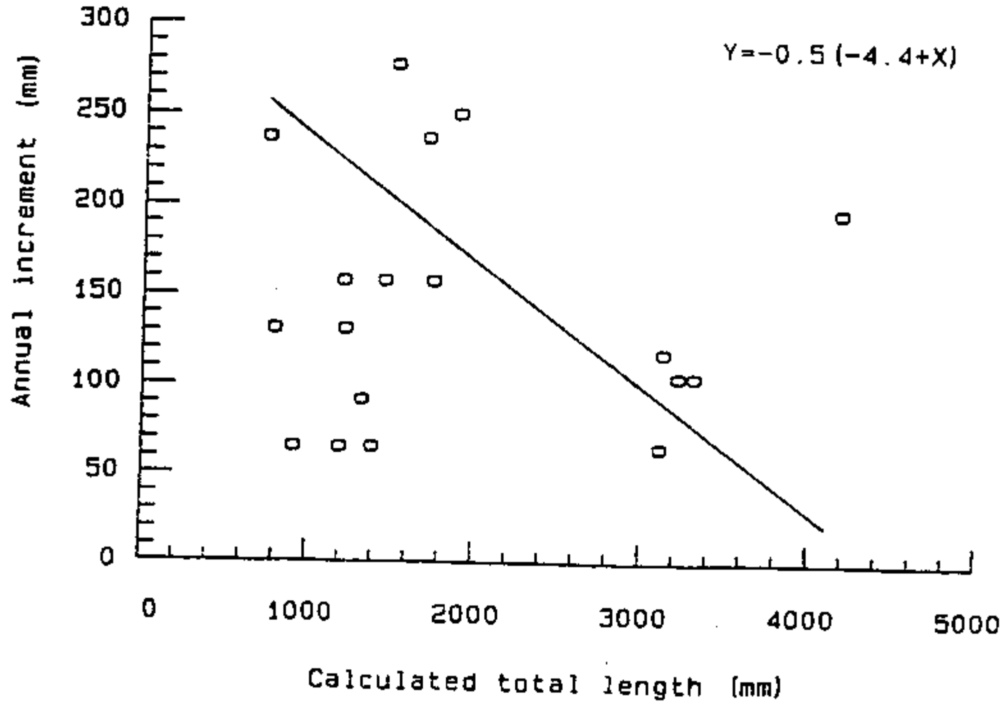

Figure 6. The relationship between calculated total length (from the inner lamina) and the calculated annual increment (see text).

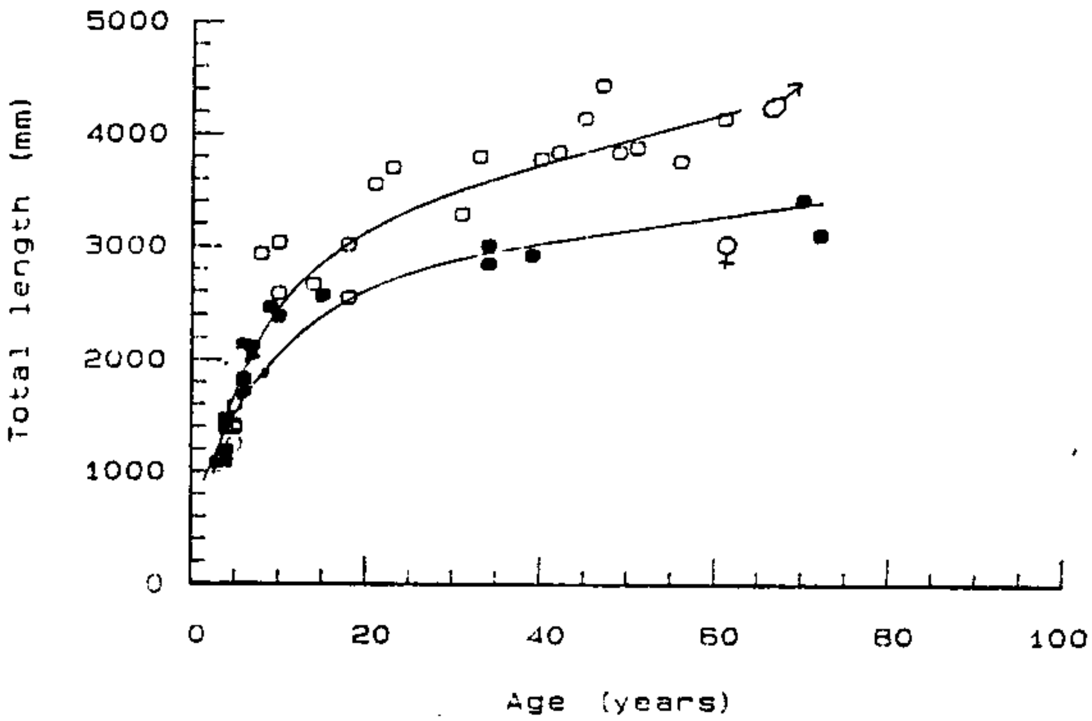

Figure 7. Growth of male (0) and female (●) crocodiles from Lake Kariba determined by skeletochronology. **Males;** *K = 2.9; A = 0.021; B = 0.634; R = -0.293.* **Females;** *K = 2.7; A = 0.007; B = 0.314; R = -0.226.*

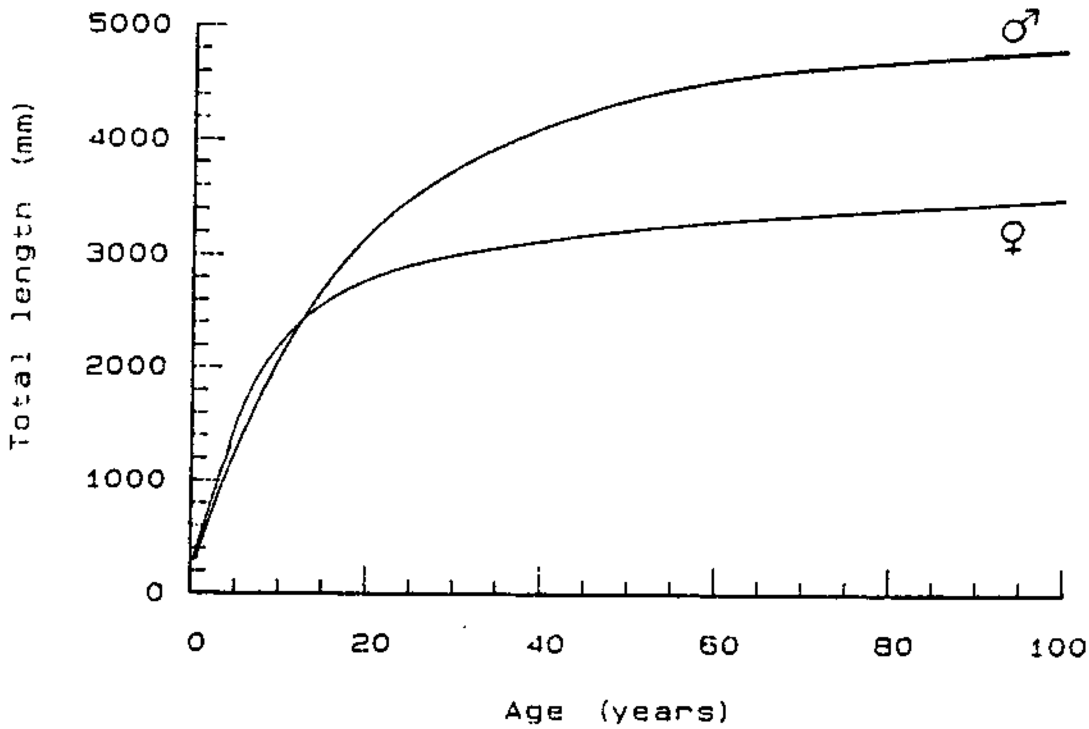

Figure 8. Growth of male and female crocodiles from Lake Cahora Bassa determined by skeletochronology. **Males;** *K = 4.4; A = 0.002; B = 0.9; R = -0.052.* **Females;** *K = 3.2; A = 0.004; B = 0.9; R = -0.1.*

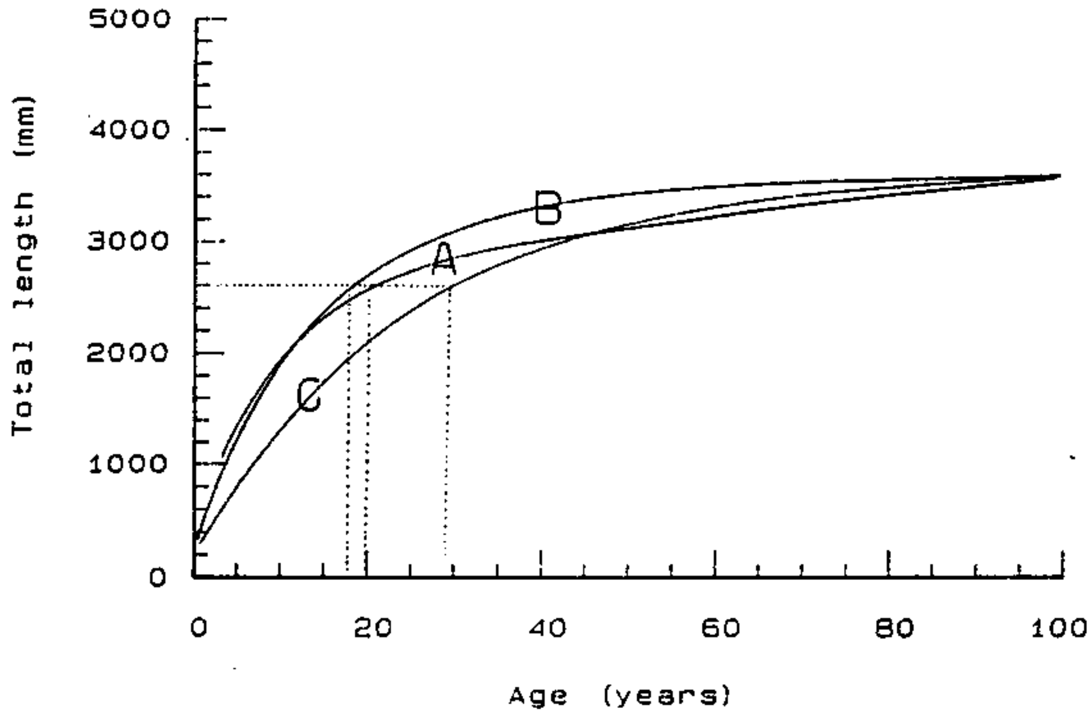

Figure 9. Comparison of female Nile crocodile growth curves, determined by skeletochronology, from Lakes Kariba (A), Cahora Bassa (B) and Ngezi (C). Dotted lines indicate the age at 2.6 m total length (the size at which most wild Nile crocodiles are thought to be capable of breeding).
Ngezi females; *K = 3.2; A = 0.004; B = 0.878; R = -0.51.*

THE STATUS OF CROCODILE POPULATIONS IN PAPUA NEW GUINEA 1981 - 1988

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THE STATUS OF CROCODILE POPULATIONS IN PAPUA NEW GUINEA 1981 - 1988

INTRODUCTION

This paper is a report on the current status of the two crocodile species that occur in Papua New Guinea (PNG). These are the *Crocodylus porosus*, the so called saltwater or the estuarine species, and *C. novaeguineae*, commonly known as the New Guinea freshwater species. The primary objective is to present an up date to data on the status of wild crocodile populations.

The commercial significance of these species results primarily from the trade of their skins, which has been going on for the last six decades (Hollands 1986a). Within the five year period prior to 1987 annual export earnings from crocodile skins were in the order of $US2.6 million. This was exceeded in 1987 alone with an increase to $US3.25 million.

As a developing country, foreign earnings as such are significant for PNG. The resource, however, requires attention to conservation and management strategies in that, with particular reference to *C. porosus* it has been subjected to depletion and population declines in many areas of its distribution world-wide. Since crocodiles are listed as endangered species, but being commercially valuable the nature of their trade in crocodile products must conform to CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) requirements. The primary goal of regulation being to ensure sustainable yield harvests on a long term basis (Hollands 1982a, 1984a, 1985, 1986a). Both of the PNG species are listed on Appendix II of CITES.

Whilst the above statements emphasize the commercial significance of the crocodile resource in terms of its value to the national budget, the worth of the crocodiles to the rural people of the major wetland areas is more significant. Crocodile products comprise the major, if not the only, income base of the swamp people. This is because development of agricultural cash crops would be very expensive where, reference is made particularly of the Sepik, Fly and the Gulf basins (Figure 1).

The development of the crocodile resource through various forms of exploitation has been reported elsewhere and will not be reviewed here (refer Hollands 1982a, 1984a, 1985, 1986a; Cox 1984). To achieve the goal of "continous use" of the resource without depletion of the crocodile populations, the government and industry have endeavoured to improve management strategies through efficient harvesting and monitoring of wild populations since the late 1960s and 1970s. With the assistance of the UNDP/FAO preliminary monitoring work began in the early 1980s. The Government's monitoring ecologist, Martin Hollands developed the current monitoring programme and this has been in operation since 1981.

A number of works have detailed the rationale and implementation of various programmes both in the development of the crocodile industry and in scientific research. The reports include those by Downes (1969, 1970, 1971a-b, 1974, 1978), Lever (1975, 1978), Medem (1976), Bolton (1977, 1978. 1981), Lever and Balson (1978), Kwapena and Bolton (1982), Graham (1980, 1981), Graham and Rose (1981), Bolton and Laufa (1982), Hollands (1982a-b, 1984a-b, 1985, 1986a-b), Hollands and Goudie (1984). Important contributions on monitoring and ecological research.on crocodile populations include the works by Pernetta and Burgin (1978), Burgin (1980a-b,1981, 1982), Hall (1980, 1981, 1983a-b), Graham and Whitaker (1980), Hollands (1982a-b, 1984a-b, 1985, 1986a-b), Cox (1984) and Cox et al. (1987).

Analysis of monitoring data on population trends since 1981/1982 was initially evaluated in 1982 (Hollands, 1982a 1984a). An early examination of the relevancy of data collection and analysis followed in 1984 (Hollands, 1984b). A further review of the aims and effectiveness of the programme was made in 1985 (Hollands, 1985). The last CSG report was made in 1986 as an up-date to the data (Hollands, 1986). The most recent population monitoring data and results are reported by Cox et.al. (1987).

This paper was prepared for the Ninth Working Meeting of the Crocodile Specialist Group (CSG) held at Lae, Papua New Guinea from 19 - 21 October 1988 and presents an up-date of the 1986 report. The paper in the first instance, outlines exploitation of the crocodile resource, population trends and envisaged monitoring activities. Other data of relevance on trade and conservation measures are also considered.

1. EXPLOITATION

Crocodylus porosus and *C. novaeguineae* occupy most of the lowlands of the main PNG landmass, whilst *C. porosus* is believed to be the only species in the offshore islands (Whitaker 1979, Hollands 1985). As Figure 1 shows there is a very wide distribution of the species, particularly on the main landmass. It should be noted though that *C. novaeguineae*'s distribution towards the coastal margins is affected by the presence of saline conditions, which it cannot tolerate. Its distribution would not extend to the immediate coastlines but fluctuate according to the influx of sea waters and tidal movements along the coasts.

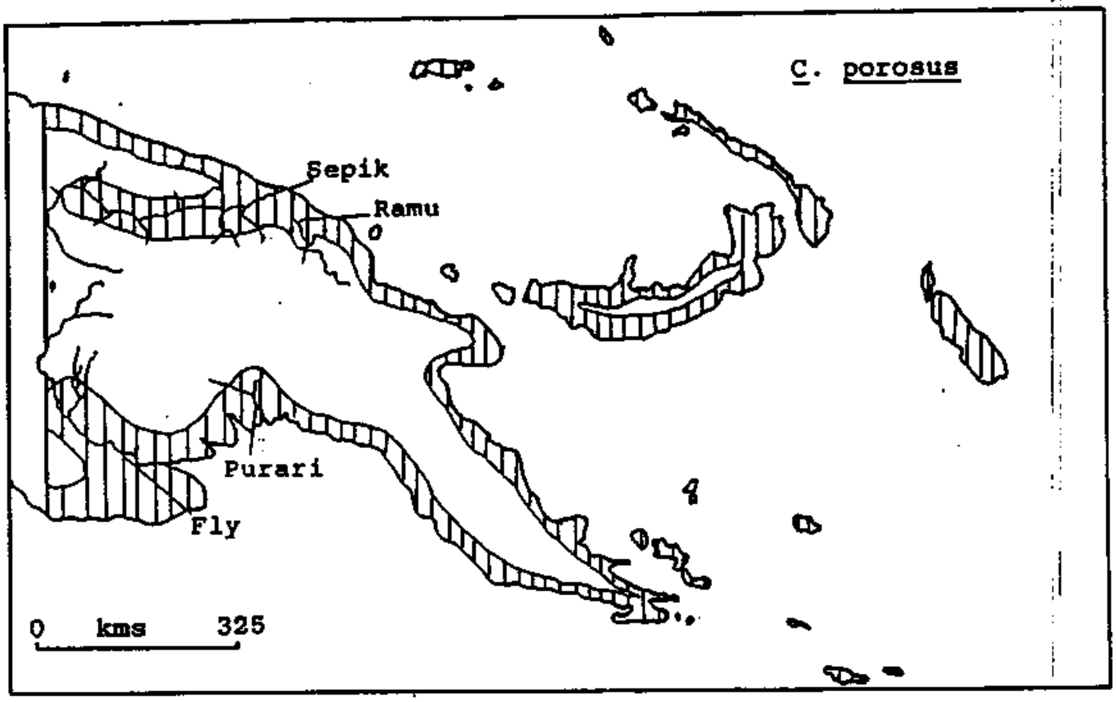
To appreciate exploitation of the species it is worthwhile to note some general features of the species in reference to PNG's natural environments and commercial trade. *C. porosus* is the larger of the two species and inhabits a much wider range. It occupies estuaries and the more open-water environs of swamps and lagoons. The species produces the best skins in crocodilian leather and products for the international market.

C. noveaguineae is the endemic so-called freshwater species to the island of New Guinea, and shows two distinct populations. One occurs in the northern portion of the country, primarily the Sepik basin, the other in the south-western portion, primarily the Fly basin. The distribution of *C. novaeguineae* overlaps with *C. porosus*, except the immediate coastal areas.

As shown in Figure 1 there is a very large area of suitable habitats for the crocodiles. The main areas of distribution are the Sepik, Western and Gulf basins, whilst additional concentrations occur in the Central and Northern Provinces as well as the main islands. According to Hollands (1986) it was reported that good populations of crocodiles abound for hunting of wild skins and development of ranching activities. The present situation is very much the same.

Whilst exploitation of the crocodile resource is valuable, the problems of available stocks is attributed to the historical trend of harvesting. Basically, traditional exploitation has always been for food. The introduction of commercial trade of skins and the hunting methods that accompanied resulted in many areas being hunted out whilst at the same time the mean size of the animals harvested was reduced to very small sizes. This is shown in Figure 2, where there was an upsurge in

FIGURE 1: **Distribution of Crocodiles in Papua New Guinea (Hollands, 1984b)**



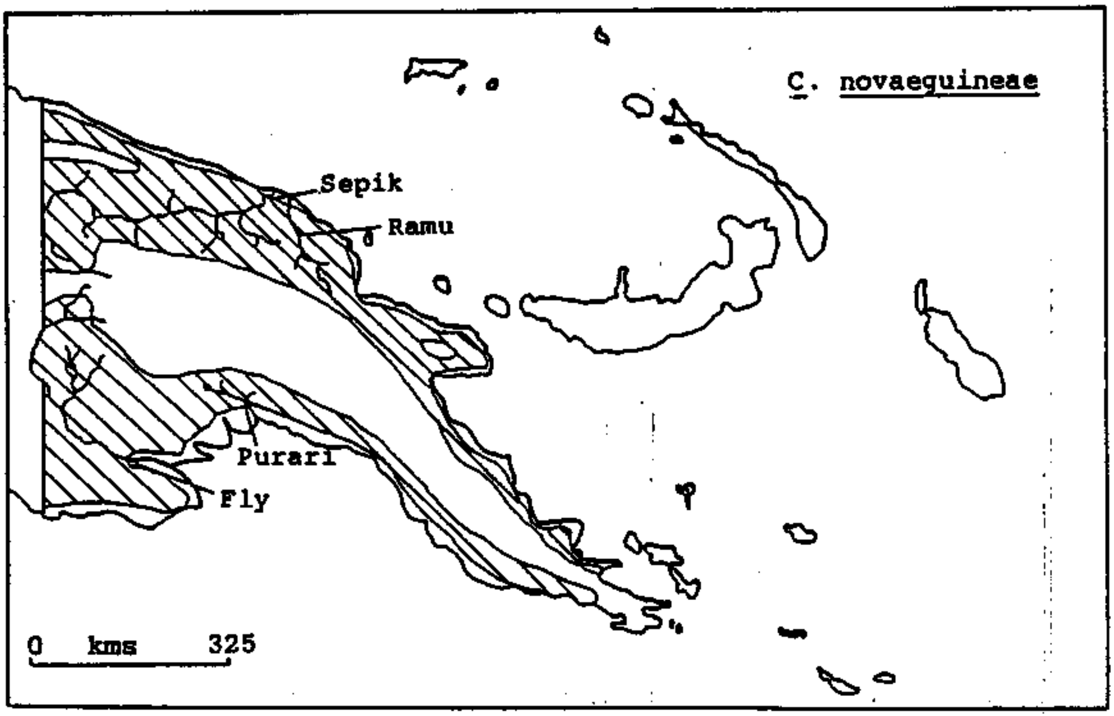
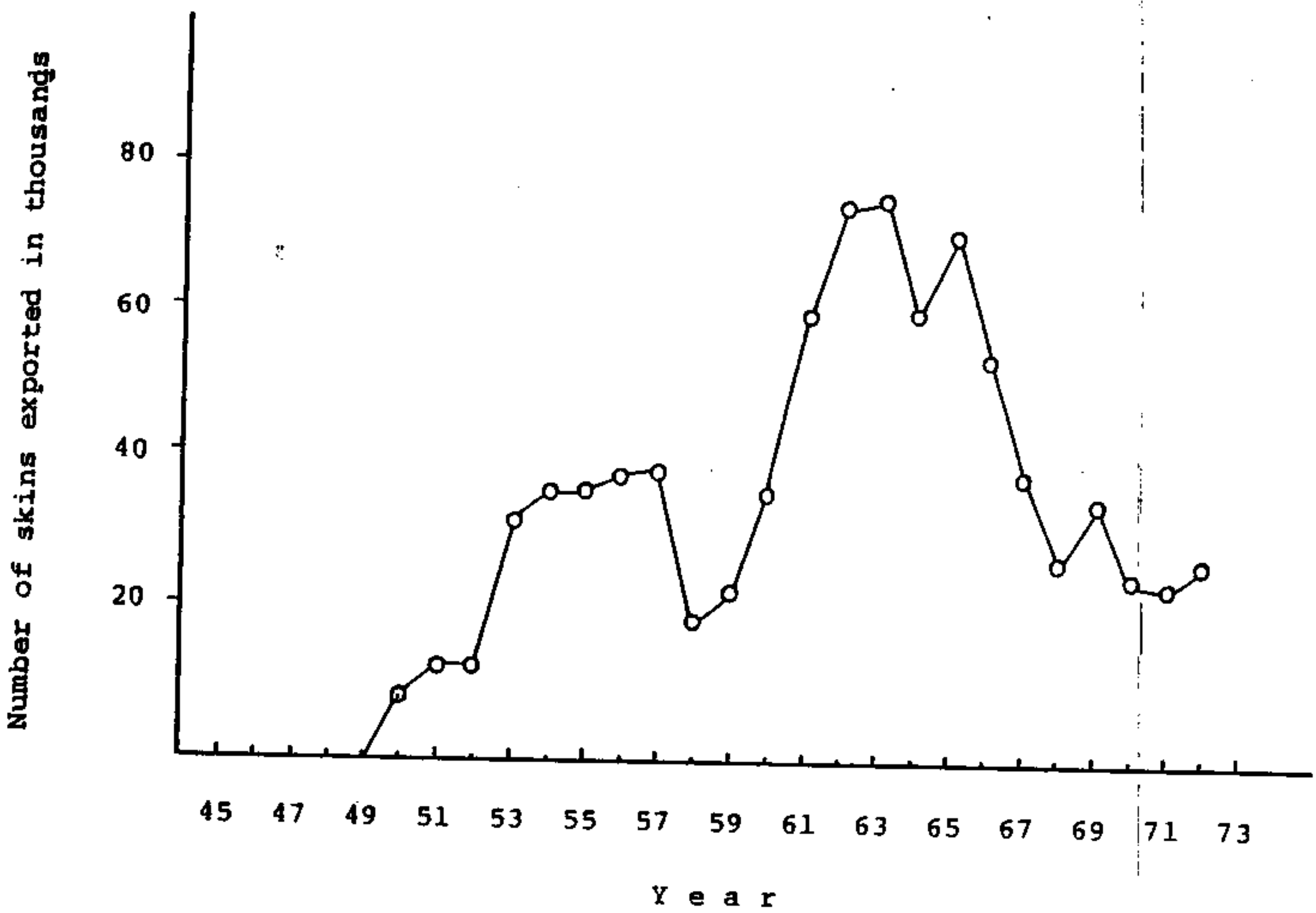


FIGURE 2: Total skins exported from PNG between 1945 - 1972 of both <u>C. porosus</u> and <u>C. novaeguineae</u> (Based on data in Hollands, 1985)



harvests according to the trade data and eventually a collapse in export of skins. The main problems were declines in populations, and the breeding stock which was shown by very small sized skins comprising the exports.

These problems have been addressed by national bans on trade of skins with commercial belly-widths of over 20 inches (510 mm) which was enforced in 1975 and sizes less than 7 inches (180 mm) in 1981. The other major development has been a gradual shift from harvest of wild skins to ranching activities (Hollands 1985, 1986a). The successful development of ranching to-date is shown in Table 1.

TABLE 1: Live purchase by major ranches and farms in PNG

YEAR	*C. novaeguineae*	*C. porosus*	TOTAL
1979	3958	974	4932
1980	7669	2141	9810
1981	8118	2178	10296
1982	8602	2799	11401
1983	2518	1901	4419
1984	3329	1469	4798
1985	6010	4025	10035
1986	6531	5310	14841
1987	9464	3701	13165

The drop of the 1983/1984 period was due to low market prices, which meant that it was not viable for farms to continue purchase of live animals, and not a decline of wild stocks. Apart from this live purchase increased from 1979-1987 with the highest increases in 1986 and 1987. Although a small number of crocodiles are bred on the farms, they are expected to be insufficient to supply the demand for a long term basis.

Experimental egg harvests of *C. porosus* have been conducted in the Ambunti District, East Sepik Province, since 1985 except for 1987. In addition to the use of the eggs to obtain biological data such as hatchability and mortality, the exercise was conceived to halt large scale human predation. Hollands (1986a) reported a dramatic decrease of the activity from 30-35% to only 3%. The impact of the egg harvest is controlled (government scientists) by a selection process in that only those subjected to floods and easy access to human harvests are taken. The overall result of the activity has been a continued marked decrease in human harvests while at the same an increase in the hatching of eggs to date.

2. POPULATION TRENDS

The primary consideration to the crocodile resource management programme at this stage is, what effect is the continued harvest having on the wild populations ?

Hollands (1982a, 1984a, 1984b, 1985) detailed the relevancy of different data sets and their analysis from various monitoring techniques since the monitoring programme was initiated. The paramount problems identified and which still beset the programme(s) include:

(a) Problems due to "wariness" as the crocodiles are still being hunted:
(b) Most crocodiles breed in very heavily vegetated habitats; and
(c) Data analysis and interpretation.

Other major problems are limited funds, logistics, equipment, manpower and expertise. Recognising the difficulties posed by the natural environments and logistical support within the programme, it has been more appropriate to place priority in identifying the "underlying population trends which are results of present management, and not a detailed inventory of their population size" (Hollands, 1986a).

2.1 AERIAL SURVEYS

The main method used to address the problem has been by annual aerial (helicopter) counts of wild nests, where repeated counts are made on identical census routes (lines). The data (present year of survey) is compared with the previous year's results. Adjustments by habitat weighting are made to the raw data to obtain a nesting index which indicates the trends of populations in terms of monitoring activities.

Aerial nest counts have however been confined only to the Middle Sepik Region because of budget constraints and this regions's high exploitation relative to other regions, (Hollands 1985, 1986a; Cox 1984). Data from the Middle Sepik is thus used to give an overall picture of the national situation.

2.11 SEPIK NEST DATA

The annual raw data from aerial nest counts are shown in Tables 2 and 3. Table 2 shows the data for *C. porosus* whilst Table 3 presents that for *C. novaeguineae*. It should be noted that as described by Hollands (1986a), the raw data is analysed within each habitat type by directly comparing the number of nests on identical routes within that habitat in the current survey and the previous survey. This is defined as the nesting index for that particular habitat, which is compared against the initial arbitrary base levels set at 100 in the first year of survey (note Table 4, refer Hollands, 1986). That is October 1981 for *C. novaeguineae* and March 1982 for *C. porosus*.

The data collection and analysis also present drawbacks. The departure of experienced field workers and experts on the aerial survey technique and the completion of the UNDP/FAO Project in the early 1980s resulted in lack of relevant manpower and expertise to collect and analyse the data. The consequence of this is reflected in Tables 2, 3 and 4 with particular reference to *C. novaeguineae* in 1986, when no surveys were done. The situation was corrected when J. Cox (FAO Crocodile Project Expert, Indonesia) was engaged to assist in the *C. novaeguineae* survey (October) in 1987 and the *C. porosus* surveys (March) in 1988.

The results of March 1987 for *C. porosus* in Tables 2 and 4 appear alarming in that a rapid increase of nest counts, followed by a marked decline in the following year are implied. This pattern did not result from actual population changes but from a high number of discrepancies in survey routes and nest counts (Cox et al. 1987). These problems were due to deployment of inexperienced and untrained personnel of which the NCP has noted and will not repeat. Whilst the data is included in Tables 2 and 4, it is not used in the trend analysis shown in Figure 3. Comparisons of routes and nest counts were made against the results of March 1986. The individual trends shown by each species are depicted in Figure 3.

C. porosus shows a steady increase to 1986 with a decrease (19) over the last two years. However the level (154) is still well above the initial level set in 1982. The trend therefore indicates that this species has recovered considerably, although there have been periodic but massive habitat disturbances by fire during the dry seasons since 1986.

TABLE 2: Aerial surveys of C. porosus in the Sepik.

SITE	NUMBER OF NESTS PER YEAR						
	1982	1983	1984	1985	1986	1987	1988
Kwandimbe	2	3	3	3	4	5	5
Japandai	n/s	3	1	2	2	2	0
Numahar	n/s	2	2	8	5	12	5
Lapangai Scrolls					n/s	1*	0
Walmau	n/s	3	3	4	n/s	1	2
Nambahar					n/s	1*	0
Wagu Lagoons	10	10	14	3	8	25	15
Kanai/Nyali/Wihab	0	0	3	3	4	3	2
Kamiemu Scrolls	4	6	6	8	8	16	9
West Kamiemu	n/s	n/s	n/s	4	5	10	6
Biaga Scrolls	n/s	n/s	n/s	3	3	2	0
Kubkain Oxbow	0	0	2	2	2	4	0
Kubkain Lagoons/Scr	7	5	8	10	10	22	11
Hauna Levels	1	1	0	1	2	7	3
Payangat/Kwayangur	0	2	2	7	1		2
Nyngium/Kokobagwa	6	1	3	8	7	3	6
Swamp 272607	n/s	n/s	n/s	n/s	1		
Chambri Barat	n/s	n/s	2	3	n/s		n/s
Mindimbit	n/s	n/s	1	2	n/s		n/s
Sop Barat	n/s	n/s	n/s	3	2	1	n/s
Lapangai						1*	
Kwasenam	15	2	2	6	7	17	5
Kuvenmas	n/s	n/s	2	2	n/s		n/s

Note: n/s Indicates sites not surveyed for that year
* Totals exclude sites not surveyed in 1986

TABLE 3: Aerial surveys of C.novaeguineae nests in the Sepik

SITE	NUMBER OF NESTS PER YEAR						
	1981	1982	1983	1984	1985	1986	1987
Korosameri	n/s	0	3	n/s	9		2
Walmau Lagoon	1	1	3	1			3
Yami Yauwe	0	7	2	1	5		1
Lapangai Scroll	1	3	2	1	2		3
Kwasenam	1	5	6	6	5		10
Bimba Lagoon	3	3	1	4	4		1
Nyali/Kanai	5	5	10	11	6		2
Kwandimbe	7	5	7	3	9		3
Wagu/Wasui	2	2	3	4	5		4
Khapar Barat	0	0	1	1	1		1
Payangat	2	3	1	2	2		2
Pwimakyiyapa	13	20	20	10	6		2
Kamiemu	10	14	22	11	27		17
Kabat (Kamiemu S.Barat)	3	5	10	5	3		8
Sop (Scroll/Lagoon)	n/s	4	4	2	3		4
Swagup	7	9	8	6	8		3
Biaga Scroll	3	4	4	3	9		3
Kubkain Oxbow	3	2	5	5	4		1
Kubkain Scroll	0	0	3	4	2		1
Kubkain Lagoons	4	7	4	3	5		5
Hauna Levels	11	13	9	5	10		11
Bowami Lakes	4	2	0	0	3		1
Swamp 272607	n/s	n/s	n/s	3	4		2
Yessan Scroll							6*
Numahar							3*
Sop Barat							3*
Wihab							1*

Note: * Totals exclude sites not surveyed in 1985

TABLE 4: Crocodile nesting indices for the Sepik

A. Habitat-Nesting Indices for C.porosus

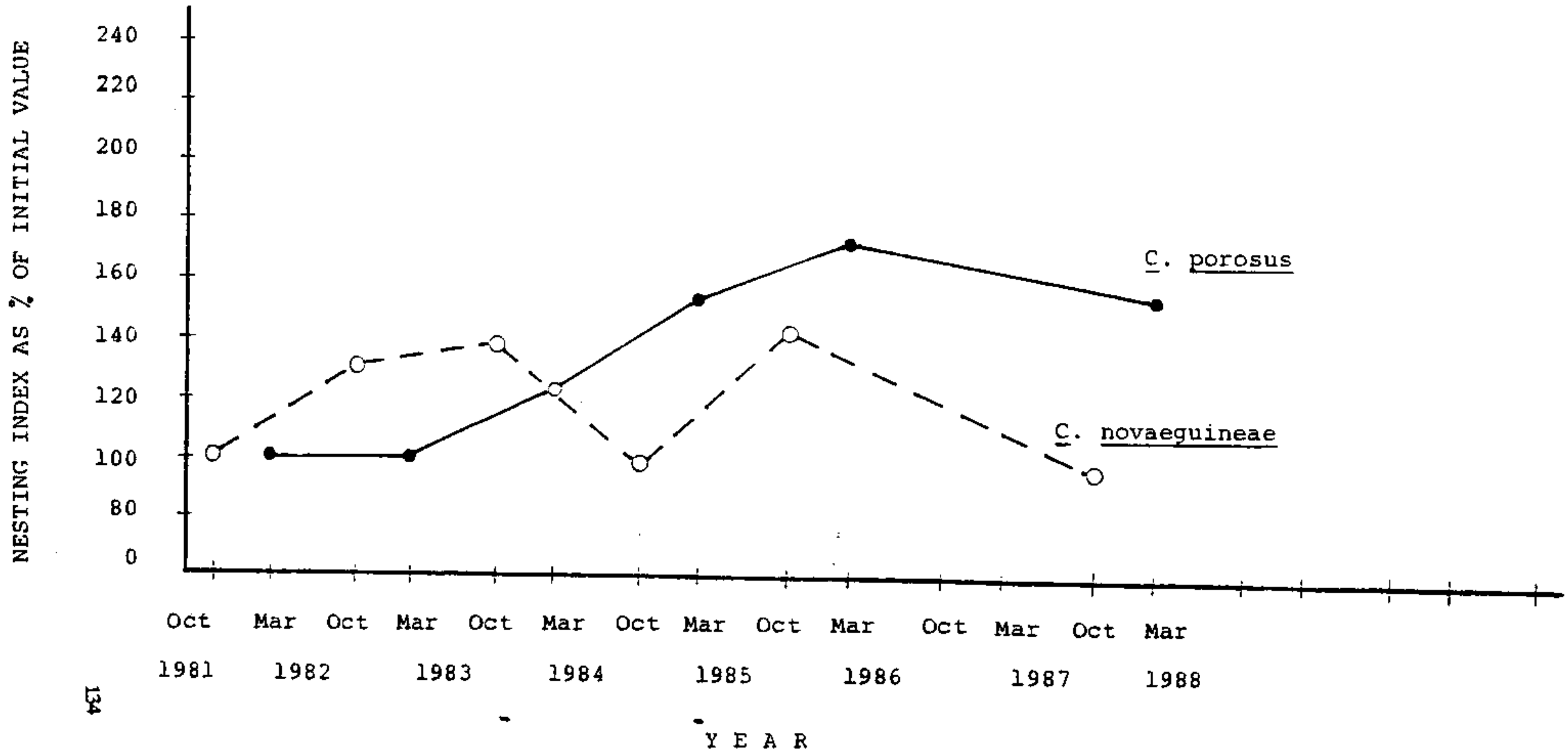
Habitat	W/Hab	Index per Year						
		1982	1983	1984	1985	1986	1987	1988
Lagoon Fringes	0.3	100	50	74	81	71	137	74
Ov.gr Oxbows and Channels	0.4	100	100	163	213	341	639	264
Scroll Swales	0.3	100	150	125	181	131	270	111
Habitat Weighted Nesting Index		100	101	123	162	188	362	154

B. Habitat-Nesting Indices for C.novaeguineae

Habitat	W/Hab	Index per Year						
		1981	1982	1983	1984	1985	1986	1987
Lagoon Fringes	0.2	100	111	122	92	95		73
Scroll	0.6	100	120	106	82	138		56
Channels/Barats	0.1	100	200	275	174	205		236
Overgrown Oxbows	0.1	100	135	157	98	176		137
Habitat Weighted Nesting Index		100	131	138	98	143		93

Notes:
(a) W/Hab - Habitat Weighting
(b) C.novaeguineae surveys of 1986 were not done
(c) C.porosus surveys of 1987 are not included in the trends analysis

FIGURE 3: Nesting trends of crocodiles in the Middle Sepik Region, PNG: October 1981 - March 1988



C. novaeguineae, in contrast shows marked population "fluctuations". Implications are not that there could be upsurges in population increases and also marked declines. It should be noted that nest-monitoring in *C. novaeguineae* is somewhat more complicated than in *C. porosus* (which prefers open environs) where limitations are imposed by the heavily vegetated habitats and wariness due to continued hunting must be appreciated.

The use of aerial surveys to obtain nest counts is indirect in that the technique monitors the numbers of nests and not the population *per se*. For monitoring purposes it is unfortunate that the percentage of female *C. novaeguineae* that breed each year depends very much on environmental factors. Rainfall and water levels are especially important because high rainfall and subsequent rises floods most nests. This means that Figure 4 probably shows large fluctuations in the nesting of a relatively stable population with 1984 and 1987 being extremely dry. In 1987 the water level wa actually unrecorded because the water level was below the base of the graduated pole used to measure water level. Given the considerations above, we consider the population of *C. novaeguineae* as being stable in the portion of the population surveyed.

2.12 OTHER AREAS

There are many areas where aerial counts are not used due to limited funds and logistics. The NCP expects to expand the surveys to new areas with suitable habitats (eg. Genolagani and Broome, 1988). These include the major wetland areas of the Ramu River (Madang Province), Central, Northern and West Sepik Provinces.

2.2 OTHER MONITORING ACTIVITIES

In areas where the habitats make aerial counts inefficient other monitoring techniques are being continued or will be reinstated. These include (refer Hollands 1982a, 1984a):

(a) Night spotting and tagging surveys in the Central (Genolagani 1988, Hulo et al 1988), Gulf (Broome and Solmu, 1988), Western (Hulo, 1988), Morobe, East and West Sepik, and Northern Provinces and the Islands Region (eg. Willie and Hulo, 1988);

(b) Examining "catch per unit effort" (CPUE); and

(c) Conducting village interviews.

Raw data from various surveys through the country are now being compiled for analysis. A major task to this regard is to identify appropriate methods for analysing the accumulated data.

2.3 TRADE STATISTICS

In addition to monitoring activities outlined above, one of the important monitoring parameters is through Trade Statistics. The main component here is in the Docket Book system where all licensed traders must comply with the data format provided.

Major details of the hunter (not always) and his village, the species being traded, where it was caught (not always provided), whether the animal is live or only the skin (includes grade) is presented. Measurements are also recorded on the belly widths, and total length if live. The main docket records provide data on the supply sources, the size ranges and number of animals harvested as well as of traders in various localities.

The data is important in monitoring the live (purchase) supply (eg. Table 1) to ranches and the number of wild skins harvested. These are compared in Figure 4 where it can be seen that ranching has reached better development, particularly for *C. porosus*. The trade data also monitors the exported skins for species both in their total numbers (approximately 20,000-24, 000/year) and source of skins (i.e. ranched or wild) although as shown in Figure 5 the bulk of the exports are still wild skins. In the case of the wild skins the skin sizes have been categorized into the illegal lower limit sizes (<18cm) and legal sized skins (18-51cm). The important parameter here is that the under sized skins have not comprised any portion of the exports since 1981 although this category was comprising almost 50% of the exports since 1977. *C. porosus* was the main victim then. Ranched skins are gradually increasing particularly for *C. porosus* which means that there is less emphasis on hunting for wild skins.

In terms of harvests from the wild killed crocodiles the size distribution is shown in Figure 6. It is shown that the bulk of the harvested size is in the lower category of between 18-23 cm (approximately 12%) belly widths. The small increase towards the 50-51cm (2-5%) belly width portion is attributed not to over-sized kills but mostly to some traders having the knowledge to stretch and/or shrink skins. It is expected that with more input into staff training on recognition of such cases the exercise would address the situation. As for the lower category sizes the increased development of ranching is envisaged to control the situation through live purchases and more rural education on the economics of small skins versus larger skins and the importance of the breeding size animals.

FIGURE 4: CROCODILE HARVEST 1977 - 1987 SHOWING WILDSKINS AND LIVE PURCHASE

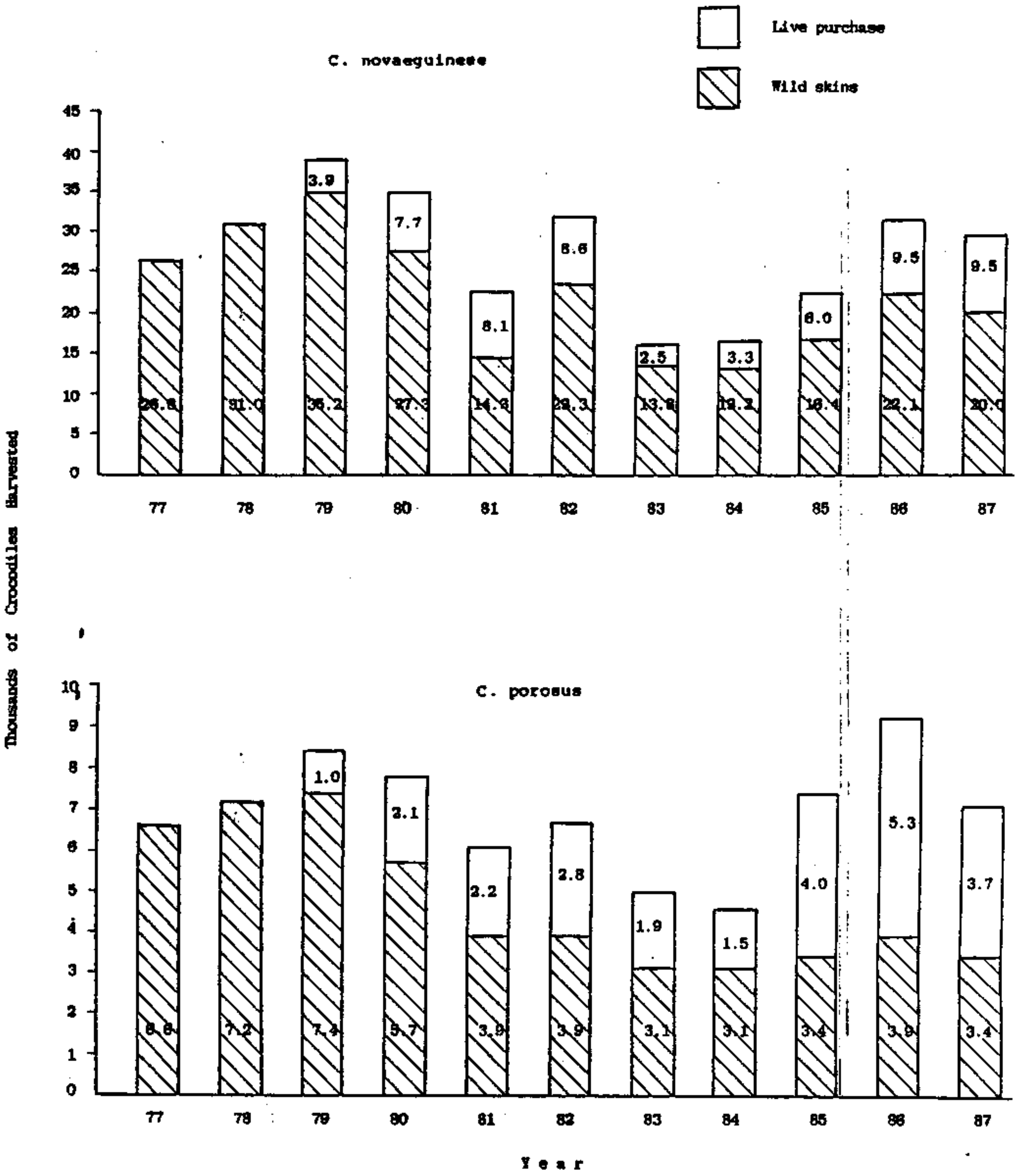
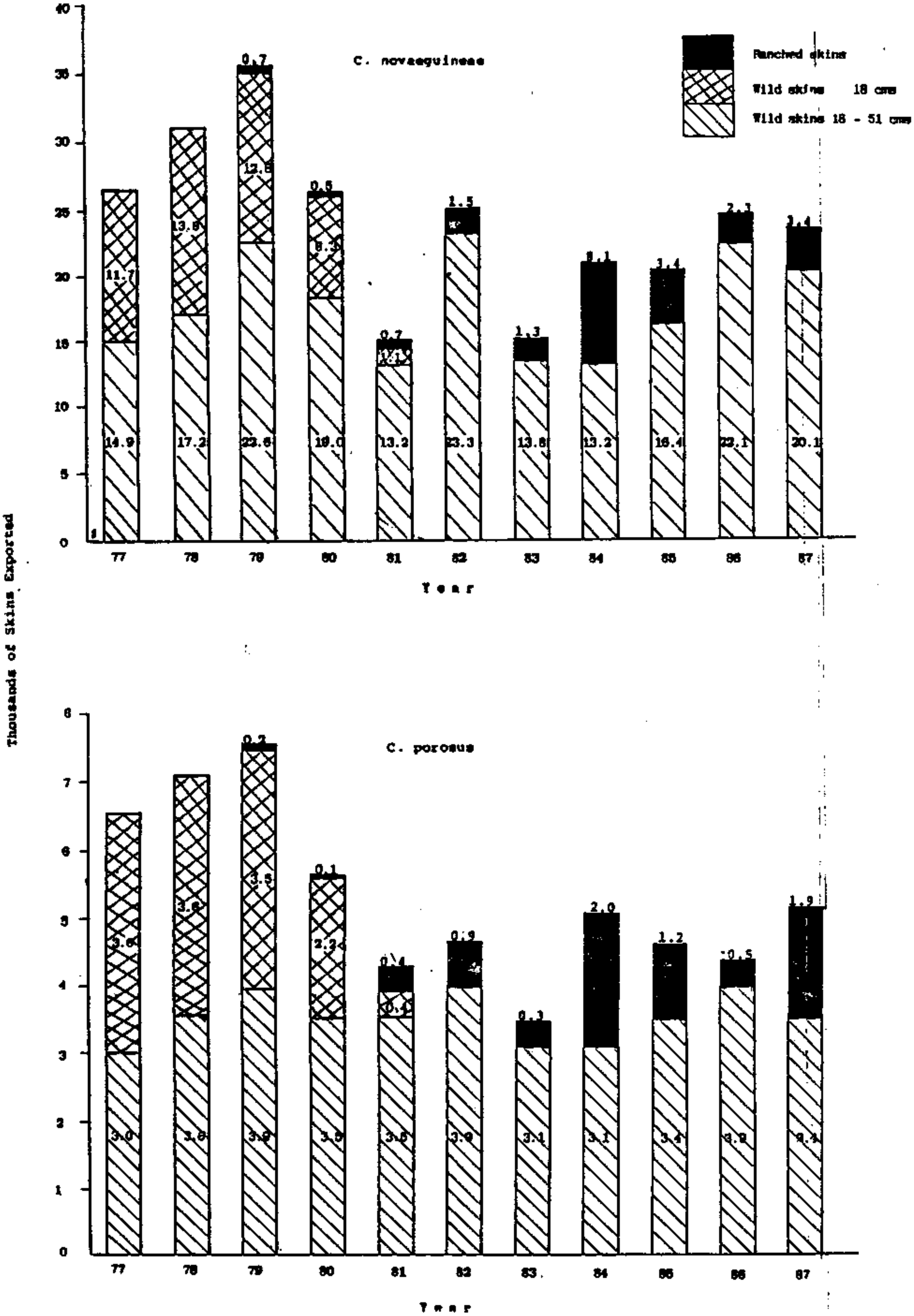


FIGURE 5: EXPORT OF CROCODILE SKINS 1977 - 1987



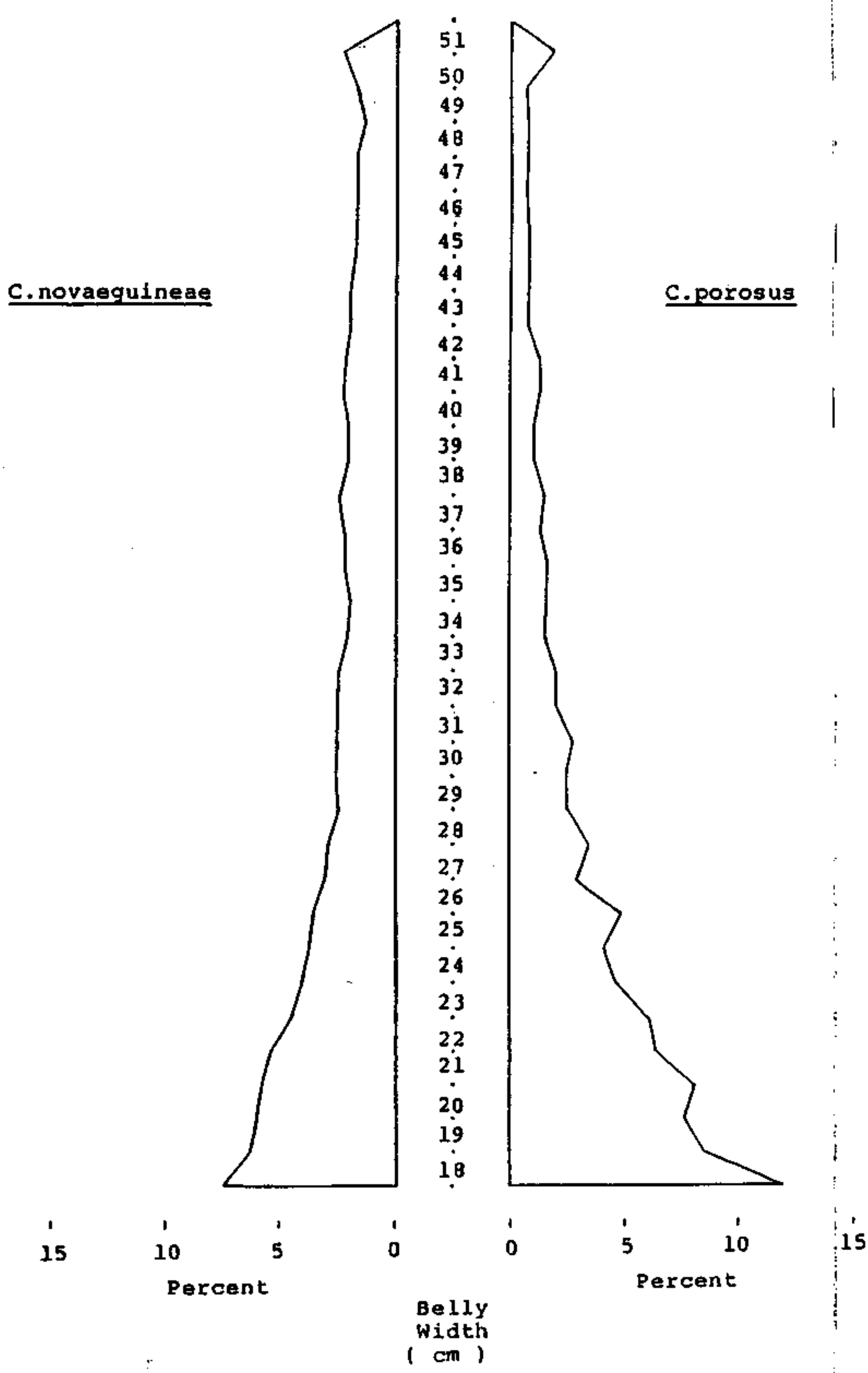


FIGURE 6: Size distribution of wild killed crocodiles in P.N.G from 1986 - 1987

An important contention is that the present management has been successful so far in fostering and monitoring crocodile populations to be viable, with particular reference to *C. porosus*. This means that the status of the species on the CITES listing (Appendix II) be maintained.

3. EXPORT PROCEDURES

Recognizing that the nature of the participants at the meeting is so varied, that is, there is a contingent of non scientific participants, but who are very much involved in the international trade. These include importers, exporters and members of the International Traffic (IUCN) being present and so it is considered to be worthwhile to present the export procedures involved in PNG. This is since PNG is the only "legal" and unrestricted exporter of both *C. noveaguineae* and *C. porosus*.

Export Procedures

The basic export procedures are:

(1) Exporting of crocodile skins (and/or live in some cases) are carried out by licensed exporter only. The export licences are approved only by the Minister for the Department of Environment and Conservation (DEC):

(2) All export applications are submitted with a levy payment (Management Levy) to the DEC;

(3) The skins to be exported are inspected by at least two PNG Wildlife Rangers (gazetted) where all large and/or small skins in the shipment are remeasured and graded;

(4) The skins are then tagged (CITES Tags); and

(5) The application (Export Permit) is then approved by the Conservator of Fauna (Secretary, DEC) to effect the export of the shipment.

4. CONSERVATION MEASURES

To enable and enhance the current status the need for conservation measures are essential to provide effective management. The primary conservation measures are outlined below:

(1) National Crocodile Project - As pointed out by Hollands (1982a, 1984a) the role and functions of the National Crocodile Project (NCP) within the crocodile resource development industry is a conservation measure to monitor trends of the wild stocks and the trade.

(2) Legislations - Enforcement of various legislations, particularly the Crocodile Trade (Protection) Act, Chapter No. 213. Fauna (Protection and Control) Act, Chapter 154 still require more emphasis. The national bans of belly width skins more than 51 cm and less than 18 cm have contributed much to improvements on skin sizes for trade, gradual shift from wild kills, and an impetus to live purchase by farms. The other envisaged development is to encourage traditional laws through the land tenure system to particularly control poaching on traditional land.

(3) Harvesting Strategies - The other major measure is through various harvesting strategies. These include:

(a) Discouraging the harvest of wild skins and placing of more emphasis on the development of ranches. The main goal here is to allow increased revenue but with less impact on the wild populations. The activity would reduce the number of small wild skins but be compensated by raising of the small-live crocodiles for higher valued (larger sized and high quality) skins.

(b) Development of farms at present ensures a buffer stock of some 35,000 animals being held across the country. These would be needed for restocking should the situation warrants it.

(c) Egg harvests ensures nest salvages from natural factors, such as, floods, other animals and especially human predation. The harvest of eggs from nests under such conditions make use of the so-called potential "wastes" to more profitable ventures through artificial incubation and farm rearing of those that successfully hatch. The exercise however is on a research basis at present where it is envisaged that more development is expected. Eggs are also collected on farms which conduct some breeding. The latter though is not expected to be a major development as it would be insufficient to supply the demand.

(4) Establishment of crocodile reserves - A major development to protection of the species is through the establishment of natural reserves. These reserves can be enacted by various legislations which include the National Parks Act, Chapter No.157, Conservation Areas Act, Chapter No.362, and Fauna (Protection and Control) Act, Chapter No.154. The legislations do have problems in implementing them where the Conservation Areas Act has not been used to date. National Parks Act "appears" to impinge on traditional ownership through state purchase and management and has met with problems. The Wildlife Management Area model under the Fauna (Protection and Control) Act has been the most successful. This is where the onus of government and management of a reserved is vested entirely on traditional owners of the area. There are fifteen (15) declared WMAs however not even one is specified for the crocodiles. The situation has warranted identification of at least twelve (12) which have been proposed through out the country as crocodile reserves.

(5) Geographical Isolation of Habitats - The natural environments offer natural protection in that some areas are not accessible and hence are not subjected to exploitation. They comprise a natural protected stock for potential use.

(6) Export Levy - PNG applies two types of export levy on the industry. The first, is the normal PNG Customs Levy which applies to all exported commodities including crocodiles. An annual sum of about K45,000 is collected by the Bureau of Customs under this levy. The second is the Management Levy, which was interdicted in 1987 and is the levy collected by DEC. The levy has a target of K50,000 per year and is provided as Appropriation In Aid (AIA) in the national budget to the DEC. The Management Levy was inevitable and essential for funding of various activities of the NCP. Monies from the Levy cater primarily for population monitoring and research costs, various law enforcement activities and relevant administration costs. Here, it is demonstrated how the national crocodile industry contributes to conservation and management measures.

The mechanism by which the Management Levy operates is by charges which are applied on a per centimetre basis regardless of the grade, species and/or over all the sizes of skins. An advantage, as a result of the Levy is that the tax burden is three times greater on small low-grade skins than top grade large skins. In simple terms the Levy discourages trade of small low-grade skins.

CONCLUSIONS

It is evident from above that PNG is currently maintaining its conservation and management objectives. Exploitation is being controlled although a lot more emphasis is still needed on enforcement of regulations. Ranching has developed to a higher degree with a gradual shift in wild kills. Population monitoring programmes are continuing with an expected expansion to new areas. The trends of nesting for *C. porosus* is still above the set level while the fluctuating *C. novaeguineae* levels about the set level need more field studies. The present data considers *C. novaeguineae* to be safe as much of the inaccessible habitats are not surveyed and hold unaccounted-for crocodiles. The trade data is significant in ensuring monitoring of exported skins in terms of quantity, quality, and sizes for international trade. This exercise has enable the Management Levy to be imposed which contributes much needed funds for population monitoring programmes.

The much needed revenue from the crocodile resource comprises a component of the national budget but more importantly is its worth to the swamp people as a means of social and economic development. Continuation of the current activities and further improvements would enable better future development of the industry whilst conservation and management programmes should ensure viable populations and species protection within the goals of the World Conservation Strategy.

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We extend our thanks to all those who have been directly and/or indirectly involved with the crocodile management programme in PNG. These include various staff under the UNDP/FAO and government personnel at various stages. Availability of various reports and comments from many people have made the programme to what it is today. Particular mention is made of the 1982 report which outlined the projections to be achieved and has formed the basis for this report. Other reports of significance include the 1984, 1986 and the 1985 technical report.

This paper benefited greatly with comments and assistance by Martin Hollands (Ottley College, UK) just prior to the CSG Working Meeting for which we are sincerely grateful. Finally, but not the least, mention is made especially of the NCP staff who are attempting to bridge many technical deficiencies in all facets of the NCP programmes but contributed immensely in preparations of various components of this paper.

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STATUS OF *CROCODYLUS POROSUS* AND *C. NOVAEGUINEAE* POPULATIONS IN PAPUA NEW GUINEA: 1981 - 1990.

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STATUS OF *CROCODYLUS POROSUS* AND *C. NOVAEGUINEAE* POPULATIONS IN PAPUA NEW GUINEA: 1981 - 1990.

1. INTRODUCTION

This paper is an updated report on the status of wild populations of the two crocodile species found in Papua New Guinea. The species are *Crocodylus porosus* and *C. novaeguineae*. The report is primarily based on the status report presented in 1988 (Genolagani and Wilmot, 1988) at the Ninth Working Meeting of the Crocodile Specialist Group (CSG) at Lae, Papua New Guinea.

In brief, Papua New Guinea's (PNG) national policy states that maximum benefits derived from commercial exploitation should be directed towards the resource owners, and that wild harvests be gradually scaled down by the development of ranching programmes, to ensure achieving the goal of sustainable-yield harvests on a long term basis (Hollands, 1984).

The data shown in this report focus primarily on wild harvests, hides exported, and the population trends to date. It should be noted that the trade data covers the 1988/1989 period and the monitoring data is updated from March 1988 to March 1990.

2. EXPLOITATION AND TRADE

PNG has still maintained a stable level of exports of both species (i.e. only skins) for the period 1988/1989 period (Figure 1). PNG remains the largest producer of *C. porosus* skins with farm production of this species reaching the highest level in 1989 (44% of total exports). Farm production of *C. novaeguineae* was also high at 33% (Figure 2).

Due to present high prices the income in 1989 from skin exports increased significantly and earned an estimated $US 5 million. Of this, at least $US 1.5 million would have been paid directly to village hunters.

The lower live harvests for both species in 1989 compared to earlier years (Table 1) is due to high water levels in the producer areas which were experienced for much of the year. It should be mentioned that the high water levels makes hunting of the animals more difficult as the animals venture into more inaccessible areas for hunters.

TABLE 1: TOTAL LIVE PURCHASE BY MAJOR RANCHES AND FARMS IN PNG

Year	*C.porosus*		*C.novaeguineae*		Total
	Live	Eggs	Live	Eggs	
1979	974		3958		4932
1980	7141		7669		9810
1981	2168		8118		10296
1982	2799		8602		11401
1983	1901		2518		4419
1984	1469		3329		4798
1985	4025	671	6010		10100
1986	5310		9531		14841
1987	3701		9461		13165
1988	4400	647	6000	850	11897
1989	3200	1198	4900	1299	10597
1990		1234			

Wild harvests of eggs of both species in the Ambunti District of the East Sepik Province has continued. Although there has been some opposition to the programme, the activity is now becoming an accepted harvesting practice in the area. This has been through extension, consultation with the Local Government and cooperation of nest owners who now recognise the conservation value(s) of protection given to the nests.

3. POPULATION TRENDS

3.1 PRESENT MAJOR PROBLEM

At the CSG meeting in 1988 a number of major activities were envisaged for implementing in 1988 and 1989/1990. These included expansion of the aerial surveys to other regions in the country, compilation and analysis of other monitoring data sets such as night survey data, tagging, village interviews and catch per unit effort statistics. The closure of the country's major revenue earner, the Panguna Copper Mine (accounts for 40% of national budget) on Bougainville island due to land owners uprising early last year resulted in an almost total cut to all monitoring activities. The only activity that has been retained is the annual aerial nest surveys for both species.

FIGURE 1: Total crocodile harvest in PNG, 1977 - 1989

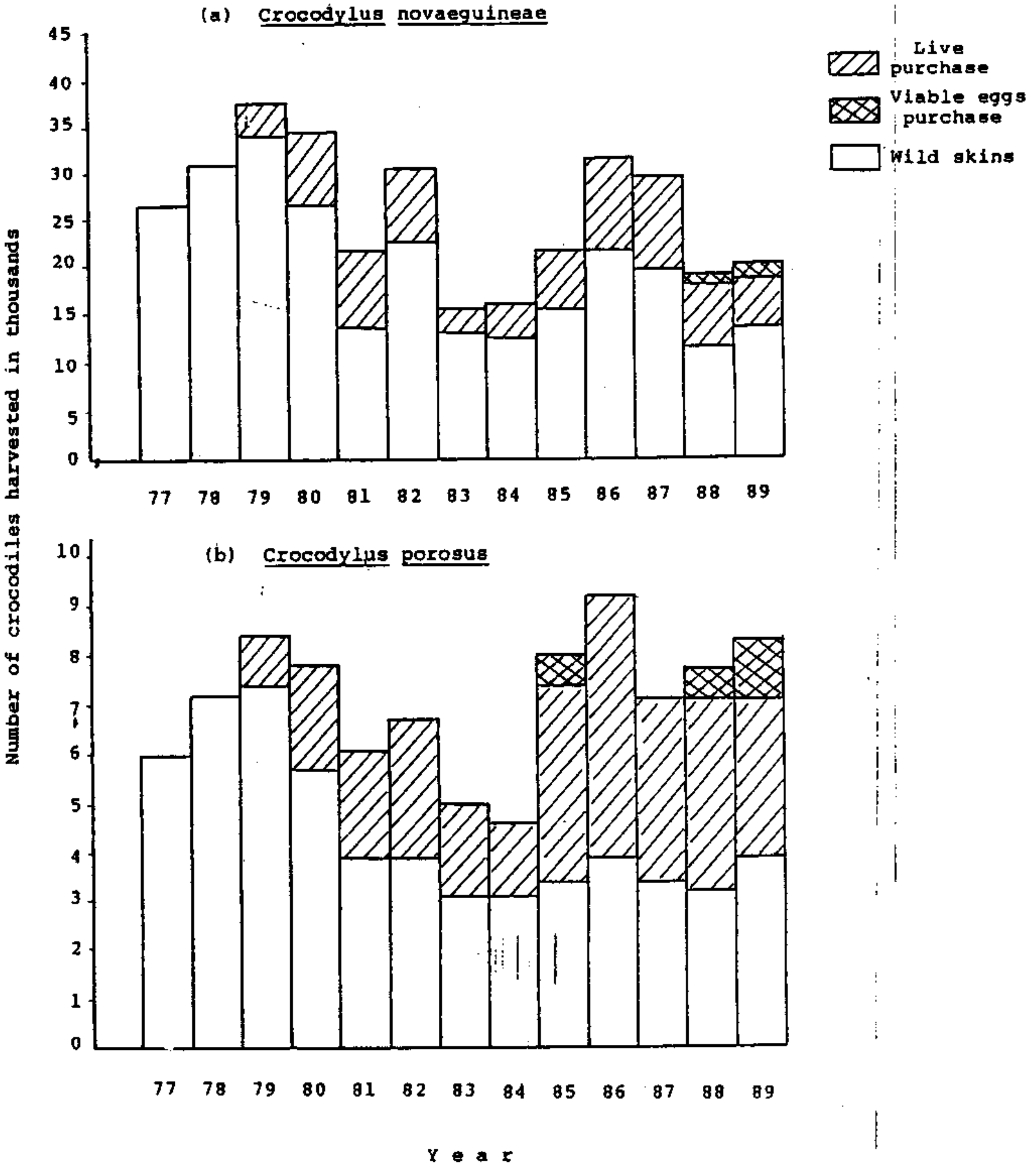
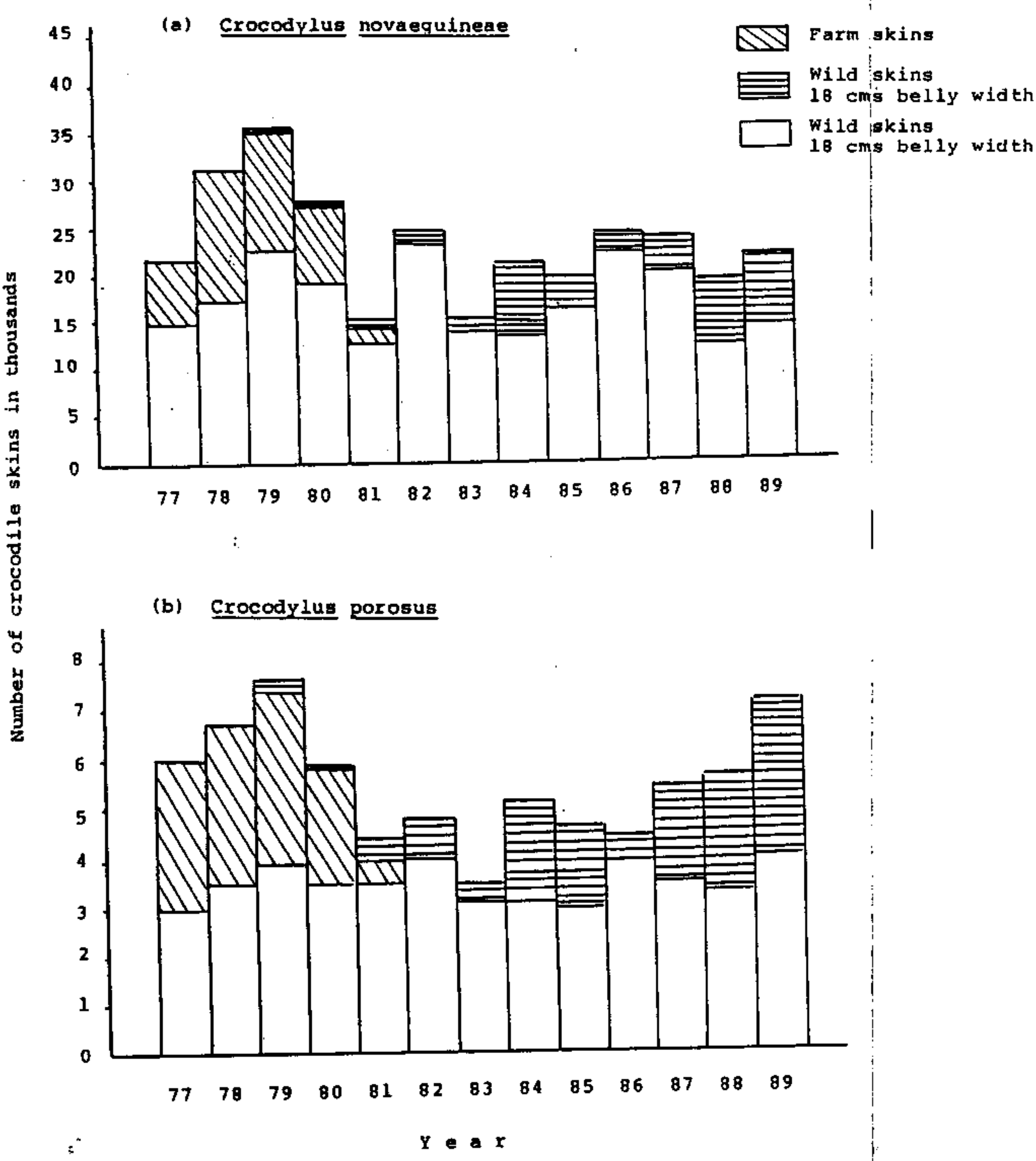


FIGURE 2: Export of crocodile skins from PNG, 1977 - 1989



Even with the cuts mentioned above the PNG Government recognises the importance of the crocodile industry. This has been demonstrated by making available needed and adequate funding to carry out the aerial surveys of the wild populations of both species, particularly for the *C. novaeguineae* surveys in October 1989 and the *C. porosus* surveys of March 1990. On this note also the National Crocodile Management Unit (NCMU) commends the Government in financing the travel of two officers to attend this meeting.

3.2 NESTING INDICES: 1988 - 1990

The 1988 report presented the population nesting indices for the period October 1981 to March 1988. Subsequent nest surveys conducted since then are the *C. novaeguineae* surveys in 1988 (Cox et al., 1989) and 1989 (Genolagani et al., 1990a) and *C. porosus* surveys of March 1989 and 1990 (Genolagani et al., 1990b).

Basically, the surveys focus on the annual surveys for active nests which are counted and compared along identical survey routes inorder to determine the nesting indices for each species (Hollands, 1984). This is conducted in the Middle Sepik Region and the data used to present a national picture of the wild population trends.

The data collection and analysis as developed by Hollands (Hollands, 1984) has been applied to date (Cox et al. 1989, Genolagani et al. 1990a; 1990b). For purposes of this meeting the raw data and details of data analyses have not been included, except the calculated results on the annual nesting trends for each species which are shown in Table 2. A graphic representation of the habitat-weighted nesting indices (Table 2) is presented in Figure 3.

As shown in Table 2 there was a decline in 1989 (148) and 1990 (148) from 1988 (155) by 4.5% for *C. porosus*. Even with the decline, the nesting index shows the indices to be still well above the "danger" indicator-level of 100 set in March 1982 (Figure 3) with an annual increase in nesting by 5.3% (n = 9 years).

For *C. novaeguineae*, there was an increase by 34% in 1988 (130) to that of 1987 (97). In 1989 (117) there was a decline of 10% from 1988. The calculated value of 117 for 1989 is however also above the "danger" level of 100 set in October 1981 with an annual nesting increase of almost 2% (1.89%) for the nine year period.

TABLE 2: CROCODILE NESTING INDICES FOR THE MIDDLE SEPIK REGION, PNG.

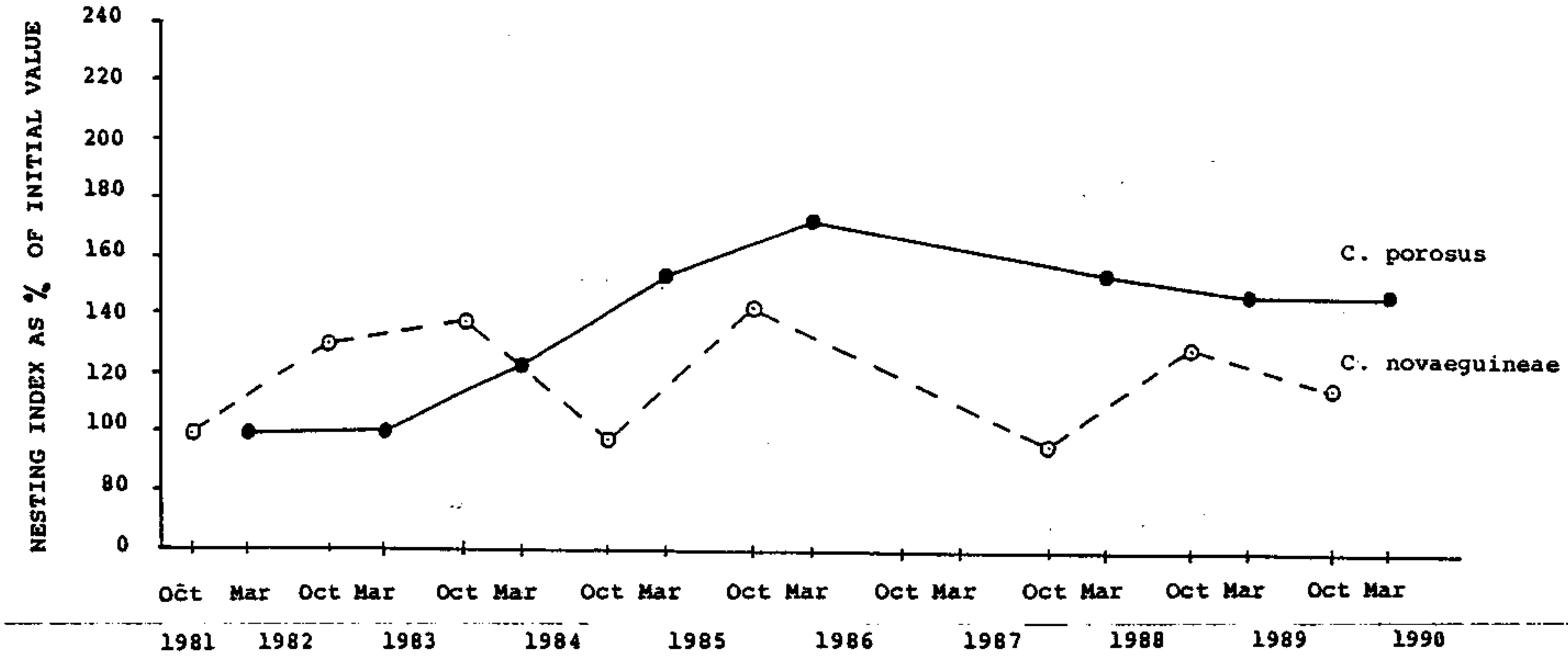
A. HABITAT-NESTING INDICES FOR *CROCODYLUS POROSUS*

HABITAT	WEIGHTING	INDEX PER YEAR								
		1982	1983	1984	1985	1986	1987	1988	1989	1990
Lake fringes/margins	0.31	100	50	74	76	67	(123)	74	108	104
Overgrown oxbows and channels (barets)	0.36	100	100	163	213	326	(637)	264	211	220
Scroll swales and levees	0.33	100	150	125	163	104	(215)	111	116	111
HABITAT WEIGHTED INDICES	1.00	100	101	123	154	173	(338	155	148	148

B. HABITAT-NESTING INDICES FOR *CROCODYLUS NOVAEGUINEAE*

HABITAT	WEIGHTING	NESTING PER YEAR								
		1981	1982	1983	1984	1985	1986	1987	1988	1989
Lake fringes/margins	0.19	100	111	122	92	95		73	107	102
Scroll swales and levess	0.57	100	120	106	82	138		56	71	71
Overgrown channels/Barets	0.14	100	200	275	174	205		236	366	304
Overgrown oxbows	0.10	100	135	157	98	176		137	175	148
HABITAT WEIGHTED INDICES	1.00	100	131	138	98	143		97	130	117

FIGURE 3 : Nesting trends of crocodiles in the Middle Sepik Region, PNG : October 1981 - March 1990



3.3 WILD EGG HARVESTS

The other monitoring parameter conducted inconjunction with the aerial nest surveys is wild egg harvests. Since its inception in 1985 only for *C. porosus* and in 1988 for *C. novaeguineae* the activity has met with mixed responses. Notable features have been the continued cooperation of landowners (nest owners) who agree, for protection of nests and a percentage is harvested by the Mainland Holdings Reptile Farm of Lae (Hollands 1985, Cox et al. 1989). On the other hand non landowners claim that the activity is detrimental in that wild stocks will decline. Currently there is a lot of consultation being made with the landowners, the Local Government and the provincial administrators. The activity is now being accepted and will continue.

The significance or if not the important feature of the wild egg harvest programme is in providing indirect and direct data on some aspects of biology and raises more topics for field research for both species (Cox et al. 1989, Genolagani et al. 1990a, 1990b). An important information obtained to date has been on evidence of recruitment into the wild populations. This has been through comparative mean clutch sizes and field visual size estimations of attendant nesting females (Cox et al. 1989, Genolagani et al. 1990a, 1990b).

4. CONCLUSIONS

The major feature of this report shows that PNG's national policy and accompanying programmes which work towards the goal of sustainable-yield harvests on a long term basis is gradually being realised. The general increase in commercial exploitation over the last seven years appear not to have a detrimental impact according to the data presented above on the status of the wild populations of both species. In addition the conservation-oriented wild egg harvests is continuing and is reinforcing nest protection by landowners in recognition of conservation values and monetary income that is generated whilst at the same time the exercise is a monitoring tool being used to detect recruitment of new nesting females.

Given the data to date, the status of the wild populations of *C. porosus* and *C. novaeguineae* are considered safe and compatible with the current levels of, especially commercial exploitation and therefore the species be maintained in Appendix II of C.I.T.E.S.

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SOME NEW INFORMATION ON THE VENZUELAN LLANOS HARVESTS

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In 1989 and 1990 PROFAUNA established harvest quotas for Caiman crocodilus, on privately owned cattle ranches. The basis of these quotas were technical reports prepared by field technicians, who were university graduates from a variety of fields (biology, animal husbandry, agronomy and environmental engineers). They were licensed to carry out caiman surveys after having attended a three day course given by PROFAUNA. During the course they were trained in dry season survey methods.

The authors examined 704 reports by 83 technicians, and found that the accuracy of reporting varied greatly. In this paper we use a selection of the most credible reports to establish some simple guidelines for future evaluations.

A preliminary selection of reports was made by examining the reported size structures of the caiman populations on individual ranches. In the Venezuelan Llanos large males (Life Class IV) make up about 20% of the non-hatchling population (Ayarzaguena, 1980; Seijas, 1986; Staton and Dixon, 1975). For the purposes of this paper, we rejected all of the reports of any technicians who consistantly reported this Life Class IV as being 40% or more. A subsequent filtering involved reports with incomplete data or other anomalies. The final data set included 97 reports by 18 technicians.

The relationship between the availability of permanent water and ranch size is summarized on Figure 1. Large ranches (20,000 hectares or more) have less than 1% of their surface area as permanent water during the dry season, whereas small ranches may have up to 10%. In some very small ranches, of only a few hundred hectares the percentage may be higher still. The owners of small ranches tend to construct more cattle ponds, dams and borrow pits per square kilometer than exist on large ranches, which are generally open rangeland. The anomalous point on Figure 1 is not necessarily incorrect, but certainly indicates a ranch that should be inspected.

The relationship between the overall density of caimans and ranch size is on Figure 2. Large ranches have a much lower density of caimans compared to some smaller ones. This is probably directly related to the availability of permanent water. Some small ranches (< 500 hectares) may have up to 1,500 non-hatchling caimans per square kilometer. The reported densities may well be accurate, as the caimans from temporary wetlands outside a property can concentrate in permanet water within it.

The relationship between caiman density and the availabity of water on ranches larger than 1,000 hectares is on Figure 3. There is a positive correlation between the overall density of caimans and the availability of permanent water. As a first approximation it suggests that the carrying capacity of the Llanos wetlands would be somewhat less than 300 non-hatchling caimans per square kilometer, but that it would only be reached in those areas where the availability of permanent water during the dry season was more than 4% of that wetland area. These data may provide an initial guide for those ranchers who wish to improve their caiman habitat.

The reports used for these analyses estimated a total of 373,863 caimans within 10,800 square kilometers of ranchland. This gives an overall mean density of 34.62 caimans per square kilometer of Llanos, which is little more than 10% of the potential density if water were not a limiting factor during the dry season. It also indicates that the total population of non-hatchling caimans in the Venezuelan Llanos would be in the order of 1,750,000.

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The authors wish to thank Grahame Webb for editing the manuscript, Andrea Gaski for helping with last minute production of the manuscript, Carlos Galan for drawing the figures, and Jose Ayarzaguena for his comments relating to the preliminary processing of the data.

Figure 1. The relationship between the availability of permanent water (as a percentage of the ranch size) and ranch size (in hectares) in the Venezuelan Llanos.

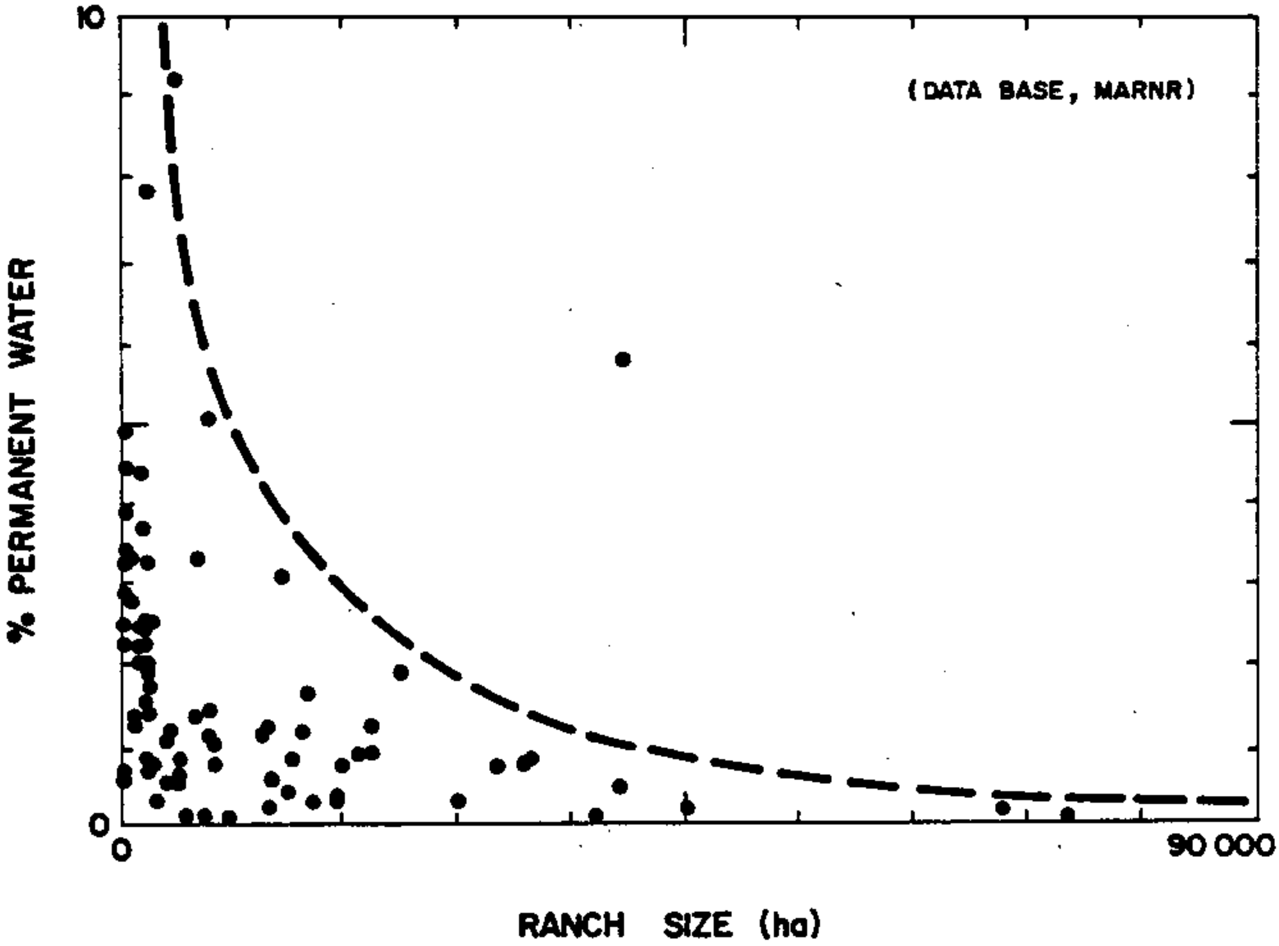


Figure 2. The relationship between the overall density of spectacled caimans (in non-hatchling caimans per kilometer of ranch) and ranch size (in hectares) in the Venezuelan Llanos.

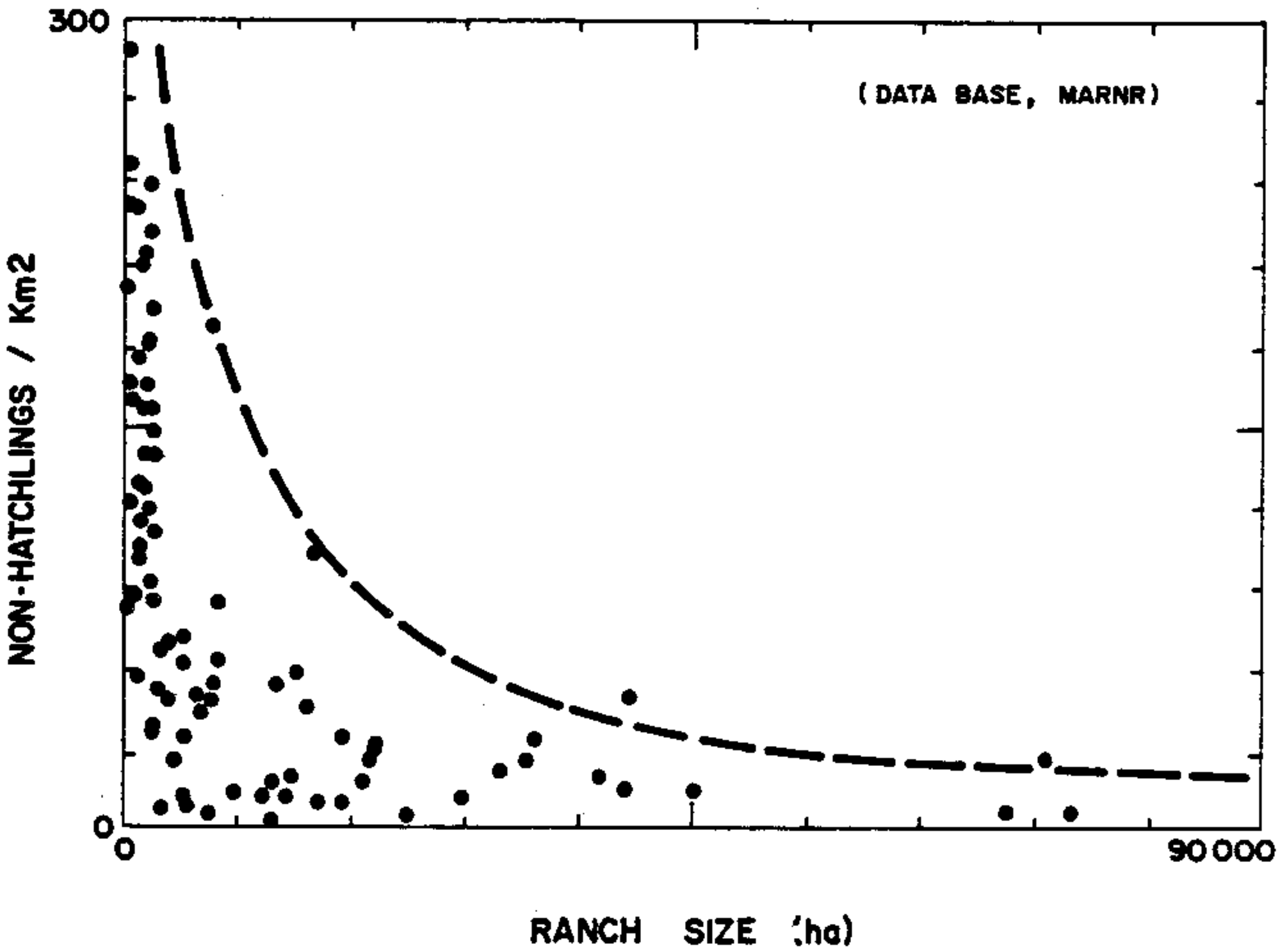
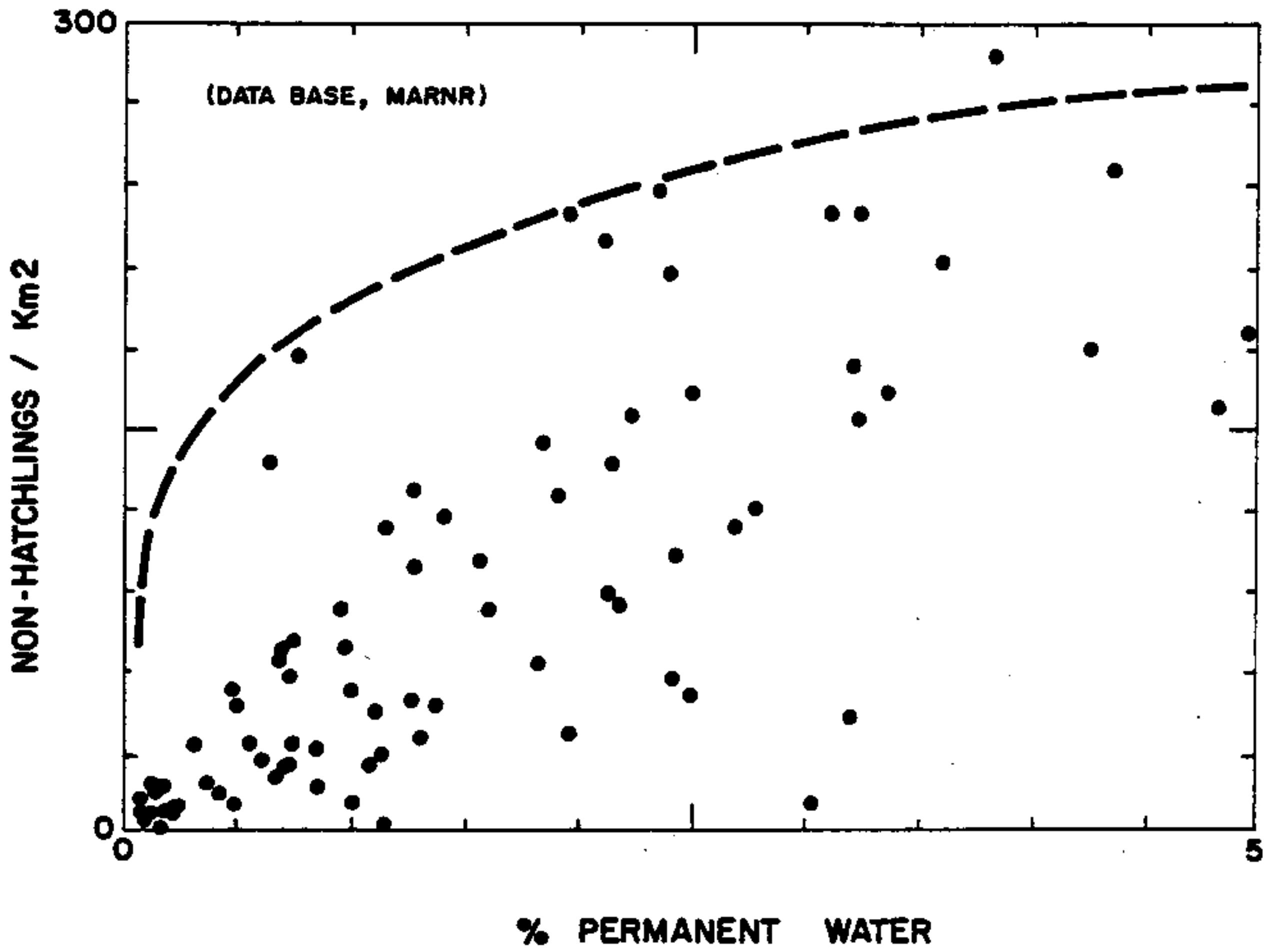


Figure 3. The relationship between the overall density of spectacled caimans (in non-hatchling caimans per square kilometer of ranch) and the availability of permanent water (as a percentage of the ranch size) in the Venezuelan Llanos.



UTILIZATION OF THE MUSCULATURE

OF THE SPECTACLE CAYMAN(Caiman crocodilus)

AS A FOOD RESOURCE;ITS PROCESSING

BY

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Special thesis work presented before Universidad Simón Bolívar on January 8,1985,in partial fulfillment of Licentiate in Biology.

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(This is an initial translation from Spanish for admission purposes. The 122 page text will be provided upon request.)

SUMMARY

In this work an integral study of the skeletal muscleture of the Spectacle Cayman(Caiman crocodilus)was realized,from an alimentary viewpoint. A series of studies and analyses was done on the muscleture of fourteen specimens of different lengths and sizes,captured in the Venezuelan states of Apure,Barinas,and Guárico.

The studies and analyses included: calculations of the relative yields of four different cuts of carcass flesh in three size groups;physical-chemical analysis of three muscle types(tail,torso,and extremities);production of a meat flour; microbiological analysis of the meat;development of a canned product;determination of the thermal parameters of the meat and of the canned product.

The yields of the meat in relation to the total weight were found to increase as a function of the size of the individual animals.This yield in the larger animals can approach 43% of total body weight.

The proximal analyses of the meat revealed it is rich in protein(about 20%) and has a low fat content(less than 1%),but is a good source of minerals such as calcium and iron.

A process was developed which permitted the creation of a flour from Cayman meat. This has a high protein content(86.6%)

and was utilized in the nutritional assays with rats.

The value of the protein efficiency ratio(P.E.R.) for Cayman meat was 3.75 and the net protein ratio(N.P.R.) was 4.50. These values, in some cases,were greater than those found for casein(3.55 and 4.34 respectively),confirming the high protein quality of this meat.

Microbiological analysis revealed low or negligible levels of the following microorganisms:mesophilic aerobes;*Staphilococcus aureus*;total coliform;fecal coliform;yeasts/molds. In all the cases the maximum values found were within the safe range established for human consumption.

A canned meat product was produced,based on experiments in pre-cooking which led to a uniform quality and a product with an agreeable flavor and a texture similar to that of canned fish.

Lastly, a series of studies of the heat penetration in 211x300 cans of the meat product and also of the raw meat was carried out. The simple heating curves in each were plotted and unique slopes were observed.Based on these curves,the factor(J) and the slope(Fh) were derived. The values found were 1.45 and 40 respectively for the developed product and 2.20 and 29 for whole sections of the raw meat.

INTRODUCTION

The Cayman(Caiman crocodilus) is the most abundant of the five species of crocodiles that exist in Venezuela. It pertains to the sub-family Alligatorinae and is found in a wide variety of acquatic environments in almost all parts of the country,up to an altitude of 400 meters above sea level.

In 1982,after a twelve-year ban on the hunting of the Cayman,the Ministry of the Environment and Renewable Natural Resources established an experimental season for the commercial harvest of the species. Earlier preliminary investigation had confirmed that ample Cayman populations existed and would support an experimental program.

Until now,crocodiles have been exploited for their skin,principally. The worldwide market demand for is estimated at some two million skins per year. Of this total, about 75% are Cayman skins from South America.

The benefits of a rational harvest of wild fauna are many:scientific research;cultural/recreational activities; and the production of consumer goods such as leather and meat.

The food crisis that affects Third World countries, and in particular,Latin American nations,makes critical the maximum utilization of available food resources. The global possibilities to develop the production of new sources of animal protein are limited.

Cayman meat,like that of many other vertabrates of our autoctonous fauna,represents an interesting source of high quality animal protein. Urgent scientific studies are required for this species,in all disciplines,which will permit the development of adequate technologies for its management and conservation.

The main objective of this work is a complete study,from an alimentary viewpoint,of the skeletal musclature of the Cayman.

To achieve this and fourteen Cayman specimens of different size and weight were studied. They were captured in the Venezuelan states of Apure,Barinas,and Guarico.This being the first alimentary study of this species,the most important aspects were addressed that would afford a complete comparison with other meats traditionally consumed in Venezuela.

First,a study of the total and partial yields of the meat was done. This included four different cuts of meat and three separate size groups of Cayman specimens.

Second,the chemical composition of the meat was determined by proximal analysis(water,protein,fat,ash)for three types of musclature in ten of the specimens. The mineral content was also calculated for important nutritional factors such as calcium,iron,phosphorous,amgnesiumzinc,sodium,and potassium.

Third,the microbe count of the meat was measured. Various microbiological assays common to alimentary science were done:

(N.M.P.) of coliform and fecal coliform;<u>Staphylococcus</u> count;mesophylic aerobe count;yeast/mold count.

Fourth,a nutritional assay was done to determine the quality of the protein in Cayman meat. For this,a meat flour was prepared,using all types of skeletal muscles from various specimens. Later,a control diet was formulated,whose primary protein source was casein.An experimental diet was also formulated,using Cayman meat flour as the main protein source. These diets were administered to two groups of laboratory rats who were later compared for the gain in body weight and protein consumption during a two week period.As a parallel, a group of animals were fed a diet without protein.

Lastly,a study of the canning and heat processing method was carried out. This method is crucial for the preservation and commercialization of Cayman meat. Various preliminary tests were ~~realized~~ for the canning of raw meat. Further tests were done in pre-cooking the meat to improve the product. A study of the heat penetration of the meat assisted the determination of the thermal characteristics of the meat product. The processing time(Bb) was calculated as well as the value of sterilization process(Fo). This study was also performed with whole meat pieces,without pre-cooking,to establish the thermal parameters of Cayman meat for future research. To confirm the derived data, a test of commercial sterility was applied.

The Method of Crocodile Hatching adopted in Arba Minch Crocodile Farm, Ethiopia

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March 1990

1. Introduction

Arba Minch Crocodile Farm was established in mid 1984 mainly for the commercial utilisation of Nile crocodiles (*Crocodylus niloticus* Laurenti 1768) of Lake Abaya and Lake Chamo.

The farm is situated at the western end of a piece of land separating Lake Abaya from Lake Chamo. It lies on the extreme south-western shore of Lake Abaya about six kilometers away from Arba Minch, the capital of North Omo Region (Annex 1). It has an area of about 3 hectares of land and its gradient is very gentle sloping towards Lake Abaya which is some 500 meters away from the site.

Twenty years ago, there was a commercial hunting concession operating crocodile hunting all over the rivers and lakes of Ethiopia. By that time the crocodile resource had been hunted to the extent at which this commercial operation could no longer continue. As a result, crocodile hunting on a commercial scale ceased (Bolton 1983, Hutton, 1988). Because of the action taken, there followed an increase in the crocodile population in the lakes and rivers of Ethiopia. As an added protective measure, and also to benefit from the commercial demand for crocodile skin, Arba Minch Crocodile Farm was set up by the Ethiopian Wildlife Conservation Organisation of the Ministry of Agriculture, being materially and technically assisted by FAO/UNDP of the United Nations.

The objectives of the farm are :-

- to collect crocodile eggs and hatchlings each year in order to produce crocodile skins and meat,
- to generate revenues in foreign exchange from the sales of crocodile skins, meat and curios,
- to restock 10% of the farmed crocodiles into all ideal lakes and rivers of the country when they are able to defend themselves against their enemies,
- to provide local tanneries with raw skins, and
- to provide job opportunities for unemployed citizens.

At the early stage of the crocodile farming operation, lack of expertise and farming facilities had some devastating consequences. But, at present, managerial experiences and adjustments made for all the crocodile requirements have resulted in running a successful crocodile farming operation.

2. Objective of the study

The objective of this work is to establish a cost-efficient method of acquiring better hatchling stock for the farm.

3. The methods used in obtaining hatchling stock

3.1 Egg collection & artificial incubation

The crocodile farming operation in Arba Minch commenced with the collection of crocodile eggs from the shores of L. Abaya and L. Chamo for the first two years.

As stated by Bolton (1984),in the first hatching operation, in 1985, crocodile eggs collected from the wild were incubated in styrofoam boxes half-filled with moistened sand. During this time there was no electricity in the vicinity, and the source of heat was charcoal. By using two locally made burners, charcoal was constantly burned day and night to raise the hatchery air temperature, which in turn heated the incubation media and helped to maintain the temperature between 28 - 34°C, the required temperature range mentioned by Pooley (1971) as cited by Bolton, 1981. Two burners were engaged at a time in order to keep the temperature always above 28°C and one burner was used when the temperature was about to exceed 34°C. Humidification was achieved by wetting the floor of the hatchery and sprinkling water over each box once a day at mid-day.

In the second hatching operation, in 1986, the method practiced was almost the same as the last method. The differences noted this time were that a large number of eggs were collected (Annex 2) and the heating was facilitated by electricity. Six bulbs (250 watts each), 3 in one row and the other 3 on the opposite row of the ceiling, were installed in the hatchery. Both rows had independent switches for regulating the temperature between 28 and 34°C. When the temperature of the hatchery was about to drop below 28°C, both rows of bulbs were switched on, and when the temperature was about to exceed 34°C only one row was switched on. Humidification was done in the same manner as stated above, trying to keep the humidity above 95%.

3.2 Collection of hatchlings after natural emergence

This method has been practiced from 1987 to date using the following procedures. Pre-identified communal nesting sites were cleared of bushes and fishermen one month ahead of the egg-laying season so as to attract mother crocodiles to the site. The nature of the major communal sites was sandy, and sometimes fine volcanic ash on the island. During the time of egg searching, nests easily identified by direct visual observation were marked with a piece of stick each. The rest of the site was then thoroughly searched by using a spade to carefully move sand from one end until the whole communal nesting area had been searched.

Whenever a nest with crocodile eggs was encountered a stick marker was then placed in the middle of the nest so as to easily know the number and location of nests identified. Finally in each communal site, all nests identified and marked were covered by piling stones over them so as to protect the nests from predation. The same procedure was repeated every ten days in all the nesting sites until the number of nests identified were found to be enough to provide the annual required hatchling quota. The nest watchmen were assigned to all major sites until the time of hatching, in order to protect nests from predators and also to listen to the hatchlings' calls and to unearth the eggs for hatching. Nests were controlled and protected from predators from a locally made watch tower and sometimes from a tent.

Listening for the hatchlings' calls was carried out at dusk and dawn in early March. The nests were usually opened two days after the first call was heard, to avoid premature hatching. Self-emerged and assisted hatchlings were then collected soon after hatching and kept in open styrofoam boxes (40x60 cms) under shade until they were transported to the farm. Most of the communal nesting sites were accessible by road while quite a few were accessed by boat. At the time of hatching, hatchlings kept in ventilated styrofoam boxes were transported daily by a Toyota pick-up from all nesting areas to the farm nursery where they were allowed to stay for 72 hours. The nursery was heated with six bulbs (250 watts each) maintaining a maximum temperature of 34°C. After 72 hours, hatchlings were taken from the nursery to the hatchling ponds where they spent one full year.

4. Results and discussion

As shown in Annex 2, results obtained suggest that the latter method was found to be a cost-efficient method of obtaining better crocodile stock. Unlike the hatchlings emerged by artificial incubation, most of the wild-hatched hatchlings were found to be much stronger, heavier and healthier with a better chance of survival.

In the course of this study the outcomes obtained of artificial incubation were not attractive as compared to the method of collection of naturally-hatched hatchlings from protected nests in the wild. In fact, the percent hatching success obtained was satisfactory, but emerged hatchlings were found to be weaker with poor survival condition possibly due to incubation temperature and humidity fluctuations brought about by poor incubation facilities. In general artificial incubation practiced in the first two years of crocodile hatching operations were cumbersome and required close day and night supervision for the regulation of incubation media temperature and humidity besides elevating the cost of heating. The procedure of egg handling and arrangement in incubation boxes, necessity of collecting eggs out of direct sunlight, and transportation over the rough roads were also other challenging tasks that forced the farm to abandon the method and devise another method. Hence, from 1987 to date, hatchlings have been collected and transported to the farm from protected nests, and no major problem has been encountered since this method was adopted.

5. Conclusion

Crocodiles of Lake Abaya and Lake Chamo mostly use common nesting grounds and they have the habit of visiting the same site every year without abandoning it. This makes the annual egg searching and protection activity so much easier and both jobs are covered by a few labourers. As a result, in Arba Minch Crocodile Farm, the method of collection of naturally-hatched hatchlings from protected nests in the wild has been adopted as the most reliable cost-efficient method of acquiring healthy hatchling stock. In so doing, it is believed that there will be no detrimental effect on the population of wild crocodiles so long as a reasonable percentage of young crocodiles are annually restocked.

Acknowledgments

I would like to express my grateful appreciation to the Ethiopian Wildlife Conservation Organisation advisor, Dr. J.C. Hillman, for his encouragement and invaluable suggestions for the improvement of this manuscript.

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Annex 2. Table showing number of communal nesting sites and nests, % hatching success, % survival etc. Since 1985.

Year	No. of communal nesting areas identified	No. of nests identified	No. of nests opened	No. of eggs in opened nests	No. of eggs hatched	No.of captive hatchlings from Lake Chamo	No. of hatchlings kept in the farm	No. of hatchlings Re-stocked	% hatching success	No. of crocodiles surviving after one year	% survival after one year
1985	7	4	2	73	68	113	181	-	93.0	90	49.7
1986	4	87	72	3,176	2,713	-	2,713	-	85.4	144	5.3
1987	2	206	126	5,521	4,928	-	2,500	2,428	89.3	2,200	88.0
1988	-	132	76	3,519	3,009	-	2,587	422	85.5	2,262	87.4
1989	-	204	204	7,752	6,244	-	6,000	244	80.6	4,257	71.0 *
1990											

* Death was high in one of the hatchling houses that had no pond heating elements.

Annex 3. Chart comparing the two methods of obtaining crocodile hatchling stock practiced in Arba Minch Crocodile Farm

1. Egg collection and Artificial incubation

Advantages:

- No predation risk.
- Very good percent hatching success.

Disadvantages:

- High cost of heating during incubation.
- Incubation needs constant supervision.
- Inconsistency of incubation temperature and humidity.
- Problem of heat in case of power failure.
- Poor hatchling survival.
- Requirement of various expensive equipment for egg collection and incubation.
- Relatively highly paid skilled labourers for egg collection, incubation and supervision.
- Problem of egg transportation over rough roads.

2. Collection of hatchlings after natural emergence.

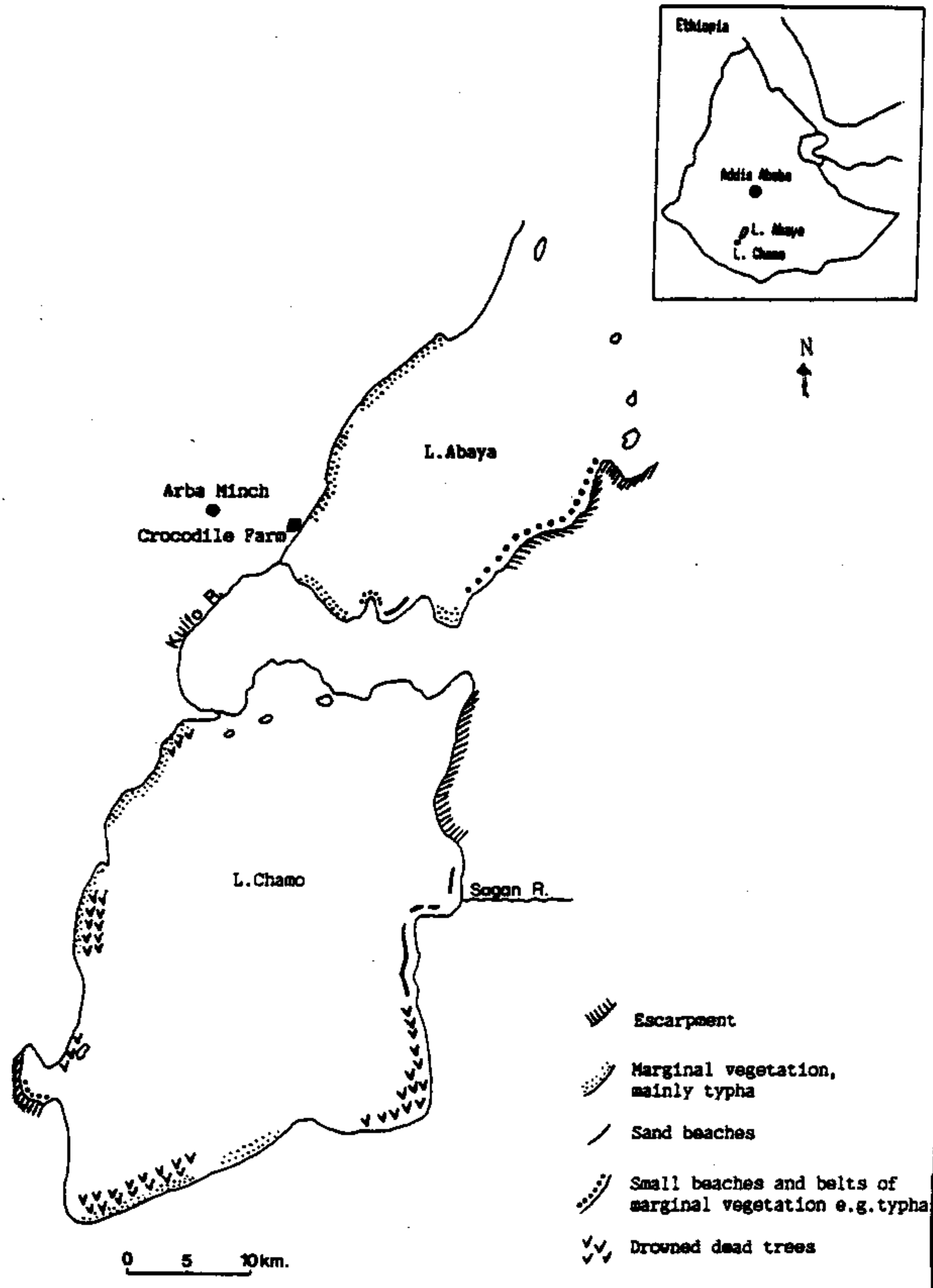
Advantages:

- No cost of heating.
- Low paid labourers for egg searching, protection & hatchling collection.
- No routine supervision.
- Very good percent hatching success.
- Requires simple, cheap equipment.
- Healthy hatchling with better survival condition.

Disadvantages:

- Low predation risk.

Annex 1. Figure showing the location of Arba Minch Crocodile Farm (AMCF)



Source: M.Bolton 1984

THE AMERICAN ALLIGATOR: DOLLARS & SENSE
(Remaining Inconsistencies in the Industry)

by

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In 1978 I graduated with a B.S. degree in zoology from the University of Georgia, which gave me an understanding of the anatomy and physiology of wildlife along with an appreciation of the vital role it plays in the ecology of this planet and its place in the hearts and minds of man.

Shortly after that I obtained employment with a company which participated in the utilization of renewable wildlife resources. Since that time I have enjoyed the rewarding and responsible experience that parallels both facets, which some would define as stewardship.

In the past 10 years I have observed numerous inconsistencies in the trade which I feel are worth noting. Today I wish to speak to you of the inconsistencies I see in a trade which utilizes a species which fills a most valuable part maintaining habitat and balance in nature along with giving us the most exquisite of classical leathers; The American Alligator.

Just as every cook goes by different recipes it would seem the case with alligator farming techniques, especially as they pertain to nutrition. Through my years as a raw skin buyer and grader and later as a tanner, I have seen varying degrees of hide qualities among the alligator skins from different areas and particularly from different farms. The diverse make-up of hide protein from one farm to another has been extreme in the same species. I have handled groups of skins that possessed excellent hide substance, skin that felt full and lively and exhibited a natural bombe. In contrast I have handled skins whose substance was so poor they felt flaccid and lifeless, serving as a poor mimic to their other counterparts. This disparity, in my opinion, is due to the lack of a set of nutritional guidelines to be followed within the association of alligator farming.

Along with the increased demand for alligator skins, a decrease in quality as it pertains to both wild and commercially raised skins has arisen. With the elimination of grading practices in taking wild skins from trappers by buyers, the incentive to produce a prime hide was undermined. There has been increased flaying damage during skinning along with increased putrefaction due to the presence of excess flesh and fat left on the hides before curing. With so much demand farms boosted production and farm populations grew, however there wasn't a corresponding increase in the number of rearing pens nor adequate addition of equilibrium or stabilization ponds. This lack of expansion did not allow the animals' metabolism to adjust to a normal rate which is needed to produce a more natural hide substance and skin proportion and to eliminate undue scarring, stress and scabbing among the animals. If not remedied soon, I predict the international grading of farmed gators will expand upward to include of the gular area and downward pass the cloacal opening to include the upper half of the tail. Also one has to admit that in farm and wild alike the legs of the alligator still are many times skinned improperly, limiting the use of the leather from the legs as it lends itself to finished goods. The knees and elbows should always be split to lay on either side with the useable small grain portion to the center. A properly skinned leg will exhibit a black stripe on either side with a yellow one on center.

Because of the incidence of red heat in the past and for the somewhat extensive elbow grease employed in wet salting raw alligator skins, it has become quite the norm to brine the skins. This method is good only if certain controls are met and held relatively constant. Concentrations of salt should equal 97% with bath temperatures never exceeding 85 F. Also there should never be any addition of organics or inorganics which may lead to the decomposition of the hide or the interference of subsequent soaking, beaming or tanning operations. In weak brine concentrations one can expect to experience skin degradation through the presence of proteolytic bacteria which will promote loose,

flaccid and lifeless hides and the leather thereof. Even in the case of saturated brines (those with increased temperatures and time) the hides will become stagnant and begin to house halophilic bacteria which exist in high salt concentrations. Like the proteolytic bacteria, halophilic bacteria can digest the hide substance lessening its strength and quality.

Many trappers and farmers have addressed this problem by the addition of a disinfectant to their brine in the form of bleach and sometimes even formaldehyde. It is possible to do irreparable damage to skins as they lend themselves to leather with the addition of these products. In high concentrations, which are sometimes needed to counteract the organics in a stagnant brine, bleach can not only oxidize natural fats in the hide so that they are difficult to degrease during tanning, which by the way can lead to uneven tanning and unlevel dyeing, but it can, in fact, oxidize the skin, weakening it, giving it a poor surface and ruining the texture of the grain. Addition of formaldehyde to brine to mask pungent odors of rancid skins can actually pre-tan the skin, set the scale on and destroy the value of the hide. I have experienced both problems with brined hides and have spoken at length with Dean T. Dinato, Leather Specialist at Buckman's Laboratories, to secure a microorganism control for both brine and dry salt systems used in preserving hides. This information accompanies this paper. Any future information will be obtainable from Crocodile Specialist Group, whom I will keep updated.

Another source of concern is producers of alligator skins have not been educated to the best location and technique for attaching the U.S. Fish & Wildlife CITES tag. This has been a cause of great frustration for tanners and exporters along with Fish & Wildlife in their efforts to maintain control. After discussions with Dennis David of the Florida Department of Natural Resources, I suggested a tagging procedure which has since been utilized within the Florida Alligator Program.

The procedure is to place the tags medially in and out through the edges of the keeled bottom of the tail approximately 3-4 inches from the end. Attached in this location the tags seldom ever break, pull out or tear out during normal handling and tanning procedures. Also it is not at all difficult to place the tag in the skin at this location even if the carcass is intact. Although there is still a need to strengthen the tags presently being used, this method would help eliminate broken seals and decrease unnecessary seizures of skins by U.S. Fish & Wildlife due to broken tags.

Today the raw alligator business is riding a wave. Because of high demand skins of even average or lesser qualities are bringing high prices. We must be apprised of the fact that not only are more and more international farm operations being established for the commercial harvest of classic crocodile skins, but in time we will see better management and law enforcement become more intact in countries where it didn't exist before, thus opening up trade for indigenous crocodilian thereof within the guidelines of CITES. And I predict that some of which will be naturally better quality skin as it lends itself to the classical leather and the product thereof.

It is essential that all inconsistencies be eliminated within the alligator trade. It must be a clean business providing the market with quality skins from a well managed and uniformly enforced natural resource. I can remember not so long ago when high supply coupled with a high dollar sent alligator skin prices plummeting to $8 to $10. Prices approaching those again would send the trappers to the hills and the farmers to the mercy of their creditors. We cannot be complacent in the wealth of our mediocrity today, while hoping these conditions won't return. We each share a concern for the well-being and longevity of this resource and trade. So we should all strive to guarantee its fruitful existence by utilizing a shared directory and knowledge in order to achieve a common goal of quality and responsibility throughout the industry without which we not only suffer in a financial sense, we will suffer much greater losses. For we have all witnessed the mighty blow the fur industry has taken from the psuedo-environmentalist by not being responsive to educating the general public with the true meaning of stewardship toward all of our natural resources. Let us not fall under the same demise but flourish with sound management, techniques and genuine concern for the industry.

"In the race for quality, there is no finish line."
David T. Kearns

An Updated Report on Alligator Management and Value-Added Conservation in Florida

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Introduction

When an alligator research and managment program was initiated in the mid-1970s by the Florida Game and Freshwater Fish Commission (GFC), it was assumed from the beginning that a sustained harvest of alligators of some magnitude was possible. Secondly, it was believed that the commercial value of alligators and other recognized values (i.e. ecological, esthestic, cultural) need not be mutually exclusive. However, it was clear that these two assumptions would be correct only if harvest rates were based upon the biological ability of alligator populations to sustain harvest and continue to function as a vital part of the system.

To establish and maintain a harvest program based upon biological considerations, an approach different from most past efforts was necessary. A review of crocodilian exploitation, prior to 1970, revealed that harvest pressure had been driven solely by economic forces. Futhermore, no portion of the profits derived from such harvests were returned to the management and conservation of the species.

The philosophy of sustained yield management that is incorporated into all United States alligator management programs has undoubtedly resulted from the broad wildlife management philosophy that has been the basis for much of United States wildlife conservation. Most wildlife research and management in the United States has been directed toward popular game species over the last 50 years. An important force behind these efforts has been strong special interest groups who placed high value on particular species or groups of species. Much of this value, particularly in the early days hinged upon the prospect that the political action, financial contributions, and voluntary taxation advocated by these groups would insure the continued opportunity to harvest these animals for sport. The continued hunting opportunity for a whole myriad of species in the United States has resulted in millions of dollars being put into research and management, millions of acres set aside for wildlife, and thousands of professional wildlife conservationists. Futhermore, this large infra-structure of professionals and special interest groups played a vital role in the broader environmental movement during the last 20 years.

It was against this background that the present approach to alligator management was developed in Florida. The idea that the user pay a large part of the bill for conservation was nothing new. Value-added conservation had largely built wildlife conservation in the United States.

In spite of obvious similarities between alligators and many traditional game species it was also recognized that there were some significant differences. No large group of organized users, dedicated to crocodilian conservation existed. True, there was a small group dedicated to crocodilian conservation, and when alligators were reputed to be endangered the environmental community rallied to their support. But, when it became clear that alligators were not endangered, much of the support from the latter group subsided. Conversely, there were hundreds of people in Florida (hunters, hide buyers, farmers, etc.) whose motives ranged, from pure monetary profit, to a mix of the profit motive and strong cultural ties to the alligator. But, they were not organized and certainly did not speak with one voice. Another important difference was that we were dealing with an economically valuable species, which had the potential to generate considerable profit for individuals. Futhermore, it was assumed economic activity would probably be sufficient to attract outside capital for investment in some phases of the alligator industry. Clearly, the possibility always existed, and still exists for harvest to be driven by the quest for short-term profits, rather than a biologically sound approach. Consequently, an infra-structure, to insure that true sustained yield management be continually implemented, was necessary.

The idea of economic feedback resulting from alligator harvest (value-added conservation) has expanded since it was articulated in some of the early GFC alligator management plans. I propose that the feedback has the potential of occuring in three separate areas. The economic value is most obvious and the one which has been discussed most. Tied very closely is the political voice which has developed as a result of the vested interest of people supporting sustained alligator exploitation. Third, is the growth of the professional cadre whose major purpose is the protection and management of alligators.

The objective of this paper is to examine those three areas and discuss the validity of basing a public crocodilian conservation program upon the philosophical tenet that commercial exploitation can be a positive force for their conservation and management.

Current Alligator Management

Florida's alligator management program includes (1) the harvest of four foot and larger alligators from public waters, (2) the collection of hatchlings from public waters, (3) the collection of eggs from public waters and (4) the harvest of four feet and larger alligators and the collection of hatchlings and eggs from private lands. In addition the Game and Freshwater Fish Commission (GFC) allows harvest of nuisance alligators and regulates alligator farming which benefits from many of the previously mentioned programs. Prior to the present expanded program there was an experimental egg and hatchling removal project, an experimental adult harvest and an alligator nuisance project.

Economic Feedback

Before an expanded harvest was permitted in Florida, a system of license and fees was established. The objective was to generate revenue to go to the GFC to offset the cost of alligator research and management. There was some level of taxation placed upon every aspect of alligator exploitation. The revenue generated by the earlier experimental programs will be enumerated later. But the amount of money made available to the state by the expanded harvest versus GFC expenditures during the same period is probably one of the more important comparisons. During the two years of the expanded program (1988 and 1989) a harvest of 3,243 and 3,031, four foot and larger animals and, 4,302 and 7,887 eggs was achieved on public lands. On private lands during the same period there were 180 and 577 four foot animals taken in 1988 and 1989, respectively. There were also 768 and 1,166 eggs taken from these same lands. Revenues totaled $384,005.00 for 1988 and $392,485.00 for 1989 (GFC records). The total expenditure on research and management, by the GFC, during this two year period was $918,000.00 (GFC records) (table 1). For the 1988 and 1989 period revenues generated by the program have offset 84% of the research and management costs within the agency.

From 1978 through 1987 money has also been returned to the GFC via the percentage charged nuisance trappers on each skin they marketed. This harvest has gone from 1,871 to 4,464 in 1988 (table 2) (Jennings 1989). This has generated revenue of approximately $125,000.00 to $300,000.00 per year. Futhermore, based on early evaluations of the program the agency saved approximately $100,000.00 per year by allowing private trappers rather than wildlife officers to take care of nuisance problems (Hines and Woodward 1980).

Since 1981 alligator farmers in Florida interested in receiving hatchlings from the wild, as well as, contributing to an understanding of the effects of early age class exploitation have funded a cooperative GFC/University of Florida study. The major objective has been to determine the impact of hatchling and egg removal upon the dynamics of alligator populations. This has been carried out by actually removing hatchlings or eggs and attempting to measure the impact (Jennings et.al 1988). From 1981 through 1989 farmers have received approximately 32,000 hatchlings from the program and, in return for those, they have contributed $513,593.00 back to the research (pers. comm. Percival). In essence, the farmers have paid the University of Florida to conduct the research that GFC uses to regulate their harvests.

Other monies have been donated to the University of Florida's School of Veterinary Medicine (SVM) for studies concerning alligator husbandry techniques. While this money was not directly generated by any type of wild harvest it is unlikely that the money would have been available had it not been for the statewide management program which made eggs and hatchlings available to the farmers. Either by direct grants from alligator farmers or from other entities the SVM has from 1979 until the present received $126,000.00 (Cardeilhae pers. comm.).

It was in the area of private lands manangement where early on it was thought that alligator manangement might have direct impact upon land management decisions (Jennings 1989). Many land managers, particularly ranchers, regard the alligator as a nuisance which may cause economic loss through depredation of livestock. Alligators occupy wetlands that sometimes are considered valuable grazing land and in other cases may be more valuable if drained. Timber companies own large tracts in Florida, which may be 25% to 35% wetlands. These wetlands are of little direct value to the companies except for wildlife leases, which are currently valued at $1.50 to $4.00 per acre.

During 1989 there were 21 participants (Jennings 1989.) involved in the private land alligator program at some level (table 3). I was directly involved with three landowners who wanted to manage alligators to increase revenues on marginal land. There is a wide array of landowner attitudes and alligator habitat quality statewide, but I have elected to present data from these three, which may give some preliminary insight into the economic potential of alligators on private lands.

Tract #1 is a part of a ranch, located in north central Florida, that is devoted to cattle and timber. One portion of this area contained a 1,585 acre marsh, which was classified as above average alligator habitat. The entire area had, at one time, been very good alligator habitat and was more than twice the size of the present marsh. In excess of 2,000 acres had previously been drained to provide cattle grazing. This area managed for alligators contained 12.1 acres of canal, 70 acres of shallow lakes, 1,239 acres of permanent marsh and 263.5 acres of intermittent marsh. Due to drier than normal conditions in 1989 much of what was considered permanent marsh also dried up. Nightlight survey data submitted to the GFC resulted in 42 harvest tags being issued for four feet and larger animals or one tag per 37 acres. In addition, hatchling surveys later in the year resulted in a harvest quota of 80 hatchlings. There were three types of harvests on this property. There were five trophy animals taken during the spring, and thirty-seven four foot anmials and 80 hatchlings taken during the fall havest period. Because the landowner carried out the fall harvest, he received a greater share of the total proceeds than the owners of Tract #2 and Tract #3. However, in order to compare this property with the others, we will present the economic data in the same manner as Tract #2 and Tract #3.

Total net revenue (after tags and license) for Tract #1 was $17,474.00, resulting in a total net income (before hunting costs) of $11.02 per acre. However, under the same scenario as Tracts #2 and #3, the landowner's share would be $4.40 per acre (table 4).

Tract #2 was a 36,000 acre property managed as a commerical forest, where the major income is derived from the sale of wood products. Hunting leases provide approximately $3.00 per acre. The general habitat type is typical North Florida flatwoods. There were 9,348 acres of wetlands deliniated of which 11.3 acres were borrow pits, 1.281 acres of shallow lakes, 452 acres of seasonally flooded grass ponds, 6,919 acres of cypress ponds and 734 acres of permanent marsh. Allightor habitat was classified as average. Nightlight surveys submitted to the GFC resulted in a quota of 82 tags for animals four feet and larger or one tag per 114 acres. Hatchling surveys were limited but generated a quota of 80 hatchlings.

Of the 82 animals harvested, three were taken by trophy hunters. All remaining tags were filled during the general commerical harvest. The total income after processing, validation, and sale costs on the four feet and larger animals was $27,003.44 or $329.31 per alligator. In addition, $800.00, after tag fees, was derived from hatchlings for a total net revenue of $27,803.44 or $2.97 per acre. The landowner share was $1.21 per acre (table 4).

Tract #3 was also commercial timber land and contained approximately 18,000 acres of which 5,028.5 acres were classified as average alligator habitat. The general habitat types included North Florida flatwoods, longleaf pine, turkey oak, sandhills and stream bottoms. Wetland types included approximately 580 acres of shallow lakes. 200 acres of seasonally flooded ponds, 2,894 acres of cypress domes and swamps, 660 acres of permanent marsh, and 280 acres of intermittent marsh.

The total harvest from the area included 42 animals, four feet and above, with a net value after processing, validation and sales cost of $11,430.94 for a per animal value of $272.00. In addition 80 hatchlings were collected, which put total net revenue generated at $13,030.94 or $2.59 per acre. The landowner share was $1.04 per acre (table 4).

The net revenue to the landowner is variable, depending upon the quality of habitat, and the type of economic arrangement. Under the circumstances, described here, the landowners' share was $1.21, $1.04 and $4.40 per acre, respectively. The contractual arrangements were either the same, or presented as the same, so differences in revenue is related only to the magnitude of the total harvest on the respective areas.

A simulated yield resulting from wood products harvested from lands surrounding the wetlands managed for alligators, provides a perspective on the relative value of the two resources. A total net cash flow was calculated utilizing a program (yield-plus) which is routinely used in making forest management descisions A site index of 60, with 700 stems/acre harvested at 25 years was assumed for a typical North Florida flatwoods site. Site preparation cost, annual management cost, including prescribed burning, and harvest expenses were deducted from gross revenues. Pulpwood and chipping saw prices were entered at $13.50/ton. Values were unadjusted for inflation. Total net cash flow before taxes was calculated to be $702.60 or $28.10 per acre per year.

The other important minor income on timber compnay lands is hunting leases, which range from $1.50 to $4.00 per acre per year. It appears that alligator harvest may be able to double the amount of income that companies are receiving from their wetland acres, by adding to the hunting lease revenues.

Drainage of marginal land to grow timber in Florida is not the issue on timber land it once was in Florida. The major threat may ultimately be development. Even though timber companies have large investments in mills, requiring a continuous supply of timber, the value of their timberland may increase to the point where it becomes a better economic decision to sell or develop the property. In view of this impending dilemma, local timber company managers welcome additional sources of revenue from land which, in many cases, is only generating an internal rate of return of 6%. Under those circumstances, additional revenue of $1.00 to $4.00 per acre on 25% of their land may be significant.

Political Action

Prior to the initiation of the present program, there was little organized political support for alligators except during the early days of the Endangered Species Act. At that time alligators were one of the most visible endangered species and there was strong political pressure opposed to any change of status. This was the case in spite of no clear evidence that alligators were endangered and that there was considerable evidence to the contrary. After the status of alligators was changed the political action of protectionist groups diminished. In their place at least three major user groups have evolved. There are two farmers groups and one trapper group, all of which are politically active. These groups obviously are guided by self-interest, but profess interest in sustaining wild harvest of alligators. This interest provides a common ground upon which the professional wildlife manager and the political action groups can work. The political action groups have provided the impetus for legislative action, resisted unfair and needless bureaucratic rules and acted as a watchdog. However, it is the combination of the self-interest groups and the professional wildlife manager that provides best assurance of a sound program.

Professionalism

In 1975 when the alligator was officially considered endangered, the GFC, which has primary management responsibility for all resident wildlife, had less than one-half manyear devoted to alligator research. Today, the GFC has 1 1/2 manyears devoted to full time research and nine man years devoted to management. An estimated two manyears of private, professional biologist time is committed to alligators on private lands. Also, this program has, through 1989, put 189,000 additional acres under an annual monitoring scheme (Jennings 1989). In addition, there are viable alligator research programs at UF in the USFWS Coop. Unit, zoology and the SVM. One measure of the effects of this commitment is research results which are the necessary components of sound manangement programs. Sometimes publication of results lag behind and management programs are initiated before research is published and subjected to peer review. However, numbers of publications are a means of measuring increased level of knowledge. Prior to 1975 there had been three scientific publications generated by GFC personnel. Since 1975, which was the beginning of the present program, there have been 28 scientific publications produced by GFC personnel.

So, today in Florida, with the alligator being legally exploited there appears to be a professional cadre devoted to alligator manangement and research that is at least ten to twelve times greater than when the alligator was officially endangered. A convincing argument can be made that the commitment of these professionals offers real conservation benefit.

Summary

Since 1977, and the beginning of attempts by the GFC to actively manage alligators, there has been approximately $2,000,000.00 generated by harvest and returned to the GFC for alligator management and research. The impact of that harvest appears to have been minimal (Woodward pers. comm.). There has been additional money, either directly or indirectly, generated by the harvest programs totaling $625,000.00. Most of this money has been directed to the University of Florida to support graduate research.

The level of knowledge has increased dramatically as a result of the UF research and work carried out within the GFC. In addition to published information, the general level of knowledge and concern about alligators has increased with the addition of GFC biologists in every region of the state. These professionals, along with private and institutional biologists, make up a cadre of crocodilian biologists exceeding the number involved in the management of any other game or non-game species in Florida.

The infra-structure made up of special interest groups (users and non-users) and professional wildlife managers is a powerful force in wildlife conservation. There is reason to believe that such an arrangement is presently providing for the proper protection and management of alligators in Florida.

The long term prospects for many forms of wildlife, including alligators in Florida, as well as, throughout the world, is tied to the presence of widespread quality habitat. In Florida, even though we have several million acres of alligator habitat, there has been significant losses and many thousands of acres of the remaining habitat has been severely degraded. In the United States we have been able to spend large sums of money setting aside areas solely for wildlife. But we will have failed as professional ecologists and land managers if we do not guide conservation efforts toward a more inclusive concept than simply setting aside refuges or museum pieces. The real challenge is to devise programs which will encourage the practice of a land ethic on the whole land organism.

There is no reason to believe that the exploitation of a wildlife resource must diminish that species' ecological value. In fact, I believe that under a sound management regime we can use the resource, and if the program is properly devised, provide added insurance against over-exploitation and perhaps, in some circumstances, provide added protection to habitat.

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Table 1. Game and Freshwater Fish Commission Revenues received versus those expended for 1988 and 1989.

	REVENUES RECEIVED		REVENUES EXPENDED	
ACTIVITY	FY 88-89	FY 89-90	FY 87-88	FY 88-89
ALLIGATOR MANAGEMENT	$384,005	$393,485	$297,000	$445,000
ALLIGATOR RESEARCH			90,000	86,000

Table 2. Summary of Florida's nuisance alligator harvest from 1978 to 1988.

Year	Complaints Received	Permits Issued	Tags Issued	Alligators Harvested	Alligators Harvested/ Complaint
1978	4,914	2,346	3,124	1,871	0.38
1979	4,639	2,486	3,321	1,679	0.36
1980	4,024	2,216	2,856	1,590	0.40
1981	4,931	2,622	3,318	1,871	0.38
1982	6,124	3,209	3,826	2,169	0.35
1983	5,955	3,003	3,550	1,871	0.31
1984	7,289	3,536	4,272	2,201	0.30
1985	6,432	6,187[a]	6,187	3,023	0.47
1986	6,018	5,458[a]	5,458	3,049	0.51
1987	7,288	6,618[a]	6,618	3,853	0.53
1988	10,305	7,978[a]	7,978	4,464	0.43

[a]Beginning in 1985, only one tag was issued per permit. Taken from Jennings, 1989.

Table 3. Results of the private lands alligator management program, 1988 and 1989.

	1988	1989
Number of participants	7	21
Wetland acres in program	73,000	159,000
Egg quota	2,050	1,350
Egg harvest	768	1,166
Hatchling quota	80	160
Hatchling harvest	80	160
4 foot quota	255	699
4 foot harvest	180	577

Taken from Jennings, 1989

Table 4. Revenues generated by harvesting alligators on three private land holdings in Florida.

Landowner	Wetland acres	Sport hunting [1]net revenue	Adult & sub-adult [1]net revenue	Egg or hatchling net revenue	Total [1]net revenue	Total net per acre	Total net per acre for landowner
#1 (3)	1,585	$6,800.00 (4)[2]	$9,074.00 (38)[2]	$1,600.00 (80)[2]	$17,474.00	$11.02	$4.40
#2	9,348	$4,800.00 (3)[2]	$22,583.00 (79)[2]	$800.00	$27,803.44	$2.97	$1.21
#3	5,028	0	$11,430.94 (42)[2]	$800.00 (40)[2]	$12,230.94	$2.59	$1.04

(1) Income after validation, tag, processing and sale cost. Hunting cost and survey cost are not subtracted.
(2) Number of animals harvested
(3) Income simulated to be handled in same manner as landowners #2 and #3.

BREEDING CROCODILES IN ZOOLOGICAL GARDENS OUTSIDE THE SPECIES RANGE, WITH SOME DATA ON THE GENERAL SITUATION IN EUROPEAN ZOOS, 1989

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INTRODUCTION

Keeping crocodiles in captivity has a long tradition and the majority of the traditional zoological gardens in the Old and the New Worlds equally kept crocodiles in their collection. Giese (1962), for example, offers many anecdotes on the acquisition of crocodilians by the Schoenbrunn-Zoo in Vienna, one of the oldest zoos. Motives varied between displaying curiosities, monstrosities or "men-eaters." During the climax of systematic zoology, a collection of live crocodilians played an important role in the education of our forefathers. Later in the history of zoological gardens, an almost "pathological urge to possess as many as possible of the described species" guided the acquisition often just to impress others working in the field. As a result, during those past times breeding success was a very rare event.

There were few enclosures where reproduction could have taken place: the quality of space, the thermal environment and the 10 diets did not meet the requirements.

During the past 30 years, the mental attitude of the majority of those responsible for maintaining reptile exhibits seems to have changed. To a certain extent, this development may have been triggered-off by one of the recommendations made at the first meeting of the IUCN/SSC Crocodile Specialist Group in 1971, which suggested that zoos should aim at maintaining one species group in a unit suitable for breeding rather than individuals of several species. It was also proposed that a definite co-ordinated plan be worked out to bring together as many of these specimens as possible for breeding. These recommendations were also accepted as resolution at the AAZAPA meeting of the same year. Unfortunately, IUDZG did not react on the commendations of the Crocodile Group.

Action took place in many United States and a few European institutions. Several breeding groups were established in exchanging "surplus specimens" and placing them on breeding loan in suitable places.

We now judge differently regarding the relation of space versus the size of the animal. Our understanding of environmental factors, such of the as light and temperature has grown and last but not least those who want to benefit from the numerous studies on free-living crocodiles triggered by the now almost classic publication by Cott (1961) easily find information.

In Zoological Gardens outside the Tropics and Subtropics, space for crocodiles is limited to the availability of heated rooms. Modern design takes advantage of a more biological sense for the environment. It seems, that the days when crocodiles were kept in sanitary-clean pools, tiled and sterile, are over. Such environments would today be likely to be criticized by the public. The role of the public is no longer that of a passive onlooker who comes to the zoo, uneducated, just to spend a few hours of recreation. It is changing more and more as it is better informed of biological connections and ecological facts. This education, drawn from the ever present medias (especially by natural history films), a better general education and specific training by the zoos own programs (guided tours, labelling systems, zoo-owned magazines, etc.) is a challenge when new displays are being planned.

In some countries, in connection with animal welfare regulations, minimum space requirements for wild animals were officially published, not least under public pressure which complained against such establishments as roadside zoos. For Switzerland the regulations on crocodilians are given in Table 1.

Space and Pen Designs

While the minimum space requirements, as elaborated in Switzerland, regulate the space for wild animals both in private and public displays, exhibits in Zoological Gardens need to be larger. Specimens show much more impressively in spacious enclosures furnished with all the necessary elements (Table 2). When new crocodile exhibits are discussed by decision makers, it is advisable to study the implications of crocodile behavior for management (Vliet 1986, Land 1987a). Basic crocodile displays consist of a pool and a land area. The pool for adult specimens should offer various water levels with a deepest point of about 150-180 cm for the larger *Crocodylus* sp. and less for the smaller species, giving ample space to dive (see Table 3 for additional data).

Heating the water may be necessary. It can be done either by hot water pipes or electric heating cables built in the surface of the pools. In a closed system where the water is circulated over a sewage-type filter system, the electric heating is built-in in the last stage of the unit. Indeed, very attractive displays can be arranged by the construction of aquarium-type pools where the crocodiles can be viewed entirely under water. Here the visitors really can appreciate the crocodiles' unique appearance. Besides, such a special display offers additional space for educational explanations, including tapes to show the crocodiles' ability in vocalization.

The shaping of the land area can be best achieved after some on-the-site inspiration or after color photos from the species habitat. The use of read boulders, trees and gravel instead of artificial building materials, such as fiberglass or gunnite, offers more of a challenge to the builder of a display. Moreover, natural boulders and gravel add more to the microclimate of the display, especially in well planted areas.

The information of nest sites is likewise important. Do we deal with a ground nest builder or with a mound builder (Greer 1971)? Data on the temperature within the nest and its environment will become important when gravid females begin to look for a place to deposit the eggs. Then we shall be in the position to assist in offering a well prepared and heated artificial nest site. Hopefully we later can display maternal care by that species in our collection.

Displaying live plants in a generously set up exhibit for crocodiles is a must! The rich growth of any tropical or subtropical plant, such as *Ficus* sp., *Philodendron* sp., *Pandanus*, together with bromeliads, ferns and orchids can simulate an almost natural looking set up.

Such displays naturally can look only satisfactory provided that there is sufficient light and temperature. In other words, lush growth of tropical plants is the indicator for optimal humidity and temperature in any crocodile exhibit. Such exhibits offer some of the excitement many visitors nowadays require to understand the needs of conservation.

In arranging exhibits, care must be taken to give all animals a chance to hide from the ever present eyes of the visitors. A good display where the specimens are "not always on a tray" offers much more challenge to the inquisitive visitors, especially when they are properly informed by a modern labelling technique.

Equally important to display pen design is the development of ample space "behind the scenes" for hatchlings and their rearing.

Temperature

Heating crocodile exhibits in temperate zones is best arranged by electricity and/or solar heat. Both floor and radiant heating is necessary. It is advantageous to arrange the heat units in such a way that the crocodiles can choose the temperature they actually prefer. Information on crocodilian thermal selection is given by Lang (1987b).

Light

Besides illuminating the exhibits for aesthetic reasons and proper presentation of the specimens, sufficient light is an eminent factor in any animal display. This is especially true with crocodilians, over which still lays an enormous amount of disdain and superstition. Ample lighting of crocodile displays is important for natural behavior of the specimens. Regal (1980) explains the role of light and radiant heat. Modern devices, such as HQI equipment, offered by almost all major manufacturers of light systems, not only provide an appealing but also sound technical lighting. Additional UV lighting, such as properly built-in black light tubes in the near ultraviolet range of 310 to 400 nanometers, for at least 12 hours per day may be necessary (Brazaitis 1986).

Veterinary Care

It is understood that in any zoological garden the reptile collection should be under the same rigid veterinary control as are the mammals and the birds. "Veterinarians needn't to apologize for the state of the art of reptilian medicine" (Fowler 1980). Close cooperation between the veterinarian and the curator in charge assists both. Both are experts in their fields, to the benefit of the specimens under their care.

Whatever the origin of a new specimen to enter into an existing group of animals, a minimum quarantine of about 30 days is highly recommended. During that time, the necessary fecal samples can be collected and eventual parasites or injuries can be treated.

For those who have little access to ample veterinary services, there are by now, fortunately, a number of modern publications available, where information of crocodilian diseases can be found (Cooper and Jackson 1981, Ippen et al. 1985, Isenbügel and Frank, 1985, Frye 1990).

Autopsies are to be performed not only for the determination of the cause of death, but also to check if the clinical diagnosis was correct.

Carcasses must be placed in museums or other scientific collections for further studies. Even specimens of so called common species and without data can become of great interest in future studies.

Sexing Techniques

After Chabreck (1967) and Brazaitis (1969), the determination of sex in living crocodilians is, at least on paper, no longer a problem. In practice, however, the immobilization, especially of the larter species, is still a problem, especially in those collections where little practical experience is available. Information on handling (Ball 1974, 1979) and immobilization of crocodiles can be found in Loveridge and Blake (1972), Bonath (1977), and Marholt and Jes (1988).

Hybridization

Interbreeding between related species should not become a goal of any captive breeding program. From the conservation and the genetic standpoint, any hybridization of crocodilian species must be rejected. Hybridization with *Crocodylus acutus* threatens the existence of the endangered *Crocodylus rhombifer* on Cuba. Hybrid offsprings of *Crocodylus siamensis* (x *Crocodylus porosus*) threatens the endangered *siamensis* (Groombridge 1987). Hybridization of *Crocodylus rhombifer* x *Crocodylus siamensis* takes place at the zoo in Ho-chi Minh City, Vietnam (Geissler and Jungnickel 1989). Hopefully none of these hybrids will be released in short-sighted "conservation" activities.

Therefore for zoological gardens with limited space, one species breeding units are strongly recommended. Accurate species identification (Brazaitis 1973, Wermuth and Fuchs 1978) is important.

Management

Good animal management techniques are equally important over the establishment of proper habitat displays.

Interesting details on crocodilian biology, which would have been difficult to obtain from wary specimens in the wild, were gathered under suitable conditions in zoological gardens. Much of what is known of parental behavior in crocodilians was obtained from observations in zoological gardens (Table 4). At Parque Zoologico de Tuxtla Gutierrez, Chiapas, Mexico, a male spectacled caiman, *Caiman crocodilus crocodilus*, opened a nest and released 25 neonates; the female parent vocalized and swam with her pod (Alvarez del Toro 1969). Parental behavior of dwarf crocodiles, *Osteolaemus tetraspis*, was described at the Fort Worth, Texas, Zoo; two females and a male transported neonates from one clutch of eggs in their mouths (Tryon 1980). At Nandankanan Biological Park, Orissa India, parental behavior of *Gavialis gangeticus* has been recorded by Bustard and Maharana (1980). At Jaipur Zoo, India, mugger crocodiles, *Crocodylus palustris*, have been observed using their mouths to transport neonates from nest to water (Yadav 1979). Morelet's crocodiles, *Crocodylus moreleti*, at Zoo Atlanta have bred and displayed a wide variety of parental behavior including nest building and neonate transporting (Hunt 1975). In long-term experiments older young of *C. moreleti* were kept with adults and interactions recorded (Hunt 1977). Metro Zoo, Miami, Florida, has kept young and parent *Crocodylus siamensis* together for up to three years; mouth transport of neonates has been observed (Bill Ziegler, pers. comm.). Zoological gardens have made important contributions to the literature of crocodilian behavior (Waitkuwait 1989). It was also through private breeders' efforts that we learned about the reproductive biology of *Paleosuchus palpebrosus* (Lüthi 1983) and *Caiman crocodilus* (Hirschfeld 1966). Successful breeding of crocodilians under artificial conditions in temperate zones has become possible (Table 5, 6, and 7). Perhaps future management concepts in zoological gardens will further encourage the keeping of adult crocodilians with their offspring.

Behler et al. (1987) reported on the remarkable success of the Bronx Zoo, New York, where recently seven species have been bred, among them *Alligator sinensis* or *Crocodylus rhombifer*, which are in urgent need or propagation outside their range.

Diet

Diets of crocodilians in zoological gardens have typically included whole mice, rats, chickens, crickets and fish. Monotypic diets of fish should be carefully monitored. Before 1971, while on a diet of salt-water fish, *Crocodylus moreleti* at Zoo Atlanta failed to produce viable embryos and a tentative diagnosis of avitaminosis E was made (Hunt 1980). In addition to the problem of rancid fish preventing the absorption of Vitamin E, thiaminase activity has been measured in many species of common food fish (Cooper and Jackson 1981). Increasing thiaminase in stored fish and monotypic diets of fish produce thiamine deficiency but can be neutralized by adding thiamin to the diet (Higashi 1961, Geraci 1974, Wallach 1978). It has also been reported that a temperature of 27° C for five minutes will destroy thiaminase in stored fish (Mattison 1982). Live fish contain negligible amounts of thiaminase and are probably safer to feed captive crocodilians than are stored fish of any species (Ellen Dierenfeld, pers. comm.).

Because of possible dangerously high concentrations of Hg, Pb, Cd, PCB, DDT, etc., Jes (1989) cautions against the use of fresh-water fishes of unknown origins. In such cases, one should consider decreasing the volume of fish in the diet.

Artificial Incubation

Traditionally staff at zoological gardens have removed eggs from crocodile nests and incubated them in a separate facility with controlled humidity and temperature. Tryon (1980) incubated Osteolaemus tetraspis eggs between 25°C and 34°C in damp vermiculite in 38 and 76 liter aquaria. At Madras Crocodile Park nine captive conceived eggs of Gavialis gangeticus were removed from the nest and incubated at temperatures between 31°C and 32°C; in the nest hole temperatures between 34°C and 35°C killed embryos in 15 eggs (Harry, 1989). To observe maternal behavior, staff at Zoo Atlanta incubated eggs of Crocodylus moreletii in a styrofoam box filled with saturated peat moss. When the neonates vocalized in the eggs, in the box, the box was buried inside the nest mound. The female parent had no difficulty in excavating the friable styrofoam (Hunt, 1980). In order to understand the phenomena of temperature-dependent sex-determination modern results (Ferguson & Joanen, [1982], Ferguson, [1985] or Webb & Smith, [1984]) should be carefully studied.

Id-Methods

As outlined earlier (Honegger, 1979) any tagging system in a Zoological Garden should satisfy the ethical and aesthetical criteria.

Lately, sophisticated systems with microelectronic technology (tansponders) have been introduced. A less expensive method using a simple leather hole punch and the scute coding system has been elaborated by Tamarack (1988).

Studbooks

So far, one international studbook for a crocodilian species has been developed: Alligator sinensis. It is published on an annual basis. A summary appears in the International Zoo Yearbook (see also Table 6). For some other species (Paleosuchus sp., Crocodylus moreletii, C. rhombifer, C. siamensis and Tomistoma schlegelii) regional studbooks are planned within the AAZPA/CAG.

Surplus Animals

The placing of surplus crocodiles on a permanent breeding loan basis within a sound management-plan, such as SSP, may be the only politically feasible way for the owners of valuable Crocodiles, as no monetary exchange takes place. Exemplary were the international cooperation on Alligator sinensis or Gavialis gangeticus which became famous.

Surplus Crocodiles, originating from public donations and/or captive breeding are a focal concern in many Zoological Gardens. The various reasons why restocking natural areas is not feasible in many cases, have been discussed by Tryon & Behler, (1982).

The AAZPA/Crocodilian advisory group (CAG) publishes, together with some input from overseas, a list of surplus crocodilians. It is intended to serve Zoological institutions world wide. Surplus lists are also publishes by the IUCN/CSG newsletter.

In 1986 Whitaker (1986) invited Zoo-people world-wide for Co-operation with the Madras Crocodile Bank and to place surplus specimens there.

Presently there are discussions about placing surplus crocodilians (Non-SSP [Species Survival Plan]-taxa) at member-institutions of American Alligator Farmers Association (AAFA), where the specimens or their offsprings could be harvested for their hides and meat at some point in the future. Concern is voiced because of ethical consideration, public perception, criticism from media and animal right groups.

It must be admitted that genuine Crocodile farms play an important part in Crocodile conservation and that the present philosophy behind AAFA (see King & Wilson, 1989) is to be trusted.

It perhaps would stimulate cooperation between zoological gardens and crocodile farmers if some of the crocodile-farms would offer space on their grounds to be set aside to maintain an "exotic" crocodile under "natural" condition for non-commercial reasons.

Such single-species enclosure, stocked with only a biological sound population, would allow studies at close range for students and researchers at relatively low cost. Such cooperation would also help demonstrate their commitment to conservation. A future cooperative step could be their willingness to maintain small numbers of an endangered species as stand-by for breeding programs.

However, the present discussion must go on, keeping in mind, that the number of surplus animals will increase, as the number of institutions with breeding programs improve.

Longevity and Albino Specimens (Table 8)

Under optimal management condition, crocodiles can attain considerable ages (Bowler, 1977) and the publication of interesting longevity records may contribute to the remarkable fame of crocodilians in the eyes of the Zoos' visitors.

If there are other Crocodilians in an institution, the display of an albino specimen adds to the statement of diversity on crocodilians and reptiles in general. But a lonely albino Crocodile, kept as a queer sensation in just a back-step in modern Zoo-philosophy.

Labelling Systems and Public Education

Having had a chance to recently visit some crocodile displays in European (and overseas) Zoos, I was very pleased to learn about the progress and the art in new labelling systems. The days where crocodiles were just labelled by common names and continent of origin seem gone. Modern labelling-systems inform the visitors on distribution, behavior and relation to man and add to the attraction of a display. Last but not least this education of a broad public during their leisure-time visit to the Zoo will be of benefit to a better understanding of the magnificent reptiles and their role their ecosystems.

The 1989 Survey in European Zoos and Aquaria

The last survey on captive crocodiles in European Zoos was made in 1974 (Honegger, 1975).

After the various breeding successes with Crocodiles in Europe I was eager to learn more about changes in the art of keeping crocodiles.

During the second half of 1989 a special crocodiles' questionnaire was mailed to all major European Zoos. Despite the fact that a number of Zoos known to have crocodilians in their possession omitted to reply, even after a reminder was sent, the response can be considered satisfactory.

The data for some of the British Zoos were collected in 1989 by Dennis Hoare of Paington Zoo, and are incorporated in the tabulations.

As it appears on Tables 1a and 9, collecting species and/or the desire to compete with other Zoos seems to be still the main aim of maintaining a crocodile collection. However, compared with the 1974 data the number of species per collection has decreased, thus allowing more space for the remainder and a better starting point for a breeding program.

On the other hand, crocodile breeding is no longer a novelty in Zoos outside a species range.

Looking at the species list (Table 10), we notice that the following taxa are missing from public collections in Europe:

Melanosuchus niger
Paleosuchus trigonatus
Crocodylus intermedius
Crocodylus moreletii
Crocodylus mindorensis

The species with the widest distribution and the largest number within European Zoos is *Osteolaemus tetraspis*. The same species has also a remarkable record in respect to its breeding. Five institutions have succeeded in reproducing this small African Crocodile (Table 11).

Amazingly, the largest African crocodile, Crocodylus niloticus, has the most numbers of all crocodilians in Europe. Eighty-six specimens can be found in 20 Zoos, and in three institutions, the species has also been bred.

The repeated breeding records with Caiman crocodilus and Paleosuchus palpebrosus are equally noteworthy. Together with the breeding success with Osteolaemus they could stimulate other zoos to start their own crocodile-breeding, even when limited space is available (see Table 3 on pen-sizes).

The two other crocodile species which were bred in Europe, Crocodylus cataphractus and Crocodylus rhombifer, apparently need more spacions enclosures, including deeper pools (Table 3).

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Summary

Living crocodilians in a Zoological Garden represent a very valuable resource. If such a group evolves through proper composition, as well as management and exhibit techniques into a breeding group, a great goal is achieved.
The data gained on the biology of the species, the information of nutrition, behaviour, breeding, the veterinary and pathological aspect are important data for the better understanding of crocodiles and will eventually assist conservation of these magnificent reptiles in peril.

However, the main reason for maintaining breeding-groups of crocodiles on display in Zoological Gardens outside their range, remains in the face-to-face education (in the widest range of the term "education") of the general public for a better understanding of their requirements and their role in any ecosystem threatened by man.

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Table 1

Switzerland:

Minimum requirements for keeping wild animals (Animal welfare act of 9.III.1978)
(Bundesgesetz (Tierschutz) vom 9.III.1978, und Verordnung vom 27.V.1981)

Taxa	Number of animals	land surface	water surface	volume	additional Landsurface*	specimens Watersurface
Alligators, large / Crocodiles, Gavial	1	4 m2	4 m2	2 m3	4 m2	4 m2
Large Caymans	1	3 m2	3 m2	1,5 m3	3 m2	5 m2
Dwarf Crocodiles / Smooth-fronted Caymans	1	2,5 m2	2,5 m2	1 m3	2,5 m2	2,5 m2

* with separation possibilition or additional enclosures.

Tab. 2

Switzerland:
Guidelines for the keeping of reptiles in breeding groups under Zoo conditions.
Swiss Fed. Veterinary Office, Berne 1979 (Dollinger, 1979)

Species	number of adults	land surface*	water surface	water volume	Temperature med. min./max.
Crocodylus niloticus, Crocodylus porosus, Tomistoma schlegelii, Gavialis gangeticus	1,1	24 m2	24 m2	20 m3	25(21-30)
other Crocodylus, Alligator spp.	1,1	16 m2	16 m2	10 m3	24(21-30)
Caiman spp., Melanosuchus niger	1,2				
Osleolaemus tetraspis, Paleosuchus spp.	1,2	8 m2	8 m2	3 m3	24(21-20)

* With separation possibilities or additional enclosures.

Fig. 3

Pen-data from some breeding operations in Europe. (Honegger, 1990)

Locality	species	breeding group	Enclosure		
			over-all size	water : land ratio	pool depth
Amsterdam	Caiman crocodilus	+	5,7 x 7,7 m	1 : 2,11	0,45 m
	Osteolaemus tetraspis	+	4,55 x 6,6 m	1 : 1,56	0,45 m
Cologne	Crocodylus niloticus	+	50 m2	3 : 1	1,2 m
	Paleosuchus palpebrosus	+	6 m2	3 : 1	1,2 m
Copenhagen	Crocodylus niloticus	+	85 m2	1 : 3	0,6 m
	Osteolaemus tetraspis	+	8 m2	2 : 1	0,4 m
Darmstadt	Osteolaemus tetraspis	+	19 m2	1 : 1	0,4 m
Emmen	Crocodylus cataphractus	+	73 m2	6 : 1,6	0,75 m
	Osteolaemus tetraspis	+	48 m2	1 : 2,6	0,75 m
Gossau	Osteolaemus tetraspis	+	15 m2	3 : 1	0,4 m
Stockholm	Crocodylus rhombifer	+	50 m2	3 : 2	0,85 m
Stuttgart	Caiman crocodilus	+	16 m2	2 : 1	0,35 m

Table 4

Dimension of facilities where adult crocodilians were kept together with their offsprings.

Species	Institution	Water-area	Land-area
Caiman crocodilus crocodilus	Tuxtla Gutierrez, Chiapas, MX	60 m2	30 m2
Crocodylus moreletii	Atlanta, GA	9 x 4,5 x 1,2 m deep	4,5 x 9 m
Crocodylus palustris	Jaipur, IN	156 m2	96 m2
Crocodylus siamensis	Miami, FL	20 m2	80 m2
Osteolaemus tetraspis	Ft. Worth, TX	2000 litres	180 m2
Gavialis gangeticus	Nandankanan, IN	59,5 x 29,7 x 9,1 m deep	71 x 51 m

Table 5

Breeding crocodilians in Zoological Gardens, 1979 - 1985
Number of institutions (source: Int. Zoo Yearb. 21-27)

Species	1979	1980	1981	1982	1983	1984	1985
Alligator mississippiensis	7	4	4		5	4	1
Alligator sinensis	1	1				1	1
Caiman crocodilus	7	4	7	5	2	7	2
Caiman latirostris	1	2	2	2			
Paleosuchus palpebrosus			1		1	2	1
Paleosuchus trigonatus	1		1				
Crocodylus acutus	2	1	1				
Crocodylus cataphractus				1		1	
Crocodylus intermedius		1					
Crocodylus johnstoni							
Crocodylus moreletii	1 1)	1	1	1	1	1	1
Crocodylus niloticus	3	4	4	3	6	5	3
Crocodylus palustris	4	1	2		1	2	5
Crocodylus porosus	1	1		1	1	2	3
Crocodylus rhombifer				1	1	3	2
Crocodylus siamensis			1	2	2	3	2
Osteolaemus tetraspis	5	3	2	3	4	1	3
Tomistoma schlegelii			1				2
Gavialis gangeticus						1	

1) nd Atlanta

Table 6
World wide position and trend of species of Crocodilians 1969 - 1986
(Source: Int. Zoo Yearb. London, Vol. - 1988, - 27, Honegger, 1982)
(Figures in brackets = numbers of specimens bred in captivity)

Species	Year	M / F / Sex unknown	Total	Number of Zoos	Remarks
Alligator sinensis	1969	12/11/50	73	38	
	1975	11/13/44	68	40	
	1979	11/13/23	47	29	
	1984	18/28/08(8.14)	37(8.14)	26	n.d. Berlin E; Higashi Izu, Jap; Peking, China
	1986	15/32/31(5.15.21)	78(5/15/21)	24	
Crocodylus moreletii	1969	3/-/28	31	16	
	1975	18/13/89(82)	120(82)	14	
	1979	10/09/09	28	13	no data Atlanta
	1984	14/24/42(4/12/35)	80(4/12/35)	11	
	1986	09/10/49(02/05/41)	68(02/05/41)	7	
Crocodylus rhombifer	1969	02/02/14	18	15	
	1975	16/17/19(06)	52(06)	22	no data Silver Springs
	1979	16/16/10	42	21	no data Havana
	1984	10/17/07(-/03/01)	34(-/03/01)	17	n.d. Buena PK; Higashi Izu, Jap.
	1986	13/27/43(04/07/31)	83(04/07/31)	23	no data Stockholm
Gavialis gangeticus	1969	06/09/37	52	23	
	1975	07/10/14	31	18	n.d. Calcutta; Gda-nsk; Silver Springs
	1979	08/07/05	20	8	
	1984	06/07/14(03/03/05)	27(03/03/05)	9	
	1986	12/35/210(4/04/195)	257(05/04/195)	13	

Table 7:

Crocodile breeding outside the species range:

Species	Captive breeding outside the species geographical range	Comments and number in Zoos 1989
Alligator mississippiensis	Most abdundant species in Zoological Gardens	CAG: Captive breeding to sustain Zoo stocks unnecessary. Display only. Europe ~~36(15/19/2)~~ 51(18/27/6) in ~~14~~ 19 Zoos.
Alligator sinensis	Breds repeatedly at Bronx Zoo, and St. Augustine Allig. Farm	International studbook (1989): 123 specimens in Zoos outside China; 84 in 13 US-Zoos, Europe 7(3/4/0) in 4 Zoos.
Caiman crocodilus (incl. ssp. crocodilus, apaporiensis, fuscus and yacare)	Readily reproduced in captivity; multiple breedings at Atlanta, Ft. Worth, Miami, San Antonio(US), Toronto(CA), Amsterdam(NL), Barcelona(ES), Krakow(P), Munich(D), Pilsen (CS), Rhenen(NL), Rotterdam(NL), Stuttgart(D) and Wroclaw(P).	CAG: difficult to surplus, therefore captive-breeding for zoo purposes unwarranted. Europe ~~39~~ 56 ~~(5/13/21)~~ (10/16/30) in ~~8~~ 11 Zoos, incl. one Caiman cr. apaporiensis.
Caiman latirostris	Multiple breedings at Atagawa Tropical Gardens and Alligator Farm(JP); Second generation hatching 1987 and 1988 at Bronx Zoo.	CAG: uncommon in Zoos. Little interest to maintain this species. Europe: 5(3/2/0) in 3 Zoos.

Melanosuchus niger	none reported	CAG: Numbers in Zoos insufficient for breeding scheme. Importation of founder stock envisaged. None in Europe.
Paleosuchus palpebrosus	Breeding recorded at Bronx Zoo, Knoxville Zoo, National Zoo, Albuquerque Zoo. Multiple breeding at Cologne Zoo(D) and a privat breeder in Switzerland (Lüthy, 1983).	Appropriate for Zoos with limited space for propagation and exhibition. Europe: ~~44~~ [46] (~~14~~ [16]/18/22) in ~~6~~ [7] Zoos
Paleosuchus trigonatus	Breeding recorded at St. Augustine Alligator Farm, and repeated at Cincinnati Zoo.	There seems little interest in exhibiting this species. None in Europe.
Crocodylus acutus	Few breedings recorded. Atlanta Zoo (early 1970), Bush Gardens Tampa (1986,1987).	Known to hybridize with Cr. rhombifer and Cr. niloticus. Only 0/1/~~0~~ [1] in Europe[, 2 Zoos].
Crocodylus cataphractus	Repeatedly breeding at Miami Metro Zoo 1982, Emmen(NL) 1987, 1989.	Miami has problems placing surplus. Appr. 25 specimens in US-Zoos. Europe 10(2/2/6) in 2 Zoos.
Crocodylus intermedius	No breeding pairs known in US and European Zoos.	The Bronx Zoo is currently raising four unrelated juveniles, either for return to the wild or as potential founder stock for US-Venezuelan cooperative breeding effort. None in Europe.

Crocodylus johnstoni	Reproduced at Melbourne Zoo (Dunn, 1977), Honolulu Zoo	9 specimens in US Zoos. Europe 4(2/2/0) in 2 Zoos.
Crocodylus mindorensis	Breeding repeatedly since 1981 at Silliman University, Negros, Philippines. First breeding outside the Philippines at Brownsville Zoo in 1989 (Anon, 1989).	Two pairs maintained at Brownsville Zoo. None in Europe. Silliman University seeks buyers for additional offsprings to finance their conservation efforts for this species.
Crocodylus moreletii	Breeding readily in captivity. Since 1971 Atlanta Zoo has produced 357 hatchlings. Two second generation breedings at Silver Springs and Gator Jungle attractions in Florida.	A regional studbook has been approved by AAZPA in 1989. The Atlanta Zoo is looking for recipients for its captive-bred surplus. Attempts to release surplus in Belize were unsuccessful. US: 366(3/6/357) specimens. None in Europe.
Crocodylus niloticus	Reproduces readyly in captivity. Breeding records at Bush Gardens (Tampa), Calif. Alligator Farm, Berlin(D), Cologne(D) (multiple breeding), Copenhagen(DK), Dudley(GB), Lyon(FR), Paris(FR), Tel Aviv Zoo(IL), Stockholm(SE).	CAG does not support any unified breeding effort. The exhibition potential is high. Europe: ~~63(11/18/34)~~ in ~~13~~ 20 Zoos. ← 86(15/25/46)
Crocodylus novaeguineae	No breeding group in US and European Zoos.	Europe: 2(1/1/0) in one Zoo.
Crocodylus palustris	Breeding very successfully with in the species range: Madras Crocodile Bank, Ahmedabad, Dehli, Hyderabad and Jaipur Zoos (IN). Calif. Alligator Farm at Ocala.	Breeding potential exists at Bronx Zoo and St. Augustine Alligator Farm. Europe ~~4(0/0/4)~~ in 3 Zoos. ← 5(1/2/2) CAG does not favour a unified breeding effort outside India.

Crocodylus porosus	Because of space requirements this very large and aggressive species is rarely maintained in breeding pairs in Zoos. Breeding in Higahi(JP).	CAG: Not to be bred in Zoos because of difficulties in placing surplus. Europe: ~~14(1/0/13)~~ in ~~5~~ 6 Zoos. → 16(1/0/15)
Crocodylus rhombifer	Breeding at Bronx Zoo, National Zoo, California Alligator Farm, at Ocala FL, Stockholm SE (multiple breeding), Larsson & Wihman, in press); Wroclaw(PL).	CAG: AAZPA studbook approved as wild population appear threatened by hybridization with Cr. acutus. Approximately 100 specimens kept: outside Cuba: US: 62(14/37/13) specimens, Europe: 25(5/7/13) in 4 Zoos.
Crocodylus siamensis	The largest group of captive Cr. siamensis is within the species range in a Farm in Bangkok. Unfortunately hybrids with Cr. porosus are encouraged to produce superior hides. Miami Zoo has bred the species since 1978 and repeated breedings have been recorded at the Bronx Zoo, St. Augustine Alligator Farm and the California Alligator Farm, at Ocala. Moscow, Rostov(SU). Higashi-Izu(JP).	CAG: AAZPA has approveda studbook. US 132 (21/21/90) specimens. Europe: ~~6(1/1/4)~~ in ~~2~~ Zoos. → 7(2/1/4) # 3 Considering the vulnerable situation in the Samutprakan Farm in Thailand, management of the present captive population advisable.
Osteolaemus tetraspis	Repeatedly bred at Ft. Worth, Seattle, Memphis, Barcelona(ES) (1987-1988), Emmen(NL) (1986, 87,89), Gossau(CH) (1989), Rotterdam(NL) (1980), Tel Aviv(IL), Tokyo(JP), Kuala Lumpur(MY)	Numerous in Zoos. CAG: Because of surplus problems, unknown nature of founder stock, limited interest among Zoos and the relatively common status in nature suspension of captive breeding efforts suggested. Europe: most common species: ~~61~~ ~~(17/21/23)~~ in ~~20~~ Zoos, plus numerous in private collections. → 67 → (19/24/24) # 23

Tomistoma schlegelii	Captive breeding at the Bronx Zoo and at Metro Zoo, Miami; and Aalborg(DK).	CAG: Regional AAZPA studbook recommended. About 60 species kept in Zoos around the world; 31 individuals in 6 US Zoos and Europe: ~~28~~ 29 (5/5/~~18~~) in 8 Zoos. ← 19
Gavialis gangeticus	An adult male Gharial, since 1980 on breeding loan from Frankfurt Zoo(D) at Nandankanan Biological Park, Orissa(IN) started a very successful breeding programm; so far 224 hatchlings have been reared. (Kar,1989).	Relatively rare in Zoos. Atlanta, Bronx, National Zoos and St. Augustine Alligator Farm hold potential breeding groups. Europe: one female at Vienna Zoo. CAG. The long-range scenario for this slow-maturing species is difficult to predict.

I.S.O. country code used.
Sources: Int. Zoo Yearb. 1-26, AAZPA/CAG mimeographed reports.

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Table 8:

Longevity and albino specimens

Species	Locality	sex	year-acquired
Alligator mississippiensis	Amsterdam, NL	0/0/2	1949
	London, GB	0/1/0	1949
	Prague, CSSR	1/1/0	1953
	Rotterdam, NL	1/1/0	1915/1920
Alligator sinensis	Berlin-E, GDR	1/1/0	1957
	Chicago, Brookf. USA	0/0/1	1952 +
	Prague, CSSR	0/1/0	1957
Caiman c. apaporiensis	Berlin-E, GDR	0/0/1	1972
Paleosuchus palpebrosus	Albuquerque, USA	0/0/1	1972 +
Paleosuchus trigonatus	Detroit, USA	0/0/1	1959 +
Crocodylus cataphrachus	Miami Metro Zoo, USA	0/0/1	1940 +
	Rotterdam, NL	1/1/0	1915/1920
Crocodylus intermedius	Chicago, Brookf. USA	0/0/1	1968
Crocodylus niloticus	Bristol, GB	1/1/0	1951
	Paris, F	0/0/3	1948
Crocodylus porosus	Dresden, GDR	0/0/1	1958(*1957)
Crocodylus rhombifer	Berlin-E, GDR	0/0/1	1962
Osteolaemus tetraspis	Berlin-E, GDR	1/0/0	1958
Tomistoma schlegeli	Amsterdam, NL	1/0/0	1939
		0/1/0	1955

Albino specimen

Crocodylus porosus	Stuttgart, GDR	1/0/0	1967

+ Data from Slavens, 1987

Table 9
Status of Crocodiles in European Zoos and Aquaria:

Institution:	No. Species inc. ssp.:	No. Specimens:	No. of enclosures:
Amsterdam NL	5(10)	19(44)	3(4)
Antwerpen B	1	4	1
Augsburg FRG	1	3	1
Banham, UK	1	1	-
Barcelona SP	9(5)	45(19)	nd(-)
Basel CH	1(2)	4(6)	1(2)
Berlin E GDR	11(13)	39(23)	-(-)
Berlin W FRG	nd(24)	nd(52)	nd(-)
Bern CH	1	2	1
Brighton, UK	1	1	-
Bristol UK	2	3	2
Chessington UK	1	3	-
Chester UK	3	9	3
Colchester UK	1	2	-
Cologne FRG	2(3)	58(22)	2(3)
Copenhagen DK	2	9	2
Cotswold UK	2	4	-
Darmstadt FRG	1(3)	2(12)	1(-)
Dortmund FRG	1	2	1
Dresden GDR 2	2(7)	2(8)	2(-)
Duisburg FRG	2(2)	4(4)	1(1)
Düsseldorf FRG	5(6)	10(7)	4(7)
Dvur Kralove CSSR	5(7)	23(22)	nd(3)
Edinburgh UK	1	2	-
Emmen NL	3	18	3
Frankfurt FRG	1(8)	1(11)	1(-)
Gossau CH	3	14	2
Hamburg FRG	2	6	nd
Hannover FRG	1(1)	2(2)	1(1)
Krefeld FRG	1	2	1
Leipzig GDR	5(3)	9(7)	5(4)
London UK	2(10)	6(27)	2(7)
Mablethorpe UK	1	1	-
München FRG	2(8)	8(18)	2(2)
Paington UK	4	6	-
Paris F	1(3)	3(17)	1(-)
Prague CSSR	4(3)	11(5)	5(4)
Rotterdam NL	3(7)	6(14)	3 will ad A. (6) sinensis BL
Saarbrücken FRG	1	1	1
Skegness UK	2	5	-
Southport UK	1	2	-
Stockholm S	2	14	2
Studen/Biel CH	1	9	2
Stuttgart FRG	5(17)	20(33)	5(5)
Thrigby Hall UK	3	10	-
Twycross UK	1	4	-
Welsh-Mountain UK	1	1	-
Wien-Meer AU	2	2	2
Wien-Schönbrunn AU	3(7)	3(9)	nd(6)
Windsor UK	1	2	-
Wuppertal FRG	1	2	1
Zürich CH	1(2)	2(5)	1(2)

Figures in brackets: 1973 survey (Honegger, 1975)

Table #10

Species	Number of Specimens	Number of Collections
Crocodylus niloticus	86 (15/25/46)	20
Osteolaemus tetraspis	67 (19/24/24)	23
Alligator mississippiensis	51 (18/27/ 6)	19
Paleosuchus palpebrosus	46 (16/18/22)	7
Caiman crocodilus crocodilus	34 (6/ 9/19)	8
Tomistoma schlegeli	29 (5/ 5/19)	9
Crocodylus rhombifer	25 (5/ 7/13)	4
Crocodylus porosus	16 (1/ 0/15)	6
Caiman crocodilus yacare	13 (2/ 2/ 9)	1
Crocodylus cataphrachus	10 (2/ 2/ 6)	2
Caiman crocodilus ssp.	8 (2/ 5/ 1)	1
Alligator sinensis	7 (3/ 4/ 0)	4
Crocodylus siamensis	7 (2/ 1/ 4)	3
Caiman latiostris	5 (3/ 2/ 0)	3
Crocodylus palustris	5 (1/ 2/ 2)	3
Crocodylus johnsoni	4 (2/ 2/ 0)	2
Crocodylus novaguinea	2 (1/ 1/ 0)	1
Crocodylus palustris "kimbula"	2 (0/ 0/ 2)	1
Crocodylus acutus	2 (0/ 1/ 1)	2
Gavialis gangeticus	1 (0/ 1/ 0)	1
Caiman crocodilus apaporiensis	1 (0/ 0/ 1)	1

Table 11

Breeding record

Locality Species	year	number eggs laid	eggs hatched	survived 30 days	Inc. Temp.	Inc. Time
Amsterdam NL						
Caiman c. crocodilus ssp.	1971	27	9	9	28/32	-
	1975	9+	9	9	-	-
	1977	29	8	8	-	-
Barcelona SP						
Caiman c. crocodilus	VI.87	22	15	11	29/32	77 d
	VI.88	?	3	-	29/32	77 d
	VI.89	22	2	1	29/32	77 d
Caiman c. yacare	VI.88	27	24	24	29/32	73 d
Osteolaemus tetraspis	VII.87	?	4	4	29/32	87 d
	VII.88	21	14	12	29/32	87 d
Copenhagen DK						
Crocodylus niloticus	1983	25	51	1	-	±3mos
	1984	20	7	7	-	±3mos
	1986	4	2	2	-	±3mos
	1988	3	1	1	-	±3mos
	1989	5	5	4	-	±3mos
Osteolaemus tetraspis	1987	18	5	4	-	±2 1/2mos
Emmen NL						
Crocodylus cataphractus	1987	26	7	7	26/29	±3mos
	1989	29	13	6	26/29	±3mos
Osteolaemus tetraspis	1986	20	9	9	26/29	±3mos
	1987	10	4	2	26/29	±3mos
	1989	20	-	-	26/29	-
Gossau CH						
Osteolaemus tetraspis	1989	23	10	7	30	81 d
Cologne FRG						
Crocodylus niloticus	1975 - 1989	500	42	40		84 - 114 d
Paleosuchus palpebrosus	1980 - 1989	370	81	80		98 - 116 d
Paris F						
Crocodylus niloticus	1958	?	10	9	?	?
	1963	?	2	2	?	?

Locality Species	year	number eggs laid	eggs hatched	survived 30 days	Inc. Temp.	Inc. Time
Rotterdam NL						
Caiman crocodilus	1980	22	3	3	30	84 d
Osteolaenius tetraspis	1948	10	5	4	-	-
Stockholm S						85 - 100 d
Crocodylus rhombifer	1985	10		?		
	1986	16		?		
	1987	-		?		
	1988	22	-	-	-	
Stuttgart FRG						
Caiman crocodilus crocodilus	1979	14	2	2	28	± 3mos
	1982	16	1	1	28	± 3mos
	1983	?	7	7	28	± 3mos
	1986	14	5	5	28	± 3mos
	1987	?	2	2	28	± 3mos
	1988	?	3	3	28	± 3mos

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Egg laying recorded

Locality	Species	Year
Amsterdam	Caiman crocodilus ssp.	1978 - 1989
	Osteolaemus tetraspis	1977 - 1989
	Crocodilus niloticus (?)	1988
Basel	Tomistoma schlegeli	1989
Darmstadt	Osteolaemus tetraspis	1988, 1989

Mercury Contamination Of Florida Alligators

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INTRODUCTION

Mercury has been and continues to be an important element to man. Mercury samples have been found in Egyptian tombs dated to 1600 BC. Cinnabar, the principal mercury ore, has been mined since 415 BC (Royals and Lange 1990) and Aristotle recorded its use in religious ceremonies (Farber 1952). More recently mercury has been used for gold extraction, hat manufacturing, as a pigment in paint, and as an aphrodisiac (Jaffee 1930, Goldwater 1936, Leicester 1961). Mercury is currently used in chlorine and soda ash production, electrical component manufacturing, dentistry, agriculture, paint and plastic manufacture, laboratories, pulp and paper production, and other manufacturing processes (Rodgers 1989). Current world use is estimated at 9,000 to 14,000 metric tons annually (Royals and Lange 1990).

Mercury occurs in the environment naturally and as a result of man's activity. Mercury is found as a common element in hot springs and in particulate and gaseous form in lava. Mercury gas is released as a result of evaporation from the oceans and the breakdown of rocks, minerals, and peat (Royals and Lange 1990). Man releases mercury into the biosphere directly through burning of coal and fuel oil containing high levels of mercury, mining activities, and the improper disposal of industrial waste and products. Mercury is introduced into wetlands indirectly as a result of dredging operations, altered water levels, and increased turbidity, which can expose or resuspend mercury laden sediments (White and Cromartie 1985, Barr 1986).

Mercury has no known biological function and its presence in fish, wildlife, and humans is potentially hazardous (Eisler 1987). Several factors influence the availability and toxicity of mercury to fish and wildlife. Mercury is more often associated with low ph and oligotrophic waters than neutral or high ph and eutrophic waters (Royals and Lange 1990). Others factors that influence mercury availability and toxicity are salinity, temperature, diet, age, sex, species, the molecular form of mercury, and the presence of other chemicals (Eisler 1987). Sublethal levels in aquatic organisms affect metabolism, blood chemistry, osmoregulation, and oxygen exchange. At comparatively low concentration in birds and mammals, mercury adversely affects reproduction, growth and development, behavior, blood and serum chemistry, motor coordination, vision, hearing, histology and metabolism. The effects of mercury on humans, fish, and many wildlife species are thoroughly reviewed by Eisler (1987), however, the effects on crocodilians are not fully understood. The presence of mercury in alligators and crocodiles in Florida has been reported by (Ogden et al. 1974, Stoneburner and Kushlan 1984, Delany et al. 1988), and (R. Labiskey, Univ. of Fla., unpubl. data).

The first cases of mercury poisoning were reported in Europe in 1865 when two men died in a chemical laboratory. Incidences of mercury poisoning have occurred in Argentina, Nicaragua, the United States, the Soviet Union, and Canada (Eisler 1987). Major epidemics have been reported in Japan, Pakistan, Guatemala, Ghana, Yugoslavia, and Iraq (Eisler 1987). The fact that mercury can bioaccumulate is of particular importance since humans consume predatory fish and wildlife. The consequences of bioaccumulation were realized during the 1950s in Japan where mercury discharged into Minada Bay resulted in toxic concentrations of mercury in fish and shellfish. By 1982, at least 1,800 human victims were verified (Eisler 1987).

Contaminated fish were first discovered in the Chipola River located in northwest Florida in 1983 when largemouth bass, a predatory gamefish, were found to contain mercury. The Florida Department of Environmental Regulation (DER) began statewide sampling of fish for heavy metals in August 1987. Mercury contaminated fish were found in Ocean Pond and the Santa Fe River, in north central Florida, as well as the Chipola River. DER conducted sampling again in November 1988 and found elevated mercury levels statewide, including high levels in the Water Conservation Areas (WCA), which are located in south Florida (Figure 1). As a result of these findings, the Florida Game and Freshwater Fish Commission (Commission) initiated statewide sampling of fish for mercury in early 1989. Fish containing levels of mercury exceeding 0.5 ppm of mercury were discovered throughout Florida.

The Florida Department of Health and Rehabilitative Services (HRS) recognizes the safe level of mercury in fish flesh to be less than 0.5 ppm, and fish containing greater than 1.5 ppm are considered unsafe for human consumption. Subsequent to Commission sampling, HRS issued health advisories recommending limited consumption of fish containing between 0.5 to 1.5 ppm of mercury from the Perdido, Blackwater, Yellow, Hillsborough, Suwannee, Upper St.Johns, and Sante Fe Rivers, and Lake Kissimmee, Lake Tohopekalgia, and East Lake Tohopekalgia. Fish containing mercury levels exceeding 1.5 ppm were found in the WCA, and HRS issued a special advisory addressing the risks of consuming largemouth bass and warmouth caught in the WCA.

Subsequently, the Commission became concerned about the possibility of bioaccumulation of mercury in other aquatic organisms within the WCA. The effects of mercury contamination became particularly important in the WCA's alligator population since the Commission initiated a public alligator harvest in these areas in 1988. The Commission's primary concern was that the flesh of harvested alligators within the WCA might contain high levels of mercury that would be consumed by humans. Since no data were available on the levels of mercury in alligator flesh, efforts were begun in February 1989 to selectively sample alligators in the WCA and other Florida wetlands.

METHODS

A total of eight alligators (1.5-2.1 m) were collected from the L38E and L35B canals in WCA 2 and the C123 and L67A canals in WCA 3, during February 1989. A 10 gram meat sample was obtained from the lateral side of the base of the tail. Each sample was placed in a plastic bag, individually labeled, and refrigerated. A second sample was collected in the same manner from ten alligators in June 1989. Samples were stored in a freezer and transported to the Commission's Fisheries Lab where they were analyzed for mercury content. Mercury content analysis was conducted using atomic absorption cold vapor generation.

Sampling of alligator meat in other areas of the state began shortly after the initial discovery of mercury in the WCA. Samples of meat (n=19) were obtained from a nuisance alligator hunter in the Ft. Lauderdale area, which is adjacent to the eastern boundary of WCA 2 and 3. Additional samples of meat (n=58), primarily from nuisance alligators, were obtained from licensed meat processors from north, central, and south Florida.

In order to determine the economic loss resulting from the suspension of alligator harvests on the WCA, we used the following economic values: harvest quota of 585 alligators, based on 1989 night-light surveys; 39 licensees, and 15 tags per licensee; 38 agent licenses, based on the statewide percentage of agent to participant licenses (98%) (David 1989); expected fill rate of 98%, based on 1988 harvest results from the WCA (David 1989); average carcass length of 2.4 m, based on 1988 harvest results from the WCA; hide price of $14 (US) per meter; wholesale meat price of $2.27 (US) per kilogram; and participant license fee of $250 (US) and agents license fee of $50 (US).

RESULTS

Analysis of alligator meat samples taken in February 1989 from WCA 2 and 3 (Table 1) revealed a mean mercury level of 1.66 ppm, which in fish is considered unsafe for human consumption by HRS standards. Samples taken in June 1989 from WCA 2 and 3 revealed higher mercury levels than those found in the first sample (Table 2), with a mean mercury level of 2.92 ppm, almost twice the level considered unsafe for human consumption of fish.

Analysis of alligator meat samples obtained from a nuisance alligator hunter in the Ft. Lauderdale area (Table 3) revealed a mean mercury level of .74 ppm.

Analysis of alligator meat samples (n=58) obtained from licensed alligator meat processors from north, central, and south Florida (Table 4) revealed a mean mercury level of .39 ppm.

The HRS' safe level for fish is based on frequency of consumption, age, and sex. However, the HRS has not established a safe level of mercury in alligator meat. Since fish are a regular part of many people's diet and alligator meat is considered a novelty item, alligator meat containing a higher level of mercury might be safely consumed. However, since HRS has no safe mercury level for alligator meat and relatively high levels of mercury have been found in WCA alligators, the Commission ordered the cancellation of the 1989 and 1990 alligator harvest in the WCA.

The economic loss resulting from the cancellation was significant. The 1989 harvest was expected to yield a gross value of $270,682 (US) to 39 licensed participants (Table 5). The loss in revenue to the state from license and tag fees was projected to be $27,610 (US) (Table 5). The 1990 harvest should have yielded comparable values. Although meat yield represents a significant portion of the total economic value of the alligator resource, the majority of the alligator's gross economic value is in the hide. Based on 1989 hide prices, approximately 71% of an alligator's value was attained from the hide .

DISCUSSION

The source or sources of mercury contamination of the WCA is not known. Several possibilities have been proposed, including runoff from adjacent agricultural fields, leaching of the muck soils which are characteristic of the Everglades wetlands that comprise the WCA, the burning of agricultural fields, and fires within the WCA. Additionally, Everglades wetlands are characteristically oligotrophic and have low ph (South Florida Water Management District 1989), which have been reported to increase mercury availability to fish and wildlife (Royals and Lange 1990).

The human health and biological hazards of mercury contamination of alligators are serious, although not totally known at this time. Juvenile alligators which were fed mercury over a 13 week period resulting in mercury levels comparable to those found in alligators from the WCA showed no clinical symptoms of adverse effects (Peters 1983). Similarly, no adverse effects from mercury contamination to alligators in the WCA have been reported. The Florida Cooperative Fish and Wildlife Research Unit has an ongoing study which is examining alligator egg viability in Florida (Percival et al. 1988). Despite the presence of mercury in adult alligators, eggs collected from the WCA in 1988 and 1989 had one of the highest viability rates of any area sampled (F. Percival, Fla. Coop. Fish and Wildl. Res. Unit, unpubl. data).

The economic loss resulting from the cancellation of the 1988 harvest in the WCA was $270,610 (US). Consequently, the economic impact to the statewide wild alligator harvest of widespread contamination of alligators could be potentially crippling. The possibility of a hides only harvest exists, however there could be concern over the waste of part of the resource. Additionally the alligator farming industry and the public might be concerned that mercury contaminated meat from hides only harvest areas could illegally enter the market.

Mercury contamination is apparently widespread in Florida's wetlands. Delany et al. (1988) reported mercury levels in alligator flesh above 0.5 ppm from two current alligator harvest areas, Lake Iamonia (mean=0.61 ppm, n=3) and Rodman Reservoir (mean=0.51 ppm, n=3). Mercury levels exceeding 0.5 ppm were found in alligator flesh from the WCA in 1989 and nuisance alligators from three areas of the state contained mercury levels above 0.5 ppm. Additionally, fish containing greater than 0.5 ppm of mercury were discovered in 1989 in one current alligator harvest area, Lake Harney, and 31 other wetlands throughout the state (FGFWFC, Div. of Fish., unpubl. data 1989). It is probable that alligators from those wetlands also have elevated mercury levels.

As a result of the widespread occurrence of mercury in Florida's wetlands, mercury contamination of alligators will continue to be a problem. An HRS policy statement on the human health hazards of mercury in alligator meat is expected soon. At that time, the Commission will consider formulation of a policy regarding alligator harvest from areas where mercury contamination of alligator meat is discovered.

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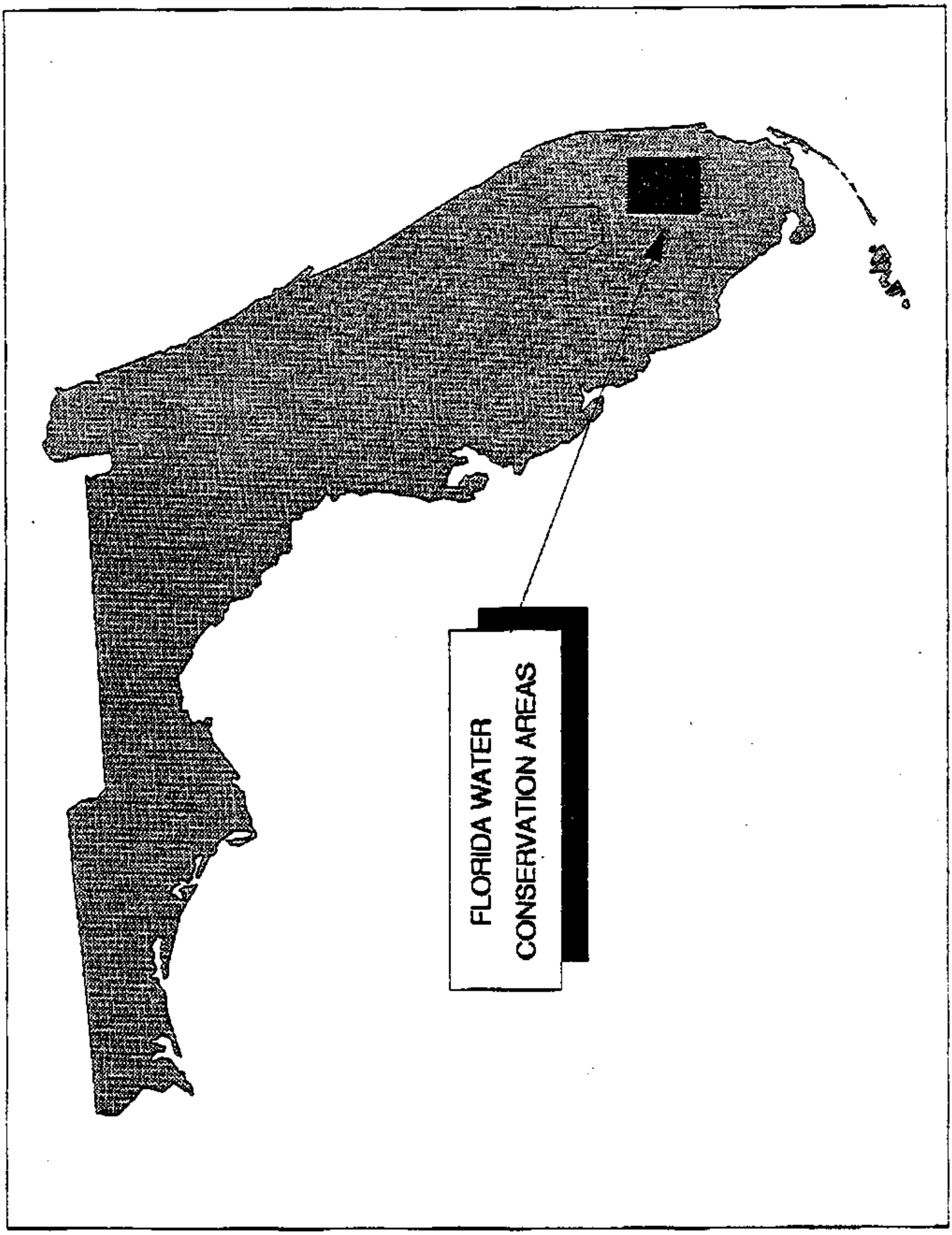

Figure 1. Map of Florida Water Conservation Areas.

Table 1. Morphological characteristics and mercury levels of alligator meat (N=8), Florida Water Conservation Areas (WCA), Feb. 6, 1989.

Collection site	Total length ft. (m)	Snout-vent in (cm)	Tail girth in (cm)	Sex	Hg (ppm)
<u>WCA2</u>					
L-35B	6.9 (2.1)	42 (107)	18.5 (47)	F	2.80
L-35B	6.8 (2.1)	40 (102)	17.0 (43)	M	1.23
L-38E	6.6 (2.0)	38 (97)	16.0 (41)	F	1.00
L-38E	4.0 (1.2)	24 (61)	9.5 (24)	F	0.46
<u>WCA3</u>					
L-67	5.5 (1.7)	39 (99)	16.5 (42)	F	1.67
L-67	6.1 (1.9)	36 (91)	16.0 (41)	F	2.88
Miami C	7.1 (2.2)	41 (194)	20.0 (51)	F	2.48
Miami C	9.2 (2.8)	59 (150)	25.0 (63)	M	0.78

Table 2. Morphological characteristics and mercury levels of alligator meat (N=10), Florida Water Conservation Areas (WCA), June 7, 1989.

Collection site	Total length ft. (m)	Snout-vent in (cm)	Tail girth in (cm)	Sex	Wt. lbs (Kg.)	Hg(ppm)
WCA2						
L35B	5.8 (1.8)	34 (86)	16.0 (40.6)	F	41 (18.6)	2.51
L35B	6.4 (2.0)	36 (91)	16.0 (49.6)	F	43 (19.5)	2.90
L35B	5.3 (1.6)	31 (79)	13.0 (33.0)	M	23 (10.4)	2.10
L35B	6.6 (2.0)	38 (97)	16.0 (40.6)	F	47 (21.3)	3.88
L35B	7.4 (2.3)	42 (107)	18.0 (45.7)	M	72 (36.7)	2.21
WCA3						
Miami Canal	7.3 (2.2)	43 (109)	17 (43.2)	F	_	3.58
Miami Canal	9.0 (2.8)	53 (135)	23 (58.4)	M	-	3.58
Miami Canal	6.9 (2.1)	41 (104)	16.3 (41.4)	F	-	2.37
Miami Canal	6.0 (1.8)	36 (91)	15.6 (39.6)	F	-	3.06
Miami Canal	7.0 (2.1)	43 (109)	15.6 (39.6)	M	-	3.04

Table 3. Morphological characteristics and mercury levels of alligator meat (N=19). Nuisance alligators collected from urban canals in southeast Florida, May, 1989.

Total length ft. (m)	Sex	Hg (ppm)
7.0 (2.1)	M	0.53
6.0 (1.8)	M	0.46
7.0 (2.1)	F	0.42
7.6 (2.3)	M	0.34
7.3 (2.2)	F	2.52
7.2 (2.2)	M	0.30
5.9 (1.8)	M	0.34
4.9 (1.5)	?	1.36
6.0 (1.8)	M	0.34
7.2 (2.2)	M	0.45
6.2 (1.9)	F	1.21
5.2 (1.6)	F	0.21
6.7 (2.0)	M	0.17
6.6 (2.0)	M	0.77
4.8 (1.5)	M	0.74
6.7 (2.0)	M	0.70
8.3 (2.5)	M	0.84
8.0 (2.4)	M	2.15
9.7 (3.0)	M	0.29

Table 4. Results of analysis of mercury content of alligator meat from alligator meat processors (N=58) North, Central and South Florida, 1989.

Capture site	Sample Size	Mean mercury level ppm (Hg)
Citrus County	(N=4)	0.31
Clay County	(N=1)	0.15
Duval County	(N=1)	0.25
Franklin County	(N=1)	0.90
Hernando County	(N=4)	0.42
Lake County	(N=3)	0.24
Lee County	(N=2)	0.44
Levy County	(N=6)	0.21
Orange County	(N=2)	0.13
Pasco County	(N=19)	0.45
Pinellas County	(N=12)	0.55
Putnam County	(N=1)	0.20
Wakulla County	(N=2)	0.39

1989 Alligator Samples, Chemical Residue Laboratory, Division of Chemistry, Bureau of Food Grades and Standards, Division of Inspection, Florida Department of Agriculture and Consumer Services

Table 5. Expected economic value (US dollars) of the 1989 alligator harvest, Florida Water Conservation Areas 2 and 3.

Economic Value to Participants	
Value of hides	$190,882.00
Value of meat	$79,800.00
Gross value to 39 participants	$270,682.00
Value per participant	$6,940.00
Economic Value to the State	
License fees (N=39)	$9,750.00
Agents fees (N=38)	$1,900.00
Tag fees (N=532)	$15,960.00
Total	$27,610.00

A SURVEILLANCE METHOD FOR MONITORING ALLIGATOR NESTS

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Abstract: I describe a field tested method for taking surveillance photographs of alligator nest sites. The surveillance system is weatherproof and produces high quality photographs under all light conditions.

Crocodilian nests attract predator activity but predators are seldom positively identified. In Louisiana predators of alligator eggs occasionally have been identified by observing the incident and by monitoring dyed alligator egg shells in raccoon scat (Joanen,1970; Fleming, Palmisano and Joanen, 1976). In Okefenokee Swamp Kodak Instamatic cameras with mouse-trap shutter releases were mounted on stakes and positioned near nest mounds; photographs identified rice rats, *Oryzomys palustris*; raccoons, *Procyon lotor* and black bear, *Ursus americanus* preying on alligator eggs (Hunt, 1989). In Everglades, Florida surveillance cameras using infrared film did not identify predators of eggs but did record next excavation and neonate transport by an American crocodile, *Crocodylus acutus* (Ogden and Singletary, 1973). My paper describes a surveillance system using a 35 mm single lens reflex camera with infrared trigger.

METHODS AND MATERIALS

Canon cameras (Canon U.S.A. Inc. One Canon Plaza, Lake Success, N.Y. 11042) were used to monitor six nests in Chesser and Grand Prairies of the Okefenokee National Wildlife Refuge, Ga. U.A.A. Chesser-Grand Prairie is an aquatic macrophyte marsh.

Components of Surveillance System

1. Camera- Canon T-70. This model is no longer manufactured but the less expensive T-50 can also be used. Estimated expense for a used T-70 or new T-50 body is \$100-200.
2. Lens- Canon FD 50 mm, f 1.8=\$50; FD 28 mm f 2.8-\$60

FD 24 mm, f 2.8-$150

3. Extension cord- Canon 1000, T-3 , 10 m - $30.
4. Flash- Vivitar 2000 (Vivitar Corporation, Santa Monica Calif. 90406-2100, U.S.A.)- $30.00
5. Diving bag- EWA Marine(Pioneer , Westmont N.J. 08108=$120
6. Battery wall clock-$10
7. Parts to waterproof transmitter- PVC pipe 17.5 cm X 5 cm PVC screw cap, glass lens.
8. Parts to waterproof receiver-Clear plastic pipe 15 cm X 5 cm. two PVC screw caps.
9. Transmitter and Receiver- Canon LC-2- $150
10. Parts to mount camera, transmitter and receiver- wooden stakes stainless steel bolts and rubber washers.
11. Umbrella
12. Film- Fuji Chrome 100 and 400; Kodachrome 64, Ektachrome 200 and 400.
13. Batteries- Camera= two AA alkaline (24 hr use change 2X week)
    Flash- four AA alkaline (24 hr use change 1x day)
    Transmitter-two AA alkaline (24 hr use change 3X week)
    Receiver-one lithium 6v(24 hr use change 2X week)
14. Power Pack (for flash if batteries not used- Simon Supercharger (Tim Simon Inc. San Rafael Ca. 94901)= $70.
15. Dessicant -Silica gel beads
15. Silicaone tape

Assembly of Waterproofing Components

Holes were punched in the diving bag to mount the camera and to connect the extension cord from camera to receiver. A hole was drilled in each plastic pipe to receive the mounting bolts of the transmitter and receiver. Sillcone tape was used to seal the threaded caps of the plastic pipes. A clear glass lens was glued to the end of the PVC pipe containing the transmitter. Dùct tape was wrapped around the extension cord to protect it from abrasion.

Operation of Surveillance System

The camera was placed in the diving bag and, in wide-angle program mode, it was focused on the nest from a distance of 2-5 m. The flash unit was mounted on the camera's shoe and was set for manual operation. The transmitter and receiver were set on auto-sensing mode and positioned 1-3 m from each other, .5-1.5 m from the nest mound and 3-5 m from the camera. The transmitter and receiver were sealed inside the plastic pipes. The height of the transmitter and receiver above level ground or water was .25-1 m. Height of camera above water or level ground was 1-2 m. To resist dislodgement, mounting stakes of camera, transmitter and receiver were pushed deeper than .5 m into substrate. To insulate film from solar heat, cameras were shaded with a small unbrella or placed under available shrubs. In operation, the receiver released the shutter of the camera each time an animal blocked the infrared light path between transmitter and receiver (Fig.1). Repeated movements of the animal through the light path produced up to 36 exposures. To record the time of the exposure a wall clock was placed in view of the camera.

RESULTS AND DISCUSSION

At the six nests, the surveillance cameras exposed 109 photographs, identifying alligators tending nests and bears preying on eggs. It was thought that predators of eggs would occasionally damage surveillance equipment but only one incident occurred: a bear bit through white PVC pipe protecting a transmitter. It was possible that the bear associated the white pipe with a white alligator egg. It was thought that flash units would affect behavior of animals preying on eggs. Seventy nine of 86 photographs identifying black bears were exposed in daylight hours: it was possible that bears reacted to the initial flash of light in darkness and left the nest before exposing additional photographs. To avoid the use of flash, infrared film could have been used for night time surveillance but in daylight hours solar heat can destroy this type of film. It was thought that the sound of the cameras' motordrives might affect animal behavior but this was not clearly demonstrated. Sealing the camera in a diving bag insulated the motor drive and the resulting sound was inaudible to humans at a distance of 5 m from the camera. Surveillance cameras did not show alligators and bears in the same photograph but in one daylight photograph a bear ran before comsuming eggs. If the bear wasn't responding to the sound of the camera's motordrive it was possible that it was reacting to an alligator outside the viewing range of the lens. Wide angle lenses with a field of view of greater than 80° should be used in situations where the camera must be placed a distance of 2 m or less from the nest. Thus, the FD 24 mm lens is especially valuable for documenting interactions between alligators and bears.

In avian and mammalian studies researchers have assembled triggering devices and modified cameras for surveillance work. Montana biologists used surveillance cameras with infrared sensors detecting body heat, to photograph grizzly bears; as bears approached bait stations, the sensors triggered the camera and flash (Turbak,1990). In Nepal, Hillard (1989) used a surveillance camera for identification of snow leopards; a pressure plate was wired to a 35 mm camera and placed in the cats' path of travel. When the leopard stepped on the pressure plate the shutter was released. After AA batteries failed to provide consistent power, a 6 volt battery was used. Although a surveillance camera was in place 561 nights, only a few photographs were produced from two dozen visits by cats. Savidge and Seibert (1988) described a surveillance method for recording predation at bird nest using Kodak disc cameras (Eastman Kodak Co. Rochester, N.Y.). The disc cameras were wired to a trigger consisting of an infrared light-emiting diode and photoreceiver supported by plexiglass arms that produced a beam directly above the nest. When a predator entered the nest, it interrupted the beam of light and triggered the camera. Maximum possible distance between the transmitter and receiver of this surveillance system is 30 cm.

The Canon surveillance system should be used in situations where high quality, sequential photographs are desired for interpretation of crocodilian nest depredations. The system can be easily waterproofed and the factory made components are dependible in extremes of temperature and humidity.

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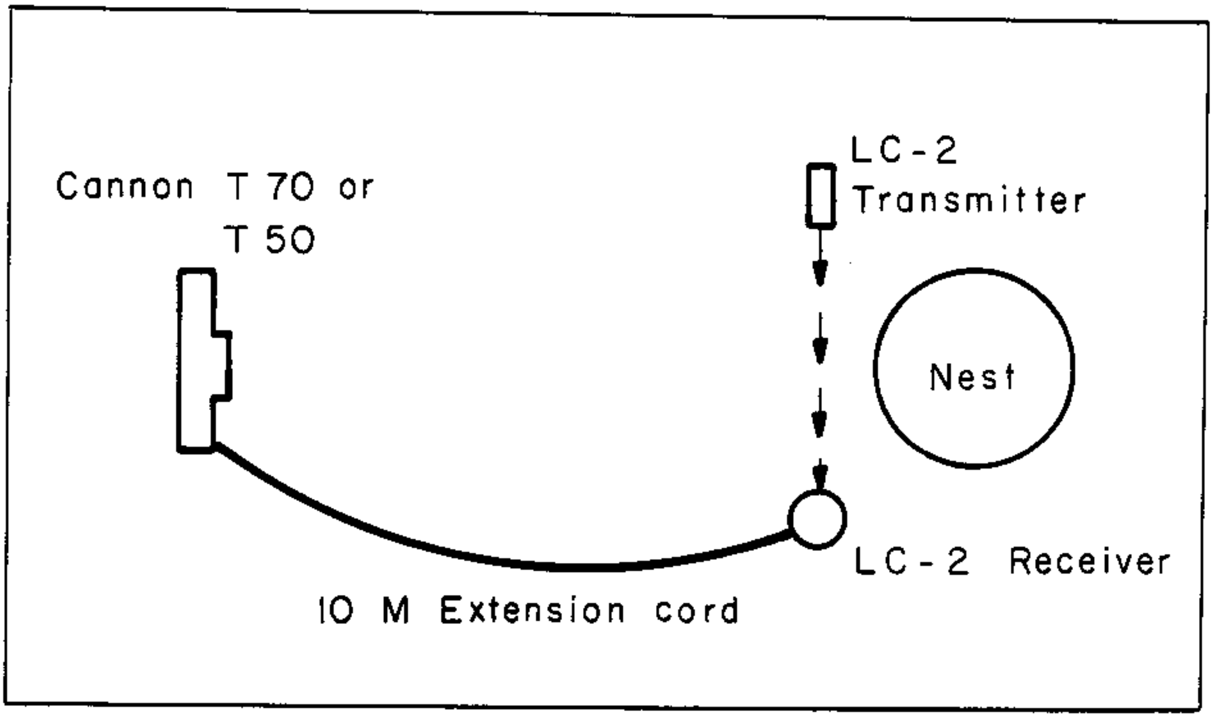

Fig. 1. Cannon camera surveillance system. An animal blocking the light path from the transmitter, signals the receiver to release the camera's shutter.

10th Working Meeting

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APPROPRIATE SOLUTIONS FOR THE UNINTERRUPTED MARKING OF CROCODILIANS, THEIR SKINS AND LEATHER PRODUCTS

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With this paper it is mainly intended to encourage the discussion on how an uninterrupted marking system for crocodilians and their skins, starting from a country of origin until the final product ends up with the consumer somewhere else in the world, could look like and to show possible solutions within the scope of CITES.

Legal requirements according to CITES

Article VI.7 of the Convention on International Trade in Endangered Species (CITES) provides that CITES protected specimens or any recognizable part or derivative thereof may be marked.

Since 1975 when CITES entered into force parties have increasingly recommended that in certain fields like i.e. crocodile ranching projects or the crocodile quota system, the export and import should only be allowed if the specimens are marked.

Already at the 8. meeting in Quito in 1986, the IUCN-Crocodile Specialist Group has demanded a marking of all skins moving in world trade. This could contribute considerably towards better controls in international trade and render it much more difficult to take illegally animals from the wild and export their skins.

Additional provisions regulating the marking of crocodilians and their skins in trade according to CITES

Marking of crocodilian skins was for the first time agreed upon at the 2nd Conference of the Parties in San Jose, Costa Rica in 1979 by adopting CITES-Resolution 2.12. However, this "farming-resolution" contains no information on how this marking should look like.

Only during the 4th Conference to the Parties in Botswana in 1983, Zimbabwe succeeded in down-listing its Nile-crocodile population pursuant to "ranching-resolution" 3.15 from Appendix I to Appendix II. From that time on, crocodilian skins from Zimbabwe were commercialized with marks affixed upon them as provided for in Resolution 3.15.

A remarkable step forward was made, when during the 5th Conference to the Parties Resolution 5.16 was adopted, giving exact details on minimum requirements for marking specimens from approved ranching projects. This resolution very clearly states, that there should be a uniform marking system.

During the same conference, the contracting parties adopted another resolution, that is Resolution 5.21, stating that the specimens which are to be commercialized or derivatives thereof have to be marked, according to the special criteria which must be fulfilled for downgrading a species from Appendix I to Appendix II under a yearly quota management. This resolution does not state how this marking should look like, but this has been explained in more detail in two notifications of the CITES-secretariat i.e. No. 364 and 375.

At the 6th Conference to the Parties in Ottawa in 1987, further innovations were made concerning the marking of crocodilian skins. These innovations were laid down in Resolution 6.17, regulating the procedure for marking crocodilian skins in quota countries, and Resolution 6.21 regulating the application of the uniform marking system for skins originating from registered breeding operations.

The latest Resolution dealing with marking requirements for specimens and their parts in trade with populations both in Appendix I or Appendix II was adopted at the 7th CITES Conference 1989 in Lausanne. This Resolution 7.12 recommends among others for live captive bred Appendix I specimens of high value - for instance **Gavialis gangeticus** or **Crocodylus intermedius** - the use of coded microchip implants on a trial basis.

The above mentioned considerations show that crocodilian skins or live captive bred Appendix I specimen of high value have only to be marked according to various CITES-regulations if they come from a ranching-project, an approved breeding operation or a country which has been granted an annual quota according to Resolutions 5.21 and 7.11. Table 1 shows the countries of origin and all crocodilian species concerned which have to be marked if internationally traded.

Applied methods for marking crocodilian hides

The tag which is used in most countries of origin for marking crocodilian skins has been developped in the United States and was first applied for marking the skins of the American-alligator. The tag is a plastic loop, which once attached cannot be removed without destroying either the tag or the skin. These tags are big enough to bear a full number code and could be fastened in a natural opening of the skin, like for instance the cloacal opening.

Advantage: The plastic tags are relatively secure against falsification, easy to apply and resist most of the processing operations to which a reptile skin is subjected; they could also be used for identification of entire, stuffed specimens.

Disadvantage: It is necessary to change over to another system of marking for reptile products for further processing which prevents continuous monitoring (Welsch, 1987).

With the exception of Australia and Zimbabwe, most of the countries mentioned in Table 1 use the United States' plastic tags for marking their skins.

The ranching project of Papua New Guinea includes the export of two different species of crocodiles. The country uses plastic tags with different colours for the different species. All skins of freshwater-crocodiles, **Crocodylus novaeguineae** are marked with green tags while the skins of saltwater crocodiles, **C. porosus** receive red tags (CITES-Not. 470, 1988). The plastic tags which are affixed upon skins from the Australian ranching project differ in its general appearance from the U.S.' tags.Australia uses two approximately rectangular small plastic plates (ca. 4 x 2,5 cm) having a plastic flap on one of the long sides which serves for sealing both parts together.

So what is the information printed on the tags moving in trade? Pursuant to CITES-Resolution 5.16, the 'uniform marking-system' requires only the IOS-Code for the country of origin, an unique identification number and the year of production. All tags presently in use fulfill these requirements and are even more specific than that.

The Australian tags - so-called 'Allflex-tags' - even contain additional informations, i.e. an abbreviation for the species from which the skin has been taken and display of the logo of the state-wildlife authority of Queensland or the Northern Territory (CITES-Not. 406, 1986).

All countries using the U.S.' tags state more or less as in Table 2 listed the same kind of information on their labels:

Table 2:

INFORMATION ON U.S. PLASTIC TAGS

- Abbreviation CITES
- IOS country code
- Species code,
  i.e. 'NIL' for **Crocodylus niloticus** or
  'GTR' for **Alligator mississippiensis**
- Year of export
- Serial identification number

The tags on crocodilian skins originating from South African farms do also comply with 'requirements of the uniform marking system' provided for in CITES-Resolution 6.21. As additional information they state the name of the farm and the registration number which has been given by the CITES-Secretariat.

Existing methods of marking crocodilian leather products

As far as the author of this report knows, apart from the marking systems accepted by the responsible management authorities in Australia and in the Federal Republic of Germany there are no other international marking systems for crocodilian leather products which comply with CITES regulations.

Finished products from crocodilian leather and other reptiles can be marked with an identification tag which is attached to less obvious parts of the product. If the identification code on the tag is checked via a central computer, the transition from the marking of the raw material to the marking of the finished product is ensured with sufficient reliability (Jelden in press).

Disadvantage: It is necessary and obviously not to avoid to change the marking system from tags on the skins to another system in order to ensure continuous marking. If the US-plastic tags on the skins remain attached to the tail-tip until the skin has been tanned and finished then only a small part of the skin remains unfinished. In this case the US-tag will only be exchanged to another marking system when the skin is cut into pieces to manufacture a particular product like i.e. handbags, belts and others.

Existing methods for marking live crocodilians

Various methods of marking live crocodilians have been described in the past, like metal or plastic markers attached to tail or neck scutes, marking with water resistant colours, hot- and freeze-branding, clipping of scutes, photographic documentation or implantation of a code-number bearing microchip by means of a disposable needle (Anon. 1989, Honegger, 1979).

When greater numbers of live crocodilians are intended to be exported for the pet- or ranching-industry, the animals should at the latest be marked before they are exported. In my opinion, the only two ways for doing this are the application of metal-markers or the microchip-system.

Metal-markers have already proved highly successful for the marking of sea turtles (Balazs & Gilmartin 1985). These markers consist of a nonrusting metal strip, which is closed with the help of special pliers and a pin which constitutes the connexion with the animal tissue. A letter-number code stating all information given by the uniform marking system or other data may be stamped into the metal strip. With crocodiles the tail is particularly suited for affixing the marker.

Advantage: When using nonrusting material the durability of the marker is very good, and when it has been affixed in the right place the risk of loosing it is very small.

Disadvantage: An infection due to marking the corresponding part of the body cannot be excluded; however, with expert handling the risk of an infection is very small. The mark mars the animals appearance.

According to what we know today, the microchip system is the most universal and reliable method for marking live animals. This includes a microchip embedded in bio-plastics which is implanted into the animal with the help of a hypodermic needle. The code-number contained in the chip can be recalled by a reading device.

Advantage: The system is relatively secure against falsification, it is very durable and doesn't handicap or mar the animal as the chip grows together with the surrounding tissue.

Disadvantage: The reading device has only a very short range and the chips are still fairly expensive (~5,- US $ in 1989).

Objectives and requirements of an uninterrupted marking system

Fortunately the marking tags and identification systems used in the different countries of origin are either identical or at least similar. But what are the basic requirements to be met by a marking system?

- In order to facilitate compliance with the CITES-regulations the system must be standardized.
- It should be of simple design, practical, easily attachable and registration should be possible.
- It should be easy to comprehend.
- Imitation or falsification should be as difficult as possible.

As far as we know today, the above mentioned requirements are most likely to be fulfilled by a physical but not by a chemical marking system. With its **Chelonia mydas** ranching proposal France submitted a marking system on a chemical basis at the 6th Conference to the parties in 1987. One of the reasons why this proposal had been rejected was the unreliability of the chemical marking.

The above mentioned considerations and comments show that an uninterrupted marking system could be put into practice as follows:

1. Hunters and skin traders in the countries of origin should require a licence granted by the government. Traders should have to keep an account of their deals. Licences for hunters could be granted on the basis of an annual quota. Licences in this case should only be valid for a certain time period.

2. Only skins and live animals of a certain size category should be permitted for export.

3. Tags should indicate following information:
   - IOS Country code;
   - Species code;
   - Serial identification number;
   - Production year;
   - Countries with an annual quota system: the actual quota and the actual number of the skin should be stated, e.g. 1000/811 would mean that a country has an annual quota of 1000 skins and that the 811th skin is intended for export;

- Description of product, e.g. flanks, bellyskin, handbag;
- Number of official inspector;
- Actual size of skin or animal intended for export.

4. For skins, flanks etc. only the "US-tags" should be used as previous experience has shown clearly that these best withstand the strain of chemical and mechanical processing.

5. Regular ad hoc-inspections of tanneries, skin dealers and hunters should be conducted.

6. Skins or live animals intended for export should be inspected prior to their export by an official inspector of a wildlife conservation authority, in order to check permitted size categories, type of species etc. After the inspection official inspectors may affix a tag at the far end of the skin, e.g. the end of the tail. The far end must be chosen for processing reasons.

7. For marking live animals intended for the pet-trade or ranching-industry metal tags or microchips should be applied in a similar way as for skins. An official inspector should affix the tags at the tail before export.

8. CITES-export documents should not be issued without previous inspection and marking of the skins or live animals. Tag numbers should always be stated on CITES-

export-documents.

9. Unused tags of a specific year may not be used the following year or any other year. Surplus markers must be destroyed. The country of origin must report on the use of the markers in its statistics which are to be compiled annually.

10. Plastic tags affixed upon the skins have to remain in place until production of the finished product starts. Further marking of finished products should be carried out in accordance with a system corresponding to the one applied in the Federal Republic of Germany.

Final comments

An effectively working marking system is not only an executive instrument within the scope of CITES and it does not only have to be that. As a kind of authenticity-seal or trade-mark it could also help to document the seriousness of a state's efforts to adhere to the regulations of CITES.

Compliance with a requirement, such as it has been put forward by the IUCN-Crocodile Specialist Group, that all crocodilian skins moving in trade must be marked without exception irrespective of whether they come from ranching, farming or other management projects, doesn't mean an unjustifiable burden for a states' enforcement bodies. Proper trade controls could even help to promote marking systems to become a symbol for quality not only in countries of origin but also in consumer states. Furthermore effectively working marking systems contribute considerably, to exclude all those skins from international trade which are of illegal origin.

Table 1:
COUNTRIES OF ORIGIN WHICH HAVE TO MARK THEIR CROCODILIAN SKINS:

		SOURCE OF THE SKINS			
COUNTRY OF ORIGIN	SPECIES	Farming CITES-RES.2.1	Ranching CITES-RES.3.15	CITES annual Quota "ranching"	Controlled Wild Harvest "cropping"
Australia	*C. porosus*	+	+		
Botswana*	*C. niloticus*		+		
Cameroon*	*C. niloticus*			+	
Congo*	*C. niloticus*				+
	C. cataphractus				+
	O. tetraspis				+
Ethiopia	*C. niloticus*			+	
Indonesia*	*C. porosus*			+	+
Israel	*C. niloticus*	+			
Kenya*	*C. niloticus*	+		+	
Madagaskar*	*C. niloticus*			+	
Malawi*	*C. niloticus*			+	+
Malaysia	*C. porosus*	+			
Mozambique*	*C. niloticus*		+		+
Papua New Guinea*	*C. porosus*	+	+		+
	C. novaeguineae	+	+		+
Somalia	*C. niloticus*				+
South Africa*	*C. niloticus*	+			
Sudan*	*C. niloticus*				+
Tanzania*	*C. niloticus*			+	+
Thailand	*C. porosus*	+			
	C. siamensis	+			
	C. incl. bastards	+			
USA*	*A. mississippiensis*	+	+		+
Zambia*	*C. niloticus*		+		
Zimbabwe	*C. niloticus*		+		

* Countries using US-plastic tags.

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ALLIGATOR FARM DESIGNS IN LOUISIANA

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Presented at the

I.U.C.N., Survival Service Commission
Crocodile Specialist Group
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Introduction

The Louisiana Department of Wildlife and Fisheries regulates alligator farming under Title 56, revised 1989 edition, along with Commission rules and regulations. Previous attempts at alligator farming consisted of housing young alligators in outside pens. Growth rates were sporadic and in most cases these pens were overstocked. Size classes were mixed and oftentimes, fighting and cannibalism resulted. Overall, growth was only slightly increased as compared to wild alligator growth. Mortality amongst hatching year young were usually quite high, and as a result, none of these earlier farms were considered profitable. The majority failed to demonstrate that alligators could be raised commercially in captivity and therefore soon went out of business.

Temperature is an important factor governing growth and it varies considerably throughout the range of the alligator. In southern Louisiana, Chabreck and Joanen (1979) reported approximately seven growing months per year for immature alligators and Joanen and McNease (1971) reported similar growth periods for adults. Coulson et al. (1973) demonstrated that under laboratory conditions, alligators did not initiate feeding activities at temperatures below 72° F. It was not until the advancement of controlled environmental chamber culture (Coulson, et al. 1973) that alligator farming began to demonstrate itself as an economically sound business venture.

Experimental Designs

Coulson's 1973 studies demonstrated captive reared alligators from heated environment had a superior body condition to wild alligators (they were 10% heavier per given length) and were twice the length of wild alligators of the same age. Joanen and McNease (1976) reported alligators fed a ground fish diet while in controlled chambers maintained at 82° to 86° F converted 49.5% of the food consumed (dry weight) into body mass over a 33-month period. After 26 months of intensive feeding, females averaged 42.7 lbs. and were 5'3" while males were 56.5 lbs. and 5'6"'; 10% of the alligators measured were more than 6'. In Louisiana, growth rates under natural conditions would require at least 4-5 years for an alligator to reach 5' in length (Chabreck and Joanen 1979).

Mortality under environmental chamber culture was found to be quite low. Survival rates from hatching to the end of the third year averaged 95% (Joanen and McNease 1976).

The advantages of using the heated grow out system as compared to natural ponds were documented as increased food conversion rates, growth, and survivability. This allowed the farmer to produce a marketable size animal, 4-1/2 to 5' long, in less than two years. As a result of these studies, the Louisiana Department of Wildlife and Fisheries mandates the use of controlled environmental chambers on all farms for housing animals up to 4' in length. These grow-out sheds, according to Louisiana regulations, must be capable of maintaining a constant minimum temperature of 85° F.

Considerable resources have been invested by the Louisiana Department of Wildlife and Fisheries in an extensive research program aimed at establishing the feasibility of raising alligators in captivity for commercial and conservation purposes. However, the lack of source for suitable farm stock has severely limited the expansion of alligator farming operations in the United States. The Louisiana Department of Wildlife and Fisheries realized this need and has provided stock off state-owned lands since 1977. Farmers were given hatchlings annually until their breeding stock became sexually mature and capable of producing the number of young required to become self-sustaining. However, the state sponsored hatchling supplement program has not satisfied the demand for new farm expansion in Louisiana. As a result, alligator egg collections from private lands (ranching) were allowed for the first time in 1986. The total number of farms in Louisiana expanded from 15 in 1985 to over 85 in 1989. Expansion continues and the total number of farms in Louisiana will reach 100 in 1990.

Operational Design

As a result of the license requirements, calling for the use of controlled environmental chambers by Louisiana farmers, two basic shed designs have evolved. The most commonly built shed consists of single layered concrete vats, enclosed with metal sides and roof. The shed is well insulated and heated by two sources. One source of heat is through water piping in the concrete floor spaced approximately 2' apart and running the entire length of the building. A hot water heater furnishes the heat source and is controlled by thermostats. The second source of heat comes when the vats are cleaned and refilled with water. Heaters furnish incoming hot water mixed with tap water and enter the tanks at approximately 89° F. This maintains constant temperature within the shed on a daily basis. This method prevents the temperature lag created by filling with tap water. This fill water heat source is used only once a day when the tanks are refilled.

Each shed is constructed with a center walkway which affords easy access to a series of concrete vats on either side. Feeding platforms for each pen are accessed through doorways adjacent to the center walkway. Grated drains extend the entire length of the building and are controlled by a common value. The drains are set usually in the center of each pen. Each vat has rounded corners, thus preventing pile-ups and drownings which might otherwise occur during the refilling process. Pile-up and drowning has been demonstrated to occur more often in the hatching year class than in any other age group.

The second most commonly used design is the stacked fiberglass trays concept. Several farmers have used this space saving idea and may have as many as four levels of fiberglass trays in a single shed. Heating is accomplished as described earlier for the single layer shed. Feeding and cleaning the upper level trays are done by the use of ladders. Exhaust fans are used by the attendants when they spend extended periods of time in the sheds such as during the cleaning process.

The walls and roof may be insulated freezer panels purchased from manufacturer and delivered to the site. Usually these buildings are erected by the manufacturer on a concrete slab. The slab is constructed with the continuous water piping imbedded in the concrete and spaced approximately 2' apart. The water piping extends the entire length of the concrete slab and will later provide the major heat source for the building. The bottom row of tanks are constructed of concrete and the upper compartments consist of fiberglass trays with approximately 3' of spacing between trays. Approximately 25% of the farms in Louisiana are using the stacked concept.

Waste Water Discharge

All waste water discharge is subject to regulations of the Louisiana Department of Environmental Quality. Regulations for disposal of waste water from alligator farming and processing facilities is subject to the Louisiana Water Control Law (part of the Louisiana Environmental Quality Act, L.R.S. 30:1051 et seq) and requires at minimum the use of a series of oxidation ponds. These ponds are constructed in accordance with state regulations and the size and number of ponds required depends upon the size of the farm culture and processing facility.

Summary

The development of the heated shed concept along with wild egg collections have been the catalyst that sparked alligator farming/ranching into a multi-million dollar agri-business in the

State of Louisiana. Culture in heated sheds has taken a relatively slow growing animal and produced a marketable size alligator in less than two years with minimum mortality. Although shed designs may vary somewhat, the common denominator that all alligator farmers must have is a source of reliable heat, produced at a relative cheap cost. As alligator farm expansion continues, new and cheaper sources of heat will be developed in keeping with the demand of this fledgling industry.

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PRODUCTION VOLUME AND TRENDS IN THE USA

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Introduction

Historical Perspective

According to Stevenson (1904), the alligator has been in commercial trade since 1800. Audubon (1827) reported alligators to be very abundant in the Mississippi and Red Rivers of Louisiana and many thousands were killed for articles of trade. He stated "the discovery that the skins were not sufficiently firm and close grained to prevent water passage put a stop to the general destruction of alligators, the effect of which had already become very apparent". Audubon (1827) further stated "as water levels receded alligators congregate into the deepest hole in vast numbers and to this day, in such places are shot for the sake of their oil, now used for greasing the machinery of steam engines and cotton mills. The alligators are caught frequently in nets by fisherman, also Negroes kill them during the autumn period as the alligator leaves the lake to seek winter quarters". According to Stevenson (1904), alligator skins became somewhat fashionable in about 1855 but for only a short period. The demand ended after a few thousand skins were shipped from the Gulf States. Alligator skins were used extensively during the Civil War (1860-1865) with many thousands of alligators being killed to supply shoe leather. Shortly after the Civil War when free commerce in shoe material was restored, the alligator was again left alone for a brief period.

Stevenson (1904) related that in 1870 "a large demand was soon created resulting in the slaughter of many thousands of animals each year, giving employment to hundreds of men. The demand soon exceeded the productive capacity of the United States and a large number of skins were imported from Mexico and Central America. As a result of the large demand for alligator skins, imitation alligator leather was first prepared in large quantities, principally from sheep skin or from cowhides and embossed with the characteristic alligator markings by passing the skins between two rollers. During 1869-70, the alligator rose to the top of the fashion scale of all leathers.

Smith (1893) estimated that no less than 2-1/2 million alligators were killed in Florida between 1800 and 1893. A good market was developed for alligator skins about 1870 and as late as 1902 the output of the U. S. tanneries was approximately 280,000 skins annually with about half of these being furnished from Mexico and Central America. At that time, it was estimated that Florida supplied 22% and Louisiana 20% of the total number of skins used in the U.S.A each year.

McIlhenny (1935) estimated that 3 to 3-1/2 million were harvested in Louisiana between 1880 and 1933. Kellogg (1929) reported approximately 10,000 skins per year were taken in Georgia between 1922 and 1926. He further stated that as a result of the drought conditions that existed in Louisiana in 1924 and 1925, unusually large numbers of skins were taken. In 1925 and 1926, 21,885 and 36,041 skins were taken respectively in Louisiana. Louisiana severance tax records show 414,126 skins sold between 1939 and 1960, with the majority (57%) being taken between 1945 and 1953.

Prior to the 1960's, size limits were not imposed on Louisiana's alligator harvests and all size classes 2' and greater were included. No matter how large a skin was, the hunter was paid for a maximum skin length of 8' for a 10', 12', or 14' skin; he received the same amount of money as he did for an 8' skin (Arthur 1928). Louisiana Department of Conservation records indicate that the 1943-44 season was the first year alligator skins 10' and above were recorded. It is believed that during the 1943 season, skins were first bought on a per foot of length and a grading system similar to that used today was introduced.

As the alligator population declined in the early 1950's, tanners developed new markets for small skins. A tremendous interest was generated by Japanese markets for hornback alligator skins (2-3' size class). Buyers encouraged hunters to take small skins in order to fill the demands which no longer were being met by the declining population of larger sized animals. This market was short-lived and in 1962, Louisiana Department of Wildlife and Fisheries closed its season to the taking of alligators and began a concentrated effort to manage this valuable resource. Other states soon followed and the alligator was given full protection within its range.

Current Alligator Harvest

The Louisiana Wildlife and Fisheries Commission reopened the alligator season in 1972 and was confined to one parish in southwestern Louisiana which according to the aerial surveys, housed the largest segment of the coastal marsh alligator population. The hunt area was gradually expanded until 1981, when the season was opened statewide.

Between 1972 and 1989, 229,592 alligators were taken in the state hunt (Figure 1). The largest alligator population occurs in the lower third of the state (about 85% of the total) and most of the hunters are in that zone, and therefore accounted for about 91% of the kill. Wild skin prices varied from U. S. $7.88/foot in 1975 to a high of U. S. $50.00/foot in 1989 (Figure 2). Prices paid for Florida and Texas skins were very similar to those shown in Figure 2. Factors influencing prices were: the demand for skins; international prohibitions of foreign commerce; and inflation or devaluation of American currency. The average size of animals taken during the 16 years of harvesting in Louisiana has remained fairly constant from year to year. The average of all skins measured (N = 229,592) was 7.02' with a range of 3' to 14'. Of the skins taken, 81% were between 5' and 8'.

Farm raised skins did not enter the Louisiana program until 1972. That year 35 farm raised skins were sold. The average size of all farm raised skins measured (Figure 1; N = 69,944) was 4.4' with a range of 2' to 7'. Most of the Louisiana farm raised alligators reach marketable size in less than two years of age.

Louisiana's 1989 farm production is estimated at 50,000 skins, along with a 25,000 wild skin harvest. The state's harvest from both farm and wild amounted to 77% of the United States alligator skin production. The economic value of the wild and farm harvest to the state amounts to about $18 million annually. France, Italy, and Japan continue to be the major tanning countries purchasing the Louisiana skins. Of the 26,798 farmed skins sold in 1988, France tanners purchased 69%, Japanese tanners 15%, Italian tanners 8%, and Singapore tanneries 7%.

There are currently 92 licensed alligator farms/ranches in Louisiana. Statewide farm inventory presently amounts to approximately 223,000 alligators. Sixteen farms have been in business long enough to establish breeding facilities and approximately 2,123 breeders are being maintained.

Louisiana alligator farm inventory expanded tremendously during 1989 as a result of an aggressive farm stock collection program; utilizing wild produced eggs and hatchling alligators. During the summer of 1989, approximately 182,671 eggs and 1,351 hatching year young alligators were collected on privately owned wetlands. The egg collection program produced a total of 143,090 young for a 78% hatching success. These eggs and young were collected over 1.84 million acres of coastal marsh, swamp and lakes throughout Louisiana. During 1989, 8,462 3'-4' alligators were released back into the wild as compensation for the collection procedure. Florida's farm production gradually increased from 3,921 skins in 1986 to 16,385 in 1989.

Alligator hide production in other states such as Texas and South Carolina is expected to increase in the near future (Table 1). Our best estimates of Florida's farm inventory amounts to approximately 92,000 alligators in captivity. Fifteen of the largest farms in Florida maintain sizeable numbers of alligators, ranging from 5,000 to 10,000 animals. Florida captive breeding alligators number slightly over 6,700 animals, and produced approximately 15,000 hatchlings last year. Louisiana's relatively young breeding herd numbers over 1,100 adult females and produced 4,400 hatchlings in 1989, which amounted to slightly less than 3% of Louisiana's annual production.

Louisiana will continue to be the lead state in production of alligator skins both from the wild harvest and from farms. Predications indicate Louisiana will produce approximately 100,000 farm skins in 1995 along with a wild harvest of approximately 25,000. Florida predicates a harvest of approximately 46,000 farm skins along with a wild harvest of approximately 12,000 skins annually (Table 1). Production from the states of Texas and South Carolina combined will remain below 5,000 skins.

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TABLE 1. Alligator harvest in the United States

	1986	1987	1988	1989	1995*
Louisiana					
Wild	17,000	20,000	23,000	24,000	24,000
Farm	3,000	2,500	27,500	50,000	100,000
Florida					
Wild	4,000	4,653	7,444	8,000	12,000
Farm	3,921	6,479	7,529	16,385	46,000
Texas					
Wild	952	1,396	1,647	1,830	2,000
Farm				20	5,000
South Carolina					
Wild	0	0	361	272	<1,000
	28,873	35,028	67,481	100,507	190,000

* Predicted

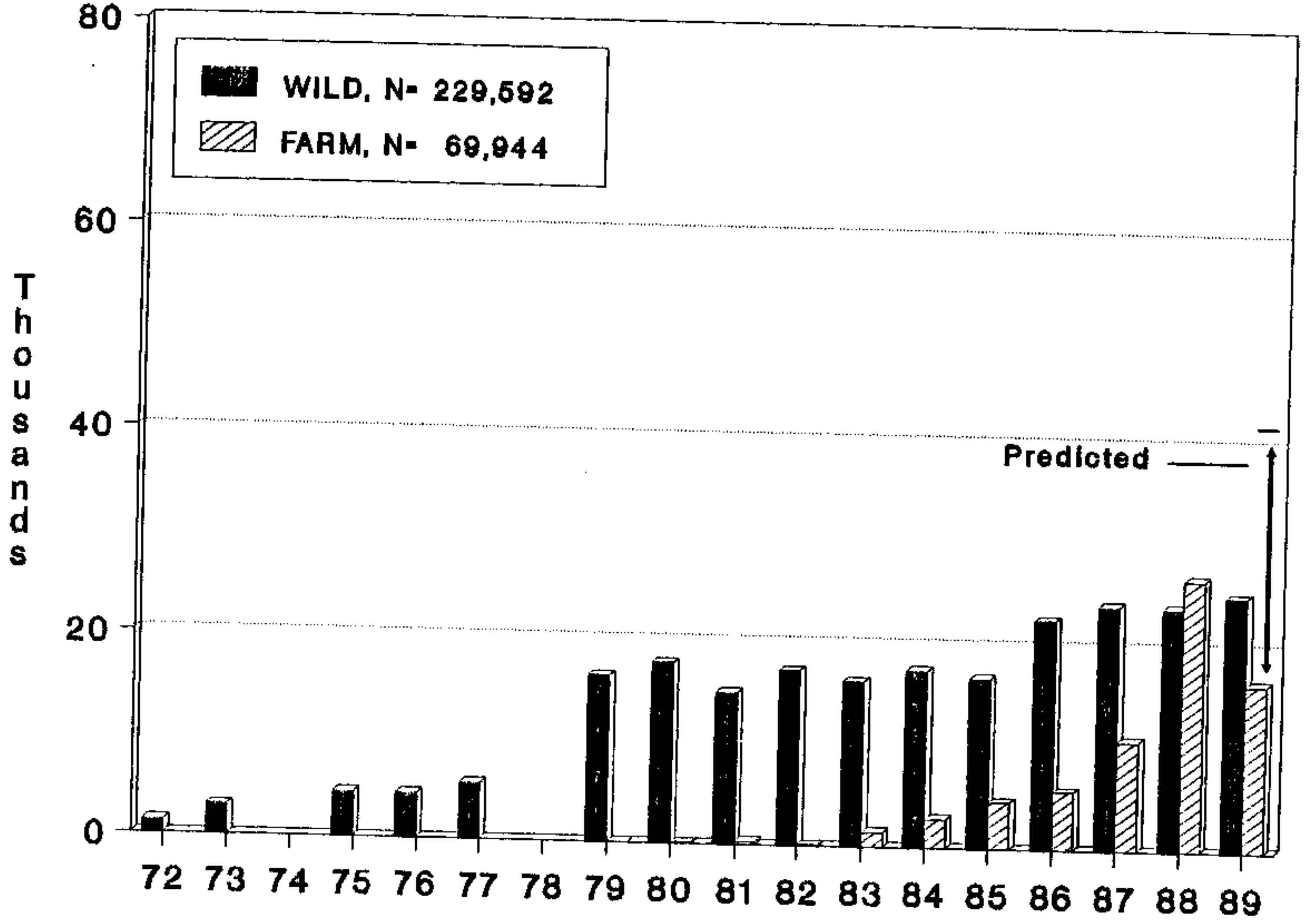

FIGURE 1. Alligator harvest in Louisiana, 1972-89

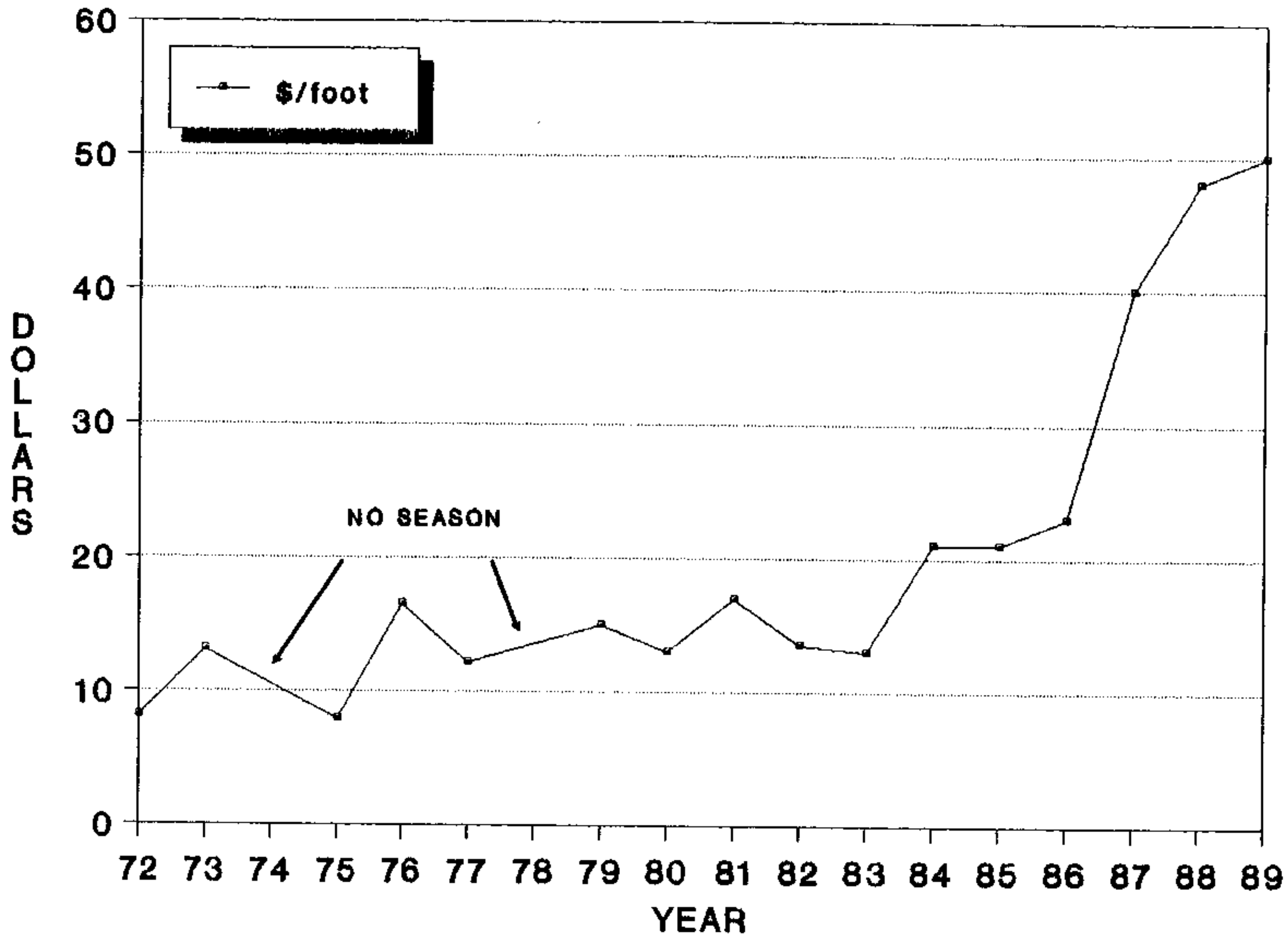

FIGURE 2. Average price paid for Louisiana alligator skins

Comparative Growth Rates of Young Alligators Utilizing Rations of Plant and/or Animal Origin

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Abstract

Data was compiled on 103 hatchling and yearling alligators (*Alligator mississippiensis*) for approximately 8 months to compare their growth rates when fed rations of either plant, animal, or plant and animal protein origin. The rations consisted of dry meal ingredients without the addition of any type of ground meat.

Although all alligators grew without any evident ill effects, those fed the combination diet excelled. The research also indicated that taurine was not critical to the alligators' diet at 500mg/kg of ration.

Purpose

The purposes of this research project were to determine the following related to *Alligator mississippiensis*: (1) Compare the growth and development rate of alligators (*Alligator mississippiensis*) fed rations composed of protein from different origins, (2) Observe differences, if any, in growth rates of alligators fed a plant protein formula where taurine (beta amino ethane sulfonate) was added to the ration, (3) Evaluate the effectiveness of a ration combining protein sources from plant and animal origins as compared to a ration consisting solely of either plant or animal protein origin, (4) Determine any feeding problems or advantages created by using a dry mill type ration for the project without the addition of ground meat.

Method and Materials

The research was conducted utilizing alligators in 2 different age groups. Each age group was divided evenly and randomly into one (1) of four (4) chambers for the project. The chambers were 8' wide by 16' long with 2' sidewalls enclosed with plywood sides and a concrete floor. There were approximately 5-10 cm. of 31 degrees C. water covering 25% of the floor area. The water temperature was controlled with an in-line heating system and hot water heaters. This arrangement aided in keeping the alligators' metabolism at a rate sufficient to allow them continued growth throughout the experiment.

The alligators in Chamber 1 of each age group were fed a ration utilizing protein of plant and animal origin.

Those in Chamber 2 were fed a plant protein ration.

Chamber 3 was the control group with a ration of animal protein origin.

Chamber 4 was fed a ration of plant origin protein + 500 mg of taurine/kg of ration (BioKyowa Inc., 1987).

All rations contained an equal supplement of vitamins, minerals and salt. Water was Ad Libitum since it is readily available in each chamber.

A dry meal type formula (Tables IX-XII) was mixed with water at approximately a 50% ratio creating a dough-like mass. There was no meat added to any of the rations.

The alligators were fed every other day. After the alligators had been given an opportunity to eat all they wanted within a one-hour period, any excess food was removed and weighed. The pens were washed down and refilled with fresh warm water.

All chambers and equipment were in place in a metal building at the Agricultural Science Center of Sam Houston State University.

Results

The four (4) study groups of *Alligator mississippiensis* in each of the two (2) age brackets were observed and data compiled for the period beginning in June, 1988 for the yearling alligators and in November, 1988 for the hatchlings (Table I-VIII). The research was completed in June, 1989. Based on weights, body length and heart girth measurements taken throughout the project, the data confirmed that alligators can grow and be maintained on a ration of plant protein origin. However, substantially more growth was noted for those groups of alligators fed rations utilizing a combination of plant and animal protein or simply an animal protein ration (Figures 1-8).

In the plant formula where 500 mg of taurine was added per kg of ration no substantial difference in those animals as compared to the other group being fed the same plant protein without taurine was noted (Table XII; Table II, IV, VI & VIII).

When comparing the growth rates of those groups being fed either an animal protein or a combination plant/animal ration, those being fed the latter showed the most growth with one notable exception. During the first phase of the experiment, the yearling alligators on the animal protein ration showed a higher growth rate than those on the combination diet. From the second weigh period on, the animals on the combination diet excelled.

All rations were within .06% in crude protein content. A large amount of Alphacel was used in the animal protein ration to hold down the protein level. There is not sufficient information to determine if this was a contributing factor to the growth rate being slightly lower for the alligators on the animal protein ration as compared to those on the plant/animal combination ration.

Another situation occurred that should be noted. During a period from late November, 1988 to January, 1989, some of the alligators died due to weather related stress as was confirmed by the Diagnostic Laboratory at Texas A & M University. The highest losses occurred in the yearling alligators on the combination diet. Of the seven (7) that died, five (5) were yearlings on the combination diet, one (1) was a yearling on the animal diet and one (1) was a hatchling on the animal diet. During this period, outside temperatures fell sharply and it is our feeling that we lost more yearling alligators because they could not get into the warm water as easily as the hatchlings thus forcing them to remain on the cold concrete floor of the chamber. This problem was apparently resolved when an overhead heating system was installed. This left less animals in the chamber utilizing the combination plant/animal diet. We cannot confirm nor deny that this affected the final results on the yearling alligators, but because of the final results on the hatchling group it did not appear to be a significant factor.

On several occasions, it was noted that the alligators would temporarily stop eating. This seemed to occur any time their pattern was disturbed by handling them or if there was excessive noise such as groups visiting the facility or mowers outside the building. All groups of animals seemed to respond fairly uniformly to these nuisances.

Another consideration during this project was using the proper balance of amino acids in each of the rations. Where possible like ingredients were used to assure as much conformity as possible. We felt comfortable from previous research (Staton, 1986, 1987) that adequate amounts of each of the amino acid groups were present in all rations (Tables XIII-XV).

Throughout the research, we were plagued by one recurring problem related to feeding. Although the rations seem to meet the nutritional needs of the subject alligators and were apparently palatable, a satisfactory form for feeding the rations was never identified. A high waste factor was evidenced each time we washed the pens out after feeding, particularly in the plant rations. This created a prehension problem which would obviously affect the animals' growth rate. Future research will need to address the economic feasibility of developing some type of cube or biscuit which the gators can readily grab and then retain when moving into the water.

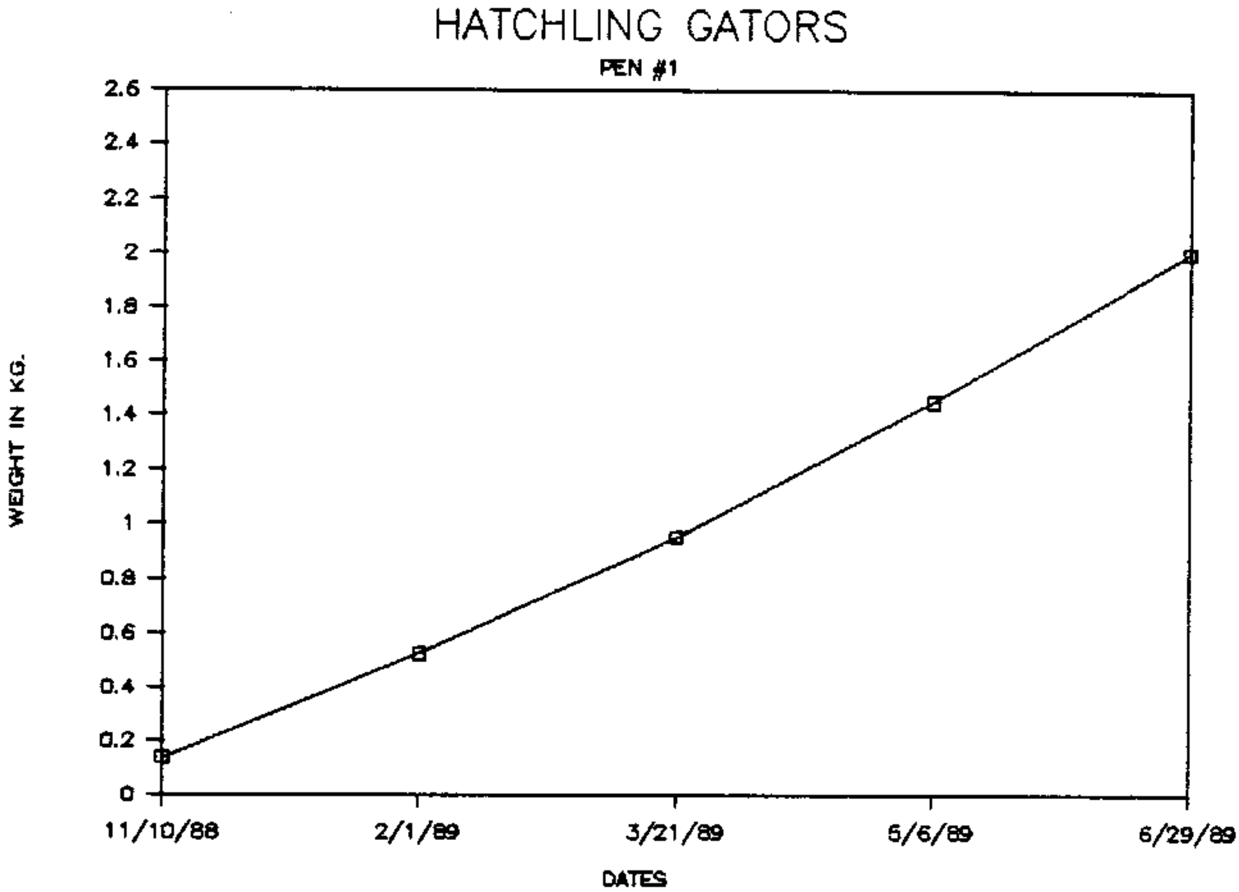

Figure 1: Growth rate of gators utilizing Plant/Animal protein

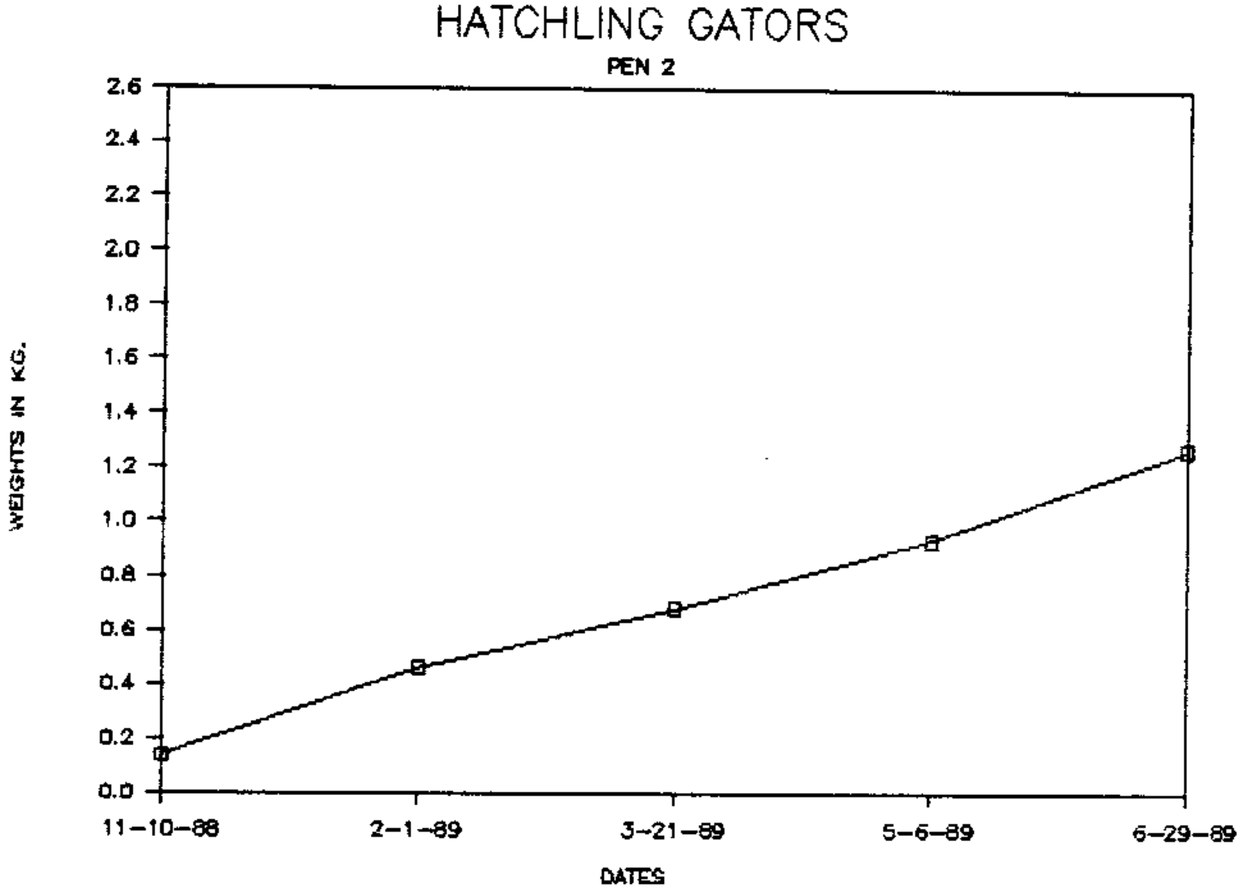

Figure 2: Growth rate of gators utilizing Plant protein

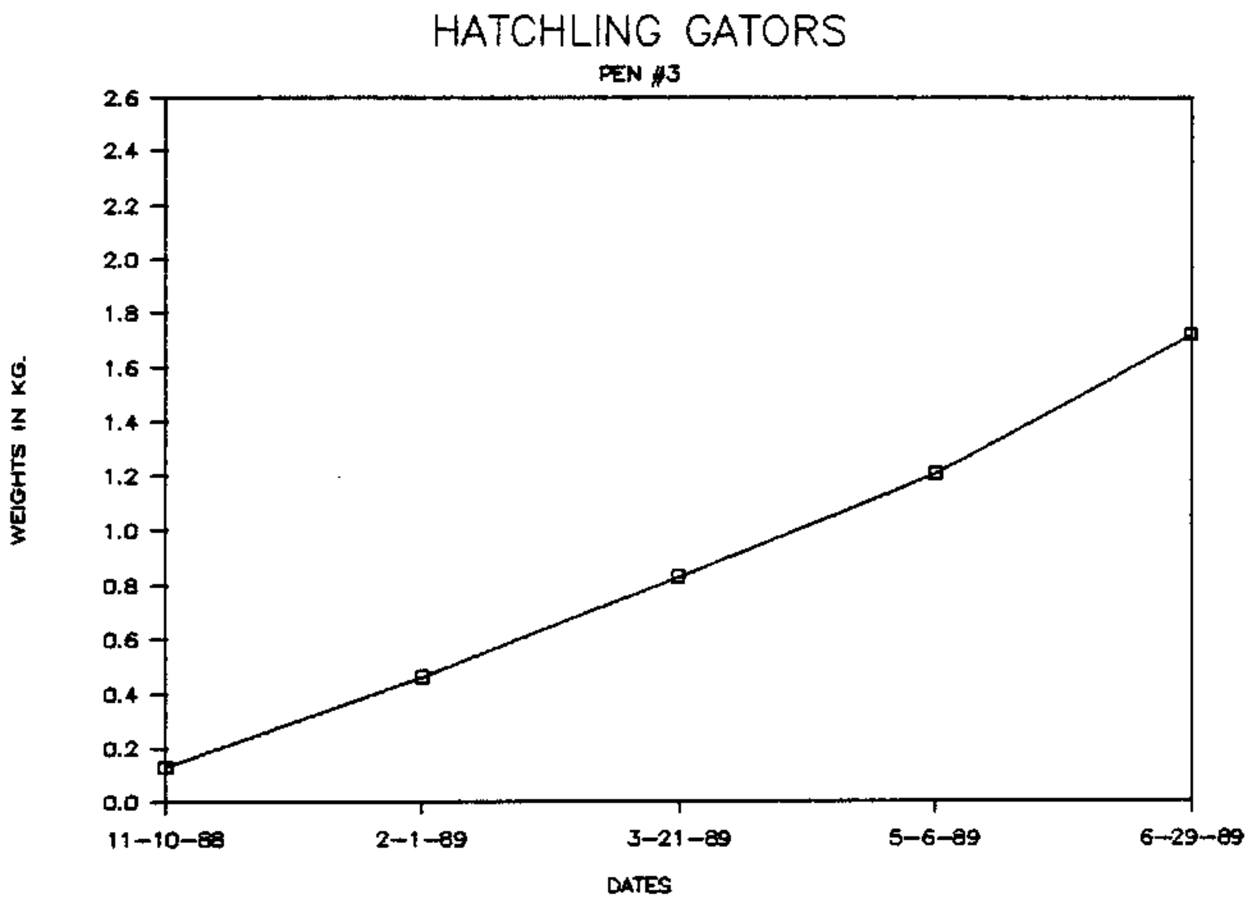

Figure 3: Growth rate of gators utilizing Animal protein

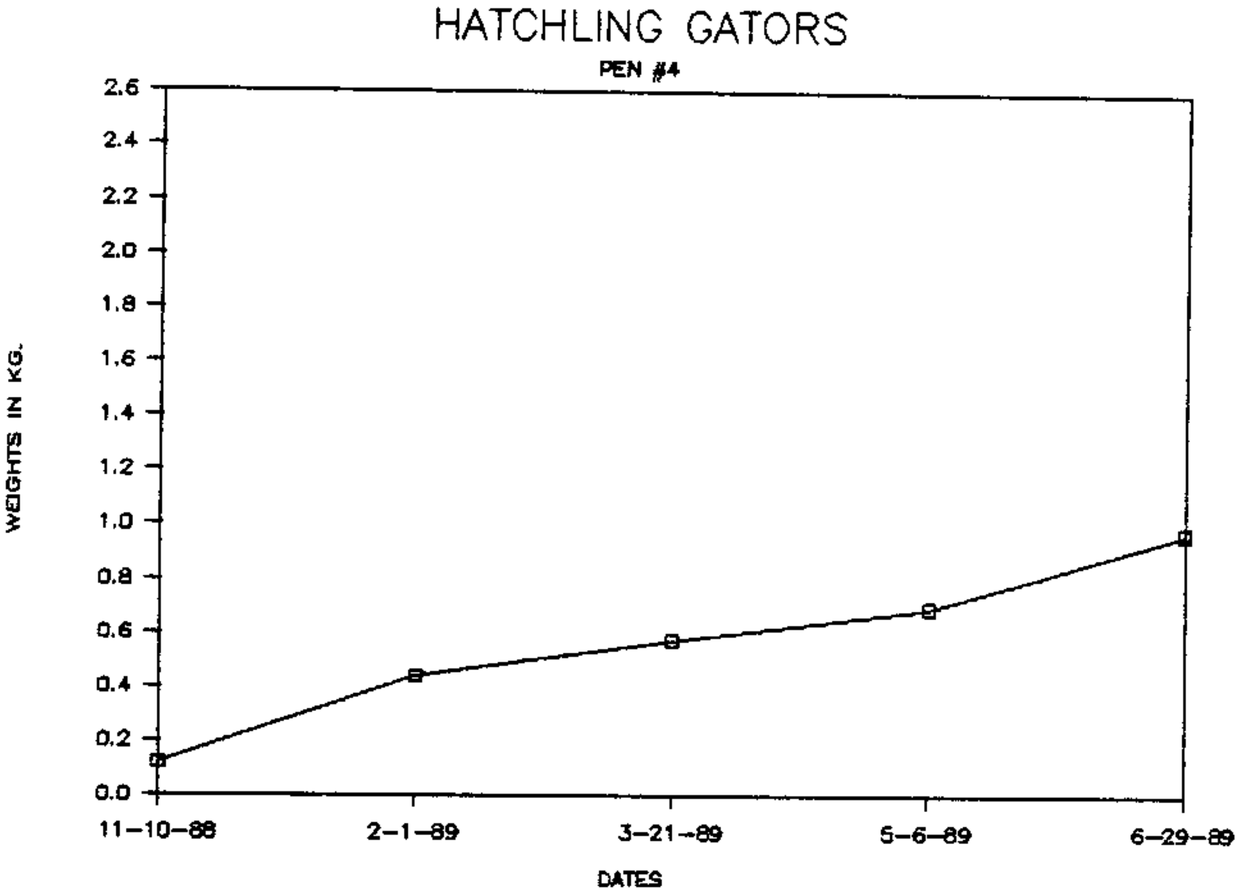

Figure 4: Growth rate of gators utilizing Plant protein + 5g of Taurine/10k ration

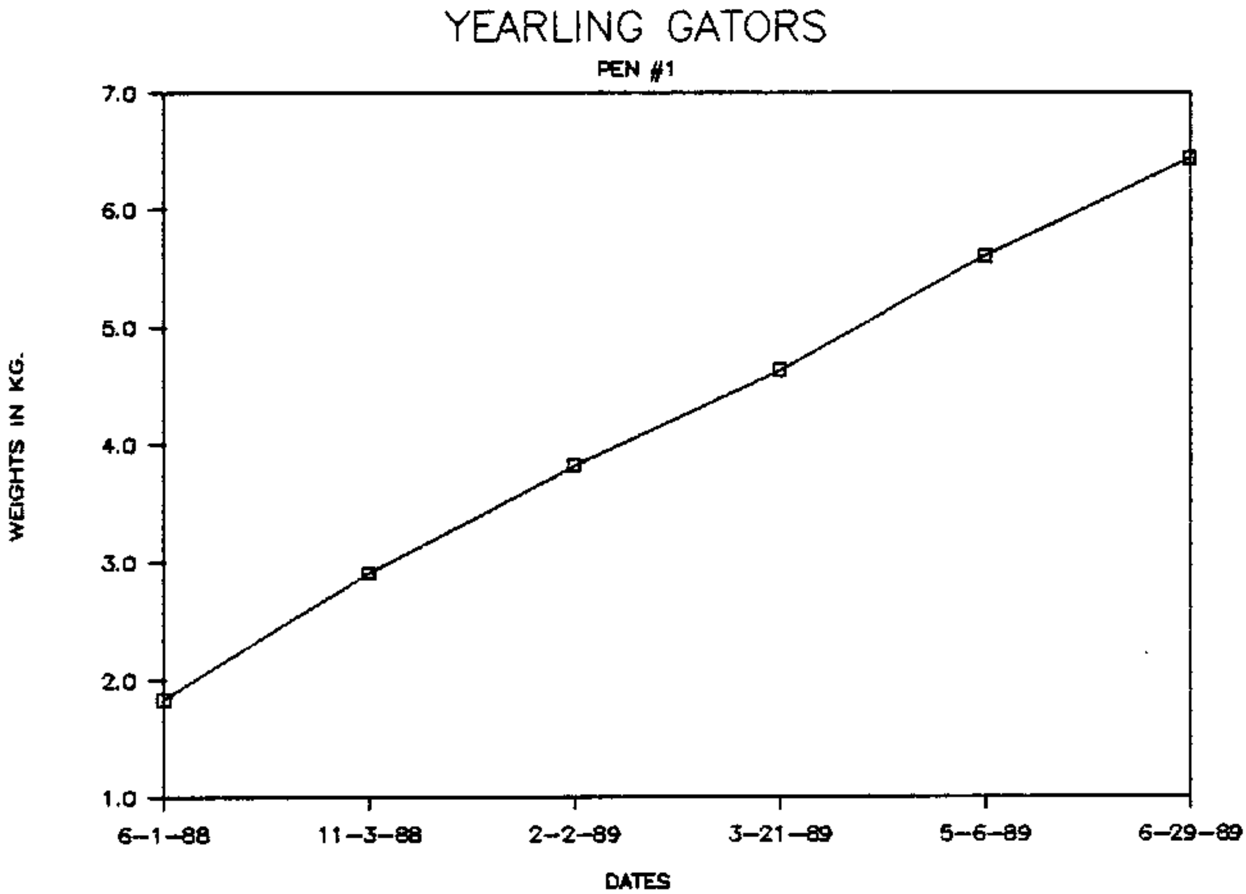

Figure 5: Growth rate of gators utilizing Plant/Animal protein ration

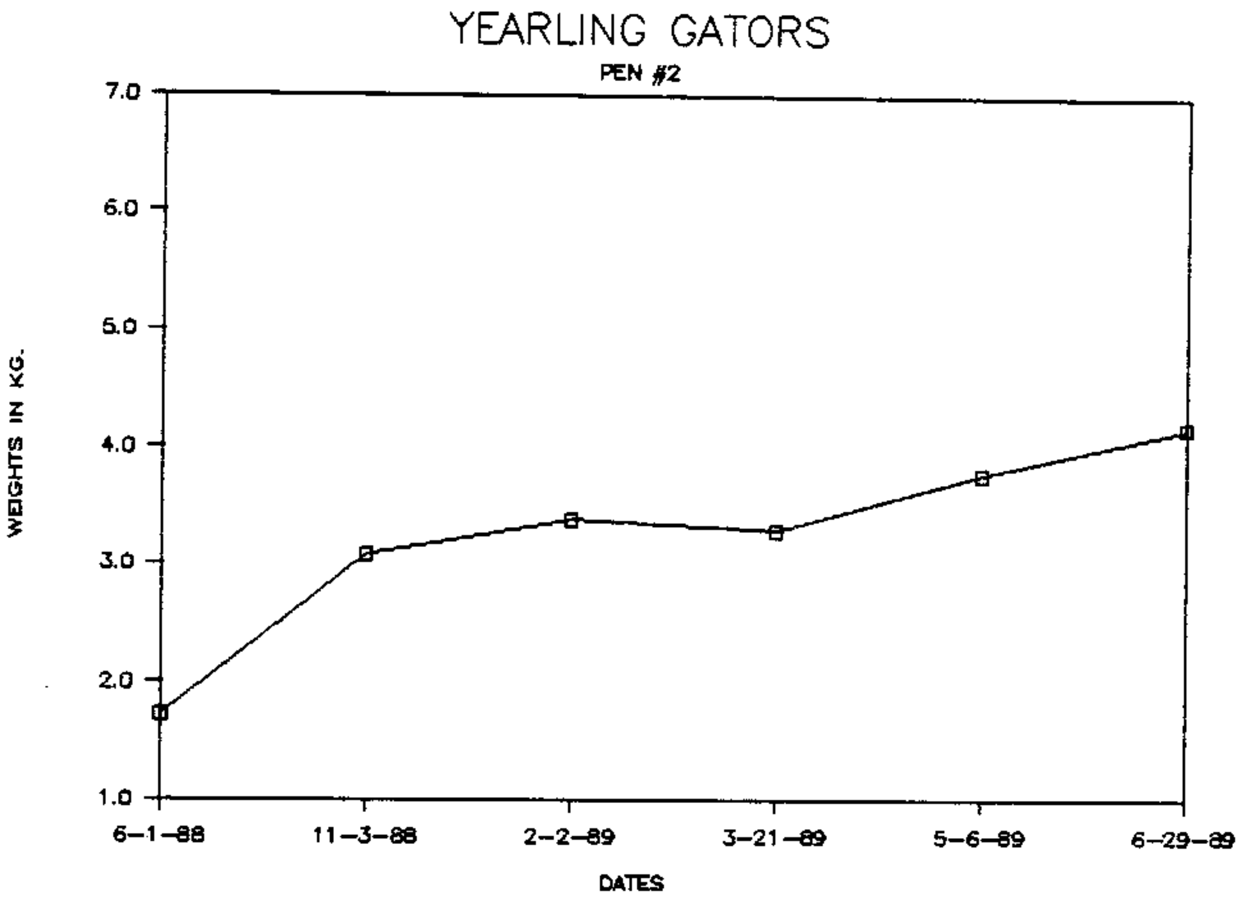

Figure 6: Growth rate of gators utilizing Plant protein

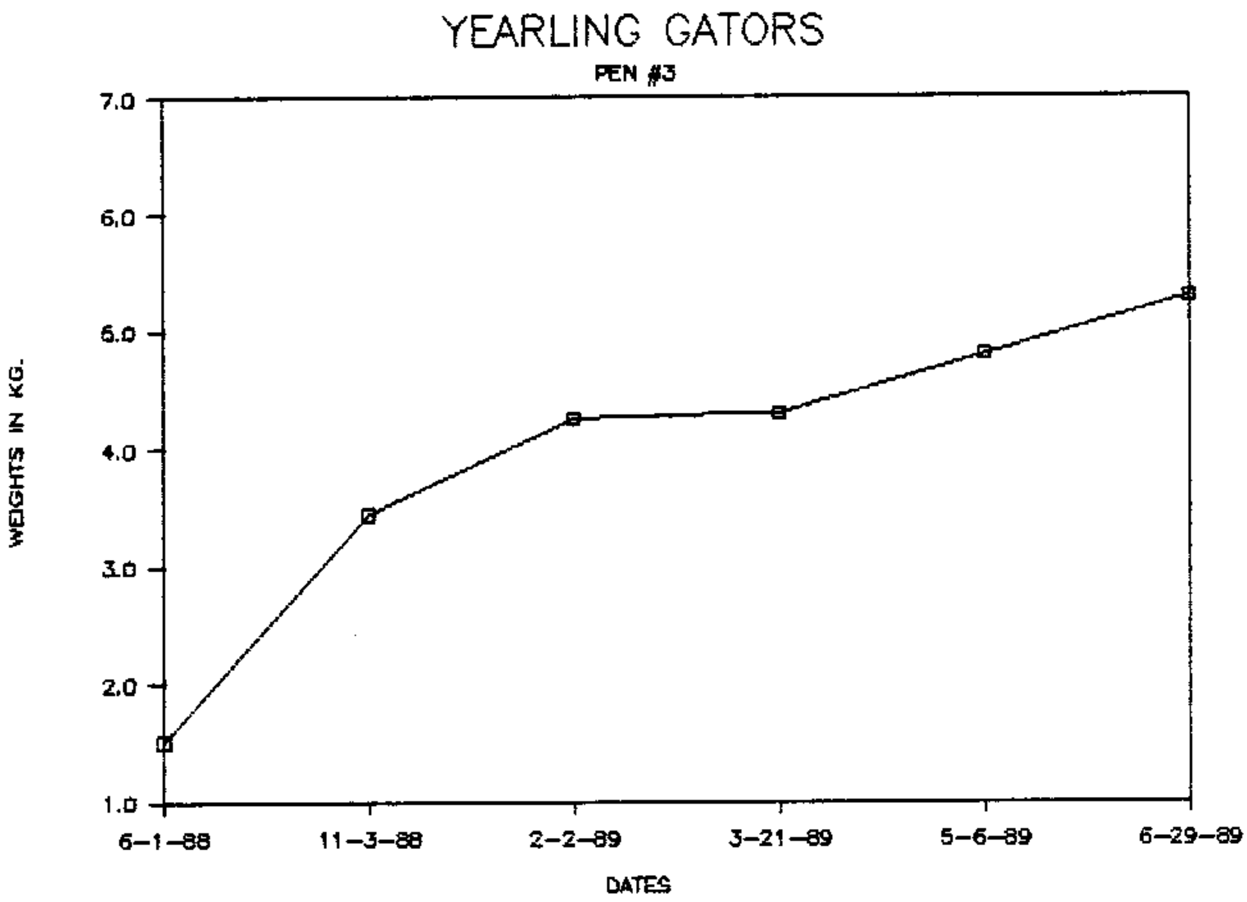

Figure 7: Growth rate of gators utilizing Animal protein

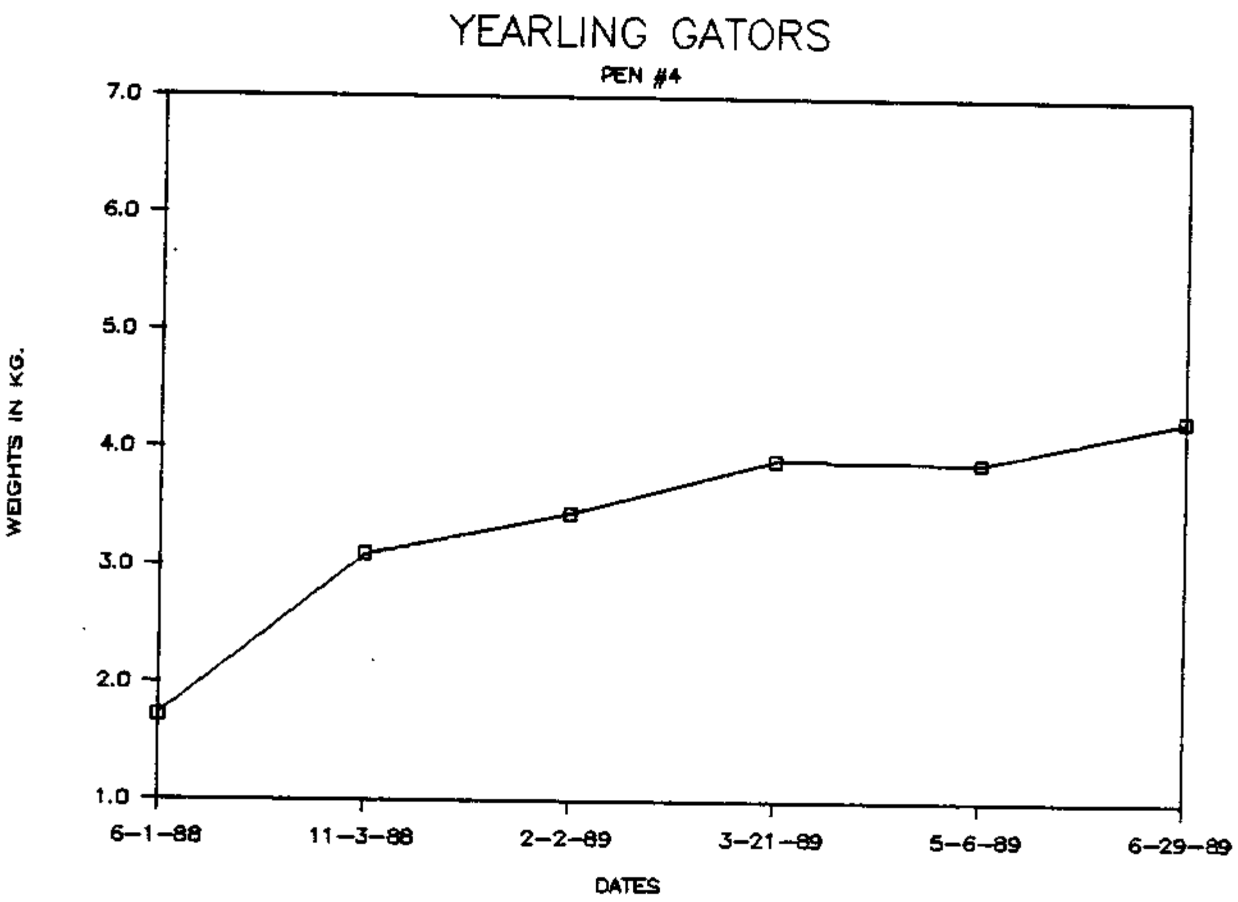

Figure 8: Growth rate of gators utilizing Plant protein + 5g of Taurine/10k ration

Table I WEIGHT AND MEASUREMENT DATA

Chamber #1 HATCHLING GATORS

TOTAL 12

	November 10, 1988			February 1, 1989			March 21, 1989			May 6, 1989			June 29, 1989			WEIGHT GAINED	GROWTH	
Band#	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm
0222	0.15	38.00	DATA	0.55	57.50	15.70	0.96	67.00	17.20	1.46	76.00	19.00	1.95	86.00	25.00	1.80	48.00	9.30
			NOT															
0239	0.23	41.00	AVAIL.	0.79	64.00	17.30	1.43	75.00	22.90	1.78	80.00	20.00	2.08	84.00	22.00	1.80	43.00	4.70
0242	0.13	37.50		0.46	55.00	13.50	0.65	60.00	16.00	1.02	67.00	18.50	1.55	77.00	23.50	1.42	39.50	10.00
0245	0.14	38.50		0.61	60.50	15.20	1.09	72.00	19.10	1.29	82.00	22.50	2.55	91.00	27.50	2.41	52.50	12.30
0254	0.12	35.00		0.45	55.00	15.60	0.85	64.00	18.50	1.21	71.00	20.00	1.56	70.00	23.00	1.44	43.00	7.40
0259	0.11	36.00		0.42	56.50	14.70	0.95	68.00	16.50	1.51	70.00	20.00	1.96	85.00	23.50	1.85	49.00	8.80
0263	0.16	39.50		0.69	61.50	15.60	1.25	74.00	19.10	2.02	84.00	21.00	2.72	94.00	26.00	2.56	54.50	10.40
0267	0.14	38.50		0.51	57.00	13.40	0.93	60.00	16.50	1.37	77.00	18.00	2.54	91.00	27.00	2.40	52.50	[illegible]
0270	0.08	32.00		0.29	46.00	12.60	0.58	50.00	16.00	1.02	69.00	18.20	1.57	77.00	21.00	1.49	45.00	[illegible]
0274	0.15	37.00		0.57	58.00	15.50	1.15	70.00	19.00	1.70	80.00	21.50	2.43	88.00	25.50	2.28	51.00	10.00
0298	0.12	34.00		0.55	59.50	13.50	0.75	64.00	17.30	1.17	73.00	21.00	1.42	80.00	19.00	1.30	46.00	5.50
5625	0.13	37.50		0.39	54.00	13.00	0.84	64.00	16.50	1.27	71.50	19.00	1.71	80.50	23.00	1.58	43.00	10.00
TOTALS	1.65	444.50		6.28	678.50	175.60	11.43	804.00	215.40	17.40	908.50	230.70	24.04	1011.50	286.00	22.41	567.00	110.40
AVERAGE PER GATOR	0.14	37.04		0.52	56.54	14.63	0.95	67.00	17.95	1.45	75.71	19.89	2.00	84.29	23.83	1.87	47.25	9.20
STD. DEV.	0.03	2.37		0.13	4.38	1.36	0.24	5.05	1.95	0.32	5.17	1.35	0.44	5.63	2.39	0.42	4.55	2.42
POP. VAR.	0.00	5.60		0.02	19.23	1.84	0.06	25.50	3.81	0.10	26.69	1.82	0.19	31.69	5.72	0.18	20.52	5.86

Table II WEIGHT AND MEASUREMENT DATA

Chamber #2 HATCHLING GATORS

TOTAL 13

	November 10, 1988			February 1, 1989			March 21, 1989			May 6, 1989			June 29, 1989			WEIGHT GAINED	GROWTH	
Band #	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm
0205	0.17	38.00	DATA NOT AVAIL.	0.65	60.00	16.30	0.86	67.00	18.50	1.22	74.00	19.70	1.67	80.00	22.00	1.50	42.00	5.70
0210	0.16	37.00		0.60	61.00	15.80	1.12	70.00	18.50	1.35	79.00	19.00	1.56	79.00	20.00	1.40	42.00	4.20
0225	0.19	42.00		0.44	55.00	16.00	0.76	65.50	16.50	1.62	81.50	19.50	2.42	90.00	24.50	2.23	48.00	8.50
0226	0.18	39.50		0.54	59.50	15.20	0.96	69.50	18.00	1.23	72.00	18.50	1.63	76.00	23.00	1.45	36.50	7.60
0255	0.14	38.00		0.40	54.00	13.40	0.60	63.00	15.20	0.88	71.00	16.50	1.36	88.50	22.00	1.22	50.50	8.60
0256	0.12	37.00		0.35	51.00	13.30	0.42	55.00	14.00	0.49	57.50	14.60	0.67	62.50	17.00	0.55	25.50	3.70
0257	0.13	35.50		0.40	54.00	15.00	0.63	62.00	16.00	0.74	64.00	16.50	1.04	70.00	22.00	0.91	34.50	7.00
0264	0.14	36.50		0.60	58.00	16.10	0.73	65.00	17.20	1.03	69.50	17.50	1.37	75.50	21.50	1.23	39.00	5.40
0266	0.10	35.50		0.45	57.00	14.00	0.68	66.00	15.90	0.94	72.50	17.00	1.44	80.50	20.50	1.34	45.00	6.50
0272	0.12	38.00		0.56	60.50	16.00	0.74	67.00	17.20	0.97	72.50	17.50	1.24	78.00	22.50	1.12	40.00	6.50
0297	0.12	38.00		0.27	49.00	11.00	0.32	49.00	11.40	0.32	51.00	12.60	0.39	54.00	15.50	0.27	16.00	4.50
1116	0.14	40.00		0.26	46.50	12.20	0.30	52.00	12.20	0.34	52.00	12.50	0.45	53.00	14.50	0.31	13.00	2.30
1125	0.16	39.00		0.44	58.00	14.50	0.66	65.00	15.20	0.91	70.00	16.50	1.24	77.00	20.50	1.08	38.00	6.00
TOTALS	1.87	494.00		6.04	723.50	188.80	8.78	816.00	205.80	12.04	886.50	217.90	16.48	964.00	265.50	14.61	470.00	76.70
AVERAGE PER GATOR	0.14	38.00		0.46	55.65	14.52	0.68	62.77	15.83	0.93	68.19	16.76	1.27	74.15	20.42	1.12	36.15	5.90
STD. DEV.	0.03	1.75		0.12	4.42	1.60	0.23	6.37	2.15	0.37	9.12	2.25	0.53	11.06	2.87	0.51	11.02	1.81
OF. VAR.	0.00	3.08		0.01	19.55	2.55	0.05	40.60	4.63	0.14	83.21	5.05	0.28	122.28	8.26	0.26	121.36	3.27

Table III WEIGHT AND MEASUREMENT DATA

Chamber #3 HATCHLING GATORS

TOTAL 12

	November 10, 1988			February 1, 1989			March 21, 1989			May 6, 1989			June 29, 1989			WEIGHT GAINED	GROWTH	
Band #	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm
0207	0.10	33.00	DATA NOT AVAIL.	0.39	53.00	13.00	0.73	63.00	16.50	1.15	73.50	18.00	1.72	83.00	22.50	1.62	50.00	9.50
0213	0.11	35.00		0.34	52.00	13.50	0.61	60.00	15.20	0.82	67.00	16.00	1.28	76.00	22.00	1.17	41.00	8.50
0215	0.14	36.50		0.38	55.00	12.00	0.58	61.00	15.20	0.73	65.00	16.00	0.96	69.50	19.00	0.82	33.00	7.00
0219	0.14	37.00		0.53	56.50	14.50	0.94	67.00	17.50	1.23	74.00	18.50	1.83	82.50	21.50	1.69	45.50	7.00
0221	0.17	39.50		0.50	55.00	15.20	0.83	65.00	16.50	1.21	72.00	18.00	1.76	82.00	23.00	1.59	42.50	7.80
0241	0.16	39.00		0.46	55.50	15.20	0.85	67.00	17.30	1.31	76.00	20.00	1.77	84.00	24.00	1.61	45.00	8.80
0260	0.13	36.00		0.45	55.00	14.70	0.87	68.00	17.20	1.29	77.00	19.00	1.89	86.00	23.00	1.76	50.00	8.30
0268	0.12	37.00		0.54	57.00	14.30	0.89	67.00	17.20	1.17	73.00	17.50	1.62	81.00	20.50	1.50	44.00	6.20
0271	0.14	38.00		0.56	59.00	14.40	0.93	67.00	18.50	1.37	77.00	19.00	2.02	87.00	22.50	1.88	49.00	8.10
1117	0.09	34.00		0.28	48.00	12.50	0.59	59.00	15.20	1.20	66.00	18.20	1.51	79.00	22.00	1.42	45.00	9.50
1120	0.15	37.00		0.66	59.00	17.50	1.14	70.00	19.10	1.63	78.00	21.00	2.14	87.50	22.50	1.99	50.50	5.00
1123	0.11	34.00		0.41	53.00	15.40	0.95	67.00	17.20	1.41	78.50	18.50	2.13	88.50	22.00	2.02	54.50	6.60
TOTALS	1.56	436.00		5.50	658.00	172.20	9.91	781.00	202.60	14.52	877.00	219.70	20.63	986.00	264.50	19.07	550.00	92.30
AVERAGE PER GATOR	0.13	36.33		0.46	54.03	14.35	0.83	65.08	16.88	1.21	73.08	18.31	1.72	82.17	22.04	1.59	45.83	7.69
STD. DEV.	0.02	1.94		0.10	2.95	1.42	0.16	3.35	1.20	0.23	4.54	1.37	0.33	5.17	1.23	0.33	5.37	1.31
POP. VAR.	0.00	3.76		0.01	8.68	2.01	0.03	11.24	1.43	0.05	20.62	1.89	0.11	26.72	1.52	0.11	28.81	1.72

Table IV WEIGHT AND MEASUREMENT DATA

Chamber #4 HATCHLING GATORS

TOTAL 11

	November 10, 1988			February 1, 1989			March 21, 1989			May 6, 1989			June 29, 1989			WEIGHT GAINED	GROWTH	
Band #	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm
0248	0.07	33.00	DATA NOT AVAIL.	0.20	43.50	11.30	0.49	59.00	13.00	0.54	59.50	16.00	0.85	67.00	16.50	0.78	34.00	5.20
0253	0.15	40.50		0.35	48.50	13.50	0.40	53.00	14.00	0.43	53.50	15.50	0.58	58.00	17.50	0.43	17.50	4.00
0263	0.17	39.50		0.53	58.00	15.00	0.59	62.00	15.20	0.65	64.50	15.60	0.93	69.00	19.00	0.76	29.50	4.00
0265	0.13	38.00		0.70	64.00	14.60	0.85	71.00	16.00	1.17	78.50	17.50	1.75	85.00	23.00	1.62	47.00	8.40
0269	0.11	34.00		0.29	49.00	12.20	0.48	58.50	13.30	0.53	60.50	14.00	0.84	68.00	16.50	0.73	34.00	4.30
1115	0.12	36.00		0.45	55.00	14.00	0.48	58.00	14.50	0.58	61.00	15.50	0.76	65.00	16.50	0.64	29.00	2.50
1118	0.13	38.00		0.59	60.50	15.00	0.68	67.00	15.50	0.88	70.50	16.00	1.21	76.00	20.50	1.08	38.00	5.50
1119	0.13	36.00		0.48	60.00	15.50	0.73	68.00	16.50	0.93	72.00	17.50	1.12	77.00	19.00	0.99	41.00	3.50
1121	0.09	33.00		0.22	43.00	11.00	0.28	49.00	11.50	0.28	49.00	12.00	0.34	53.50	13.50	0.25	20.50	2.50
1122	0.12	36.00		0.43	53.50	14.00	0.59	60.00	15.30	0.83	68.00	16.50	1.21	74.00	19.50	1.09	38.00	5.50
1124	0.14	38.00		0.55	57.30	15.20	0.67	64.00	15.20	0.74	67.00	16.00	1.11	73.00	19.50	0.97	35.00	4.30
TOTALS	1.36	402.00		4.79	592.30	151.30	6.24	669.50	160.00	7.56	704.00	172.10	10.70	765.50	201.00	9.34	363.50	49.70
AVERAGE PER GATOR	0.12	36.55		0.44	53.85	13.75	0.57	60.86	14.55	0.69	64.00	15.65	0.97	69.59	18.27	0.85	33.05	4.52
STD. DEV.	0.03	2.40		0.15	6.69	1.51	0.15	6.20	1.41	0.24	8.08	1.48	0.36	8.47	2.42	0.35	8.21	1.57
POP. VAR.	0.00	5.75		0.02	44.78	2.29	0.02	38.46	1.98	0.06	65.32	2.18	0.13	71.67	5.83	0.12	67.34	2.48

Table V WEIGHT AND MEASUREMENT DATA

Chamber #1 YEARLING GATORS

TOTAL 11

	June 1, 1988			November 3, 1988			February 2, 1989			March 21, 1989			May 6, 1989			June 29, 1989			WEIGHT GAINED	GROWTH	
Band#	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm
684F	1.97	83.00	21.00	3.11	99.00	24.90	4.14	106.00	26.00	4.88	110.00	29.50	4.53	113.00	31.50	6.87	128.00	33.00	4.90	45.00	12.00
472F	2.16	81.00	22.00	3.56	103.00	26.50	4.57	111.00	29.50	5.40	114.00	32.00	6.63	120.00	33.00	7.64	129.00	34.50	5.48	45.00	12.50
451F	2.17	50.00	18.50	2.17	91.00	23.50	2.60	96.00	25.00	3.17	101.00	27.40	4.03	110.00	29.00	4.00	115.50	31.50	2.63	65.50	13.00
696F	2.33	87.00	22.00	3.04	100.00	26.50	5.28	108.00	32.50	6.47	114.00	33.00	8.03	120.00	37.00	8.78	124.50	37.50	6.45	37.50	15.50
470F	1.61	78.00	21.60	2.64	95.00	23.00	3.58	102.00	28.00	4.57	111.00	30.50	5.72	117.00	32.50	6.60	124.00	33.00	4.99	46.00	11.40
640F	1.95	82.00	23.00	3.04	82.00	26.00	4.17	103.50	27.50	4.81	107.00	30.50	5.55	114.00	31.00	6.60	118.00	32.50	4.65	36.00	9.50
633F	1.07	70.00	16.50	1.90	72.80	20.50	2.42	87.50	24.50	2.73	93.00	24.50	3.50	97.00	25.40	3.77	103.50	27.00	2.70	33.50	10.50
359M	1.75	83.00	21.00	2.90	94.50	24.00	3.56	98.00	25.50	4.22	104.00	29.00	5.07	110.00	29.50	5.81	117.00	30.50	4.06	34.00	9.50
455F	1.76	82.00	20.00	2.66	99.00	24.00	3.30	102.50	25.00	3.76	104.00	27.00	4.48	110.00	29.20	4.63	111.50	29.50	2.87	29.50	9.50
620F	2.06	83.50	22.00	3.77	105.50	27.00	5.22	115.00	30.50	6.66	120.00	34.30	8.80	130.00	34.50	9.30	134.50	35.00	7.24	51.00	13.00
652F	1.30	75.50	20.00	2.44	96.00	24.60	3.21	100.00	25.50	4.24	109.00	28.60	5.39	115.00	29.50	6.08	121.50	36.00	4.70	46.00	16.00
TOTALS	20.21	850.00	227.60	32.03	1037.80	270.50	42.05	1129.50	299.50	50.99	1190.00	326.30	61.73	1256.00	342.10	70.88	1327.00	360.00	50.67	469.00	132.40
AVERAGE PER GATOR	1.84	78.00	20.69	2.91	94.35	24.59	3.82	102.60	27.23	4.64	108.18	29.66	5.61	114.18	31.10	6.44	120.64	32.73	4.61	42.64	12.04
STANDARD DEV.	0.36	9.92	1.78	0.60	9.07	1.82	0.91	7.17	2.51	1.17	7.49	2.70	1.56	7.84	2.98	1.62	8.35	2.89	1.42	9.67	2.17
POP. VAR.	0.13	98.50	3.16	0.36	82.33	3.30	0.83	51.42	6.29	1.38	56.15	7.27	2.44	61.42	8.89	2.63	69.73	8.39	2.02	93.41	4.71

Table VI WEIGHT AND MEASUREMENT DATA

Chamber #2 YEARLING GATORS

TOTAL 15

	June 1, 1988			November 3, 1988			February 2, 1989			March 21, 1989			May 6, 1989			June 29, 1989			WEIGHT GAINED	GROWTH	
Band#	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm
[illegible]3F	2.06	65.00	21.50	3.94	101.50	26.00	4.58	108.00	29.00	4.74	111.00	31.00	6.02	114.50	31.50	7.57	120.00	31.80	5.51	35.00	10.30
5681F	1.46	77.00	19.50	2.72	97.00	24.00	2.95	101.50	26.50	3.03	103.00	28.00	3.05	103.00	28.00	3.13	104.00	28.70	1.67	27.00	9.20
5691F	2.12	87.00	25.00	3.27	97.00	25.00	3.43	101.00	25.50	3.19	103.50	26.00	3.25	105.00	26.00	3.66	108.00	30.50	1.54	21.00	5.50
5647F	1.84	83.00	20.00	3.26	103.00	24.00	3.61	107.00	26.50	3.54	108.00	27.00	3.57	108.50	27.50	4.03	110.50	27.90	2.19	27.50	7.90
5690F	1.66	80.00	19.00	3.26	102.00	24.70	3.76	108.00	27.00	3.80	113.00	27.60	0.63	114.00	28.50	6.47	122.00	30.00	4.81	42.00	11.00
9473F	1.56	79.50	20.50	2.77	96.50	23.00	3.03	101.50	25.00	2.86	102.00	24.90	2.82	102.00	24.00	3.13	102.50	27.00	1.57	26.00	6.50
9461F	2.05	83.00	23.30	3.71	96.50	26.00	3.63	101.00	27.00	3.51	103.00	27.90	3.94	103.50	27.00	4.19	106.00	27.50	2.14	23.00	9.00
9464F	1.64	79.00	19.50	3.15	101.00	23.00	3.60	105.00	26.50	3.37	105.00	27.00	3.87	100.00	27.00	3.86	112.00	27.90	2.22	33.00	10.40
5641F	1.63	79.00	19.00	3.21	101.50	24.00	3.31	107.00	27.50	3.52	107.50	27.90	5.90	113.50	31.00	5.95	113.50	31.00	4.32	34.50	12.00
5630F	1.86	83.00	21.00	3.44	98.00	24.50	3.76	102.00	26.00	3.50	104.00	26.50	3.75	105.00	26.50	4.32	106.00	30.00	2.46	23.00	9.00
5688F	1.87	80.00	21.00	3.50	101.00	25.00	3.79	104.00	25.00	3.51	105.00	26.00	3.44	105.00	27.50	3.81	105.00	31.20	1.94	25.00	10.20
5629F	1.49	76.00	18.00	2.59	94.50	24.00	2.87	98.00	24.50	2.73	99.00	25.40	2.94	99.50	25.40	3.29	100.00	28.50	1.80	24.00	10.50
9469F	1.58	79.00	19.00	2.70	97.00	23.00	3.12	102.00	24.00	3.03	102.00	24.00	3.17	105.00	26.70	3.31	105.00	30.00	1.73	26.00	11.00
5626F	1.70	81.50	21.50	3.11	102.00	24.00	3.45	105.00	25.00	3.21	105.50	26.70	3.31	106.00	27.50	3.49	106.50	28.00	1.71	25.00	6.50
5676F	1.26	72.00	19.00	1.53	82.00	20.00	1.80	85.00	21.10	1.70	87.00	21.50	1.82	87.00	21.50	2.28	90.00	21.50	1.02	18.00	2.50
OTALS	25.86	1204.00	306.80	46.16	1470.50	360.20	50.69	1536.00	386.10	49.32	1558.50	397.60	51.48	1579.50	405.60	62.49	1611.00	431.50	36.63	410.00	139.50
VERAGE PER ATOR	1.72	80.27	20.45	3.08	98.03	24.01	3.38	102.40	25.74	3.29	103.90	26.51	3.43	105.30	27.04	4.17	107.40	28.77	2.44	27.33	9.30
TANDARD EV.	0.24	3.60	1.79	0.55	5.00	1.41	0.59	5.47	1.76	0.62	5.70	2.07	1.28	6.50	2.36	1.37	7.53	2.41	1.28	6.04	3.44
OP. [illegible]	0.06	12.96	3.20	0.31	25.02	1.98	0.35	29.94	3.10	0.39	32.44	4.28	1.65	42.26	5.56	1.08	56.64	5.82	1.64	36.52	11.04

Table VII WEIGHT AND MEASUREMENT DATA

Chamber #3 YEARLING GATORS

TOTAL 15

	June 1, 1988			November 3, 1988			February 2, 1989			March 21, 1989			May 6, 1989			June 29, 1989			WEIGHT GAINED	GROWTH	
Band#	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm
5649M	1.38	78.00	19.00	3.51	100.50	25.00	4.23	108.00	27.00	4.40	109.00	29.00	5.05	114.00	30.00	5.75	119.50	31.80	4.37	41.50	12.80
5635F	1.42	77.00	20.00	3.29	102.00	25.00	4.50	108.50	29.50	4.73	111.00	29.50	5.24	117.00	30.00	6.07	122.00	30.00	4.65	45.00	10.00
9468F	1.94	82.00	20.00	3.91	103.00	24.00	4.26	110.00	28.50	4.44	111.00	29.00	4.74	115.00	29.50	5.48	120.00	31.10	3.54	38.00	11.10
9453M	1.99	87.00	21.00	4.32	111.00	27.00	5.43	118.00	31.50	5.55	118.50	31.50	6.06	124.00	32.50	6.72	129.50	34.50	4.73	42.50	13.50
9454F	1.21	74.00	18.00	2.58	93.00	23.00	3.03	97.50	26.50	3.03	100.00	26.50	3.41	104.00	27.00	3.68	108.00	27.50	2.47	34.00	9.50
5689F	1.35	76.00	19.00	2.57	96.00	23.00	2.93	100.00	24.50	2.98	100.00	25.00	3.26	103.00	25.50	3.53	107.00	26.70	2.18	31.00	7.70
9475M	1.33	74.00	20.30	3.23	98.00	24.00	3.97	107.00	27.00	4.25	108.00	29.50	4.83	112.00	31.20	5.53	118.00	32.50	4.20	44.00	12.20
9452M	1.48	77.00	19.00	3.59	102.00	24.50	4.52	110.00	29.00	4.13	110.50	29.00	4.20	111.00	29.50	4.64	113.50	31.20	3.16	36.50	12.20
9467M	1.93	84.50	20.70	4.18	110.00	27.50	5.55	116.50	31.00	5.55	117.50	32.00	6.78	123.00	34.30	7.05	127.00	35.00	5.12	42.50	14.30
9462F	1.69	82.00	19.00	4.12	110.50	27.50	5.27	115.00	32.00	5.55	120.00	32.50	6.43	124.00	32.50	7.39	130.50	33.50	5.70	48.50	14.50
5693F	1.63	81.00	20.00	3.63	103.00	24.30	4.05	106.00	20.00	4.06	107.00	28.50	4.30	110.00	29.00	4.86	115.00	29.20	3.23	34.00	9.20
5692F	1.87	82.00	21.00	4.03	105.50	26.00	5.22	114.00	30.00	5.01	116.00	30.50	5.62	119.00	31.00	6.11	125.00	32.00	4.24	43.00	11.00
5639M	1.20	71.00	19.00	2.77	93.00	23.50	3.82	100.00	27.50	3.37	100.00	27.50	3.63	102.00	27.90	3.21	102.00	28.00	2.01	31.00	9.00
5674F	1.15	72.00	17.70	2.53	92.00	22.50	3.01	100.00	25.00	3.13	101.50	26.00	3.04	102.00	26.50	3.76	107.00	26.70	2.61	35.50	9.00
5673F	1.02	78.00	19.00	3.46	102.50	25.00	4.33	110.00	29.00	4.41	110.00	29.00	4.83	116.00	29.50	5.76	120.00	30.50	4.74	42.00	11.50
TOTAL	22.59	1175.50	292.70	51.72	1522.00	373.40	64.12	1620.50	426.00	64.67	1640.00	435.00	72.22	1696.00	445.90	79.54	1764.00	460.20	56.95	580.50	167.50
AVERAGE PER GATOR	1.51	78.37	19.51	3.45	101.47	24.89	4.27	108.03	28.40	4.31	109.33	29.00	4.81	113.07	29.73	5.30	117.60	30.68	3.80	39.23	11.17
STD. DEV.	0.31	4.48	0.98	0.59	6.02	1.55	0.83	6.20	2.15	0.86	6.56	2.07	1.04	7.51	2.31	1.27	8.44	2.58	1.11	5.21	2.01
POP. VAR.	0.09	20.08	0.95	0.35	36.25	2.42	0.68	38.45	4.61	0.74	43.09	4.27	1.09	56.33	5.33	1.62	71.31	6.64	1.22	27.16	4.05

Table VIII WEIGHT AND MEASUREMENT DATA

Chamber #4 YEARLING GATORS

TOTAL 14

	June 1, 1988			November 3, 1988			February 2, 1989			March 21, 1989			May 6, 1989			June 29, 1989			WEIGHT GAINED	GROWTH	
Band#	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm	WT/kg	Length/cm	HG/cm
5697M	1.76	80.00	21.00	3.39	102.00	24.50	3.93	107.00	27.90	5.03	112.00	28.00	5.16	116.00	29.50	5.76	120.00	34.00	4.00	40.00	13.00
5699F	1.63	81.50	20.00	3.38	105.50	24.00	3.66	107.00	25.50	4.43	108.00	26.50	3.58	108.00	28.00	4.13	112.00	29.20	2.50	30.50	9.20
9466M	1.43	77.00	18.50	2.66	98.00	23.00	2.96	101.00	23.50	2.78	102.00	24.10	3.25	102.50	27.50	3.79	103.00	31.00	2.36	26.00	12.50
5694F	1.57	78.50	19.50	3.16	102.00	24.00	3.37	104.00	26.00	3.27	106.00	26.00	4.02	107.00	28.00	4.16	107.50	29.20	2.59	29.00	9.70
5685F	1.77	80.00	21.00	3.05	98.00	23.50	3.22	100.00	23.50	3.02	100.50	25.40	3.26	101.00	27.00	3.97	101.50	29.00	2.20	21.50	8.00
5651F	1.68	72.00	16.50	2.19	92.00	21.00	2.44	95.00	22.00	3.02	97.00	23.50	3.39	100.50	24.80	3.53	104.00	27.50	1.85	32.00	11.00
5682F	1.88	81.00	20.50	3.74	104.00	24.00	4.08	110.50	27.50	4.60	110.00	28.00	4.69	112.00	28.50	5.11	115.50	33.00	3.23	34.50	12.50
9465F	1.87	83.00	21.00	3.34	96.00	25.00	3.79	111.00	26.00	3.82	112.00	26.70	4.56	112.00	28.00	4.53	112.00	30.00	2.66	29.00	9.00
5695F	1.96	85.00	21.50	3.24	106.00	24.00	3.50	106.00	24.50	3.13	109.00	25.00	3.31	106.00	27.90	4.29	105.50	29.00	2.33	20.50	7.50
5642F	1.65	79.50	20.50	3.21	101.50	25.00	3.80	105.00	27.50	4.91	109.50	28.50	5.12	114.00	30.00	5.17	118.00	34.30	3.52	38.50	[illegible]
5640F	1.70	80.00	20.00	3.14	103.00	24.00	3.52	105.00	25.50	4.52	107.00	26.70	4.05	103.00	28.00	4.51	113.00	33.00	2.81	33.00	13.00
9471F	1.68	79.00	20.50	2.92	99.50	23.00	3.14	100.00	26.00	3.86	102.00	26.00	3.35	102.50	26.50	3.45	103.00	26.50	1.77	24.00	6.00
5687F	2.15	87.00	22.50	3.77	110.00	25.00	4.36	111.00	26.50	5.09	113.00	27.90	4.33	114.00	29.00	4.66	114.00	30.00	2.51	27.00	7.50
5632F	1.26	72.00	20.00	2.25	90.00	22.00	2.52	92.00	22.00	3.[illegible]	92.00	25.00	2.38	93.00	25.00	2.63	94.00	25.40	1.35	22.00	5.40
TOTALS	24.01	1115.50	283.00	43.44	1407.50	332.00	48.29	1454.50	353.90	54.75	1480.00	367.30	54.45	1497.50	387.70	59.69	1523.00	421.10	35.60	407.50	138.10
AVERAGE PER GATOR	1.72	79.68	20.21	3.10	100.54	23.71	3.45	103.89	25.28	3.91	105.71	26.24	3.89	106.96	27.69	4.26	108.79	30.08	2.55	29.11	9.86
STD. DEV.	0.21	4.01	1.37	0.45	5.25	1.11	0.54	5.54	1.86	0.00	5.98	1.48	0.78	6.27	1.44	0.77	7.05	2.62	0.67	5.08	[illegible]
POP. VAR.	0.04	16.09	1.88	0.21	27.55	1.24	0.29	30.72	3.45	0.65	35.81	2.18	0.61	39.27	2.07	0.59	49.67	6.88	0.45	34.58	[illegible]

TABLE IX PLANT / ANIMAL PROTEIN RATION
CHAMBER #1

%Crude Protein per Ingredient	Ingredient	% Used In Ration	% Protein in Ration
66%	Soybean Meal	18.00%	11.88
84%	Fish Meal	12.50%	10.50
85%	Blood Meal	12.00%	10.20
60%	Corn Gluten Meal	5.00%	3.00
26%	Distiller's Solubles	38.00%	9.88
15%	Wheat Shorts	1.00%	0.15
40%	Yeast	1.00%	0.40
	Dextrin	1.00%	
	Fat	5.00%	
	Mineral Mix	2.33%	
	Di-Cal-Phos	2.33%	
	Salt	0.34%	
	Vitamin Pre-Mix	1.50%	
		=======	=========
	TOTALS	100.00%	46.01

TABLE X PLANT PROTEIN RATION
CHAMBER #2

% Crude Protein per Ingredient	Ingredient	% Used In Ration	% Of Protein In Ration
65%	Soybean Meal	38.0%	24.70%
38%	Sun Flower Meal	16.0%	6.08%
60%	Corn Gluten Meal	21.5%	12.90%
26%	Distillers Solubles	8.5%	2.21%
15%	Wheat Shorts	1.0%	0.15%
	Dextrin	6.0%	
	Poultry Oil Fat	2.5%	
	Jones Mineral Mix	2.33%	
	Di-Cal Phos	2.33%	
	Salt	0.34%	
	Vitamins Pre-Mix	1.5%	
	TOTALS	100%	46.04%

TABLE XI ANIMAL PROTEIN RATION
CHAMBER #3

% Crude Protein per Ingredient	Ingredient	% Used In Ration	% Of Protein In Ration
80%	Feather Meal	14.00%	11.20
70%	Poultry By-Prod Meal	31.00%	21.70
85%	Blood Meal	7.50%	6.375
84%	Fish Meal	8.00%	6.72
	Alphacel	25.00%	
	Dextrin	3.00%	
	Poultry Oil (fat)	5.00%	
	Jones Mineral Mix	2.33%	
	Di Cal Phos	2.33%	
	Salt	0.34%	
	Vitamin Pre-Mix	1.50%	
	TOTALS	100.00%	45.995%

TABLE XII PLANT PROTEIN RATION + TAURINE
CHAMBER #4

% Crude Protein per Ingredient	Ingredient	% Used In Ration	% Of Protein In Ration
65%	Soybean Meal	38.0%	24.70%
38%	Sun Flower Meal	16.0%	6.08%
60%	Corn Gluten Meal	21.5%	12.90%
26%	Distillers Solubles	8.5%	2.21%
15%	Wheat Shorts	1.0%	0.15%
	Dextrin	6.0%	
	Poultry Oil Fat	2.5%	
	Jones Mineral Mix	2.33%	
	Di-Cal Phos	2.33%	
	Salt	0.34%	
	Vitamins Pre-Mix	1.5%	
	TOTALS	100%	46.04%

NOTE: 5g Per 10,000g. of ration have been added to this formula.

TABLE XIII: AMINO ACID CONTENT
AS % OF PROTEIN
PLANT PROTEIN RATIONS

RATION IS 46.04% PROTEIN

Amino Acid	% of Ration	= % of Protein
Methionine	1.065	= 2.313
Cystine	.7396	= 1.606
Lysine	2.206	= 4.791
Tryptophane	.634	= 1.377
Threonine	1.818	= 3.948
Isoleucine	.996	= 2.163
Histidine	1.172	= 2.545
Valine	2.325	= 5.049
Leucine	4.657	= 10.115
Arginine	3.105	= 6.744
Phenylalanine	2.595	= 5.636
Glycine	1.975	= 4.289

TABLE XIV AMINO ACID CONTENT
AS % OF PROTEIN
ANIMAL PROTEIN RATION

RATION IS 45.99% PROTEIN

Amino Acid	% of Ration	= % of Protein
Methionine	0.358	= 0.778
Cystine	2.197	= 4.777
Lysine	2.294	= 4.988
Tryptophane	0.359	= 0.780
Threonine	1.664	= 3.618
Isoleucine	1.990	= 4.327
Histidine	1.124	= 2.444
Valine	2.338	= 5.080
Leucine	3.261	= 7.090
Arginine	2.393	= 5.200
Phenylalanine	1.661	= 3.611
Glycine	2.890	= 6.283

TABLE XV AMINO ACID CONTENT
AS % OF PROTEIN
PLANT / ANIMAL PROTEIN RATION

RATION IS 46.01% PROTEIN

Amino Acid	% of Ration	= % of Protein
Methionine	.933	= 2.027
Cystine	.648	= 1.408
Lysine	3.236	= 7.033
Tryptophane	.364	= 0.791
Threonine	1.951	= 4.240
Isoleucine	1.591	= 3.457
Histidine	2.00	= 4.346
Valine	2.651	= 5.761
Leucine	4.562	= 9.915
Arginine	2.642	= 5.742
Phenylalanine	2.440	= 5.303
Glycine	2.528	= 5.494

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DISTRIBUTION AND STATUS OF THE CROCODILIANS OF HONDURAS

Results of a Survey Conducted for the Convention on International Trade in Endangered Species of Wild Fauna and Flora and the Honduras Secretaria de Recursos Naturales Renovables

By

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BACKGROUND

Honduras (112,088 km^2) is the second largest Central American nation (after Nicaragua). The country is dominated by a mountainous central region with rugged peaks that reach almost 3,000 m in altitude. Extensive lowland regions are found along the 644 km long Caribbean coast in the north and a smaller amount of coastal wetlands are located in the Gulf of Fonseca in the south. Along the north coast, wetlands habitats are generally restricted to rather narrow coastal lowlands and river valleys, especially in the northwestern and north-central region. The greatest amount of wetlands habitats is associated with a broad alluvial plain, approximately 65 km wide, in the northeastern part of Honduras that extends 360 km along the coast into eastern Nicaragua. This region, called La Mosquitia after the Mosquito Indians who inhabit the region, contains extensive low-lying savanna and coastal wetlands habitats and is continuous with the eastern Nicaraguan lowlands (also part of Mosquitia). The majority of this region is located in the department of Gracias a Dios, containing approximately 20% of the Honduran territory. It is the least developed part of the country.

Honduras has two native species of crocodilians; the American crocodile (*Crocodylus acutus*) and the Central American caiman (*Caiman crocodilus chiapasius*). The crocodile is a large species (adult males reach lengths of 3.5-5 meters) that may be found in either freshwater or brackish water habitats in coastal lagoons and rivers along both the northern and southern coasts of Honduras. The Central American caiman is a smaller species, adult males reach lengths of 2-2.5 meters (Alvarez del Toro 1974), that is found principally in freshwater marsh or swamp habitats, although it also enters brackish water. Past commercial hunting of crocodilians in Honduras concentrated on the crocodiles because its hide is more valuable than that of the caiman. Hunting in Honduras, as well as throughout the range of the species, severely reduced population levels and warranted inclusion of the American crocodile on the CITES Appendix I list of endangered species in the mid-1970's (King, Campbell, and Moler 1982). Owing to the less intensive hunting pressure, as well as their ability to reproduce at a smaller size and their ecological adaptability, *Caiman crocodilus* has remained relatively numerous in many parts of its range (King 1989), including the coastal lowlands of Honduras.

Apparently during the latter part of the 1970's and the early 1980's, the market for crocodile skins in Honduras declined greatly. The reason for this was twofold, first, the crocodiles became so scarce that it was difficult to hunt them for a living, and second, increased restrictions on international trade in endangered species made the sale of crocodile hides more difficult.

Honduras is trying to develop programs for the sustained utilization of wild populations of Central American caimans. In addition, in the private sector there is considerable interest in farming the American crocodile, since it produces a more valuable hide. The crocodile remains endangered throughout most of its range, including Honduras, and retains an Appendix I listing on CITES. Due to its larger size and delayed sexual maturity, the species may be less resilient to direct harvesting from the wild than are the smaller caiman. Other nations in Latin America are actively managing their caiman populations, but Honduras is a test case for the development of the first viable management program for a true crocodile in the Americas. No such program currently exists. If the program is successful it could serve as a model for similar crocodile conservation/management programs in other parts of Central and South America.

Owing to the importance of the Honduran project in terms of conservation, the management program in Honduras must be developed carefully and with a firm scientific, as well as socioeconomic, foundation. An adequate understanding of the current status and ecology of the wild populations is essential for planning any wildlife management program. The survey results reported below are an important first step towards meeting the scientific prerequisites for developing a conservation/management program.

Before any management program can be implemented, data must be collected on the current status and distribution of the species to be exploited, as well as management related aspects of its ecology. Articles IV 2a and 3 of CITES require that the Scientific Authority in each party nation shall monitor the issuance of export permits for wildlife species to insure that exportation will not be detrimental to the survival of the wild populations of that species. The Scientific Authority cannot make such a determination without data on the status and distribution of the species in the wild.

Honduras is the first nation in Central America to initiate a regional survey in cooperation with CITES. Two types of management programs are currently under consideration in Honduras:

- direct harvest of caiman from the wild, and
- sustained utilization of crocodiles through farming or ranching.

'Farming' requires the maintenance of a captive stock of breeding animals to produce eggs and young which are reared in captivity to commercial slaughter size. The husbandry used must be capable of reliably producing F_2 generation in captivity. 'Ranching' involves the harvest of eggs or hatchlings from the wild for rearing in captivity to commercial size. Ranching cannot be sustained unless the wild population and its habitat is protected in order to produce the eggs and hatchlings needed by the ranch. Ranching of Appendix I species is not allowed under CITES. Therefore, before *Crocodylus acutus* can be ranched, a series of country-wide surveys would have to demonstrate that the wild population is increasing or is near carrying capacity and should be transferred to Appendix II. Short of that, a single survey would have to demonstrate that the species is sufficiently abundant in the wild to sustain an annual harvest.

By contrast, CITES Article VII 4 allows farms that are registered with CITES to trade Appendix I products produced from captive propagation on those farms. This is because farming should have a smaller potential impact on wild populations since, as a rule, only the original start-up breeding stock is taken from the wild. Even then, surveys of the wild populations help assess the impact of taking start-up stock for farms.

The objectives of the present survey were to:

- determine the current status and distribution of the American crocodile and Central American caiman in Honduras, and lay the groundwork for a long-term monitoring program,
- produce recommendations for the development and implementation of a national management program for both the Central American caiman and the American crocodile, and
- obtain basic ecological data for both species.

METHODS

The survey was divided into two principal components: 1) a calibration study on two particular crocodile/caiman populations, and 2) surveys throughout a stratified sample of the remaining major crocodilian habitats. A third component, the analysis and quantification of habitat types and distribution, has not yet been completed. Actual censusing concentrated on the coastal lagoons, river systems, and lakes which represent the major habitat for these two crocodilians. Secondary efforts were made to census peripheral areas adjacent to the major river courses as well as more isolated wetlands habitats.

Besides information on current population status, one of the most critical points addressed in any study of this type is population trend, i.e., is the population increasing, decreasing, or remaining stable? As crocodilians are rather long-lived species, data need to be collected over a suitably long period of time before any population trends may become apparent. The results of this survey will help to estimate current population levels, and lay the groundwork for continued, less intensive surveying to monitor population trends. However, a tentative assessment of crocodilian population trends over the last 12 years can be made by comparing the results of this survey with data from censuses done 12 years earlier in Laguna Caratasca in La Mosquitia (Klein 1976, 1977, 1979).

A. Standardized Survey Procedures

With two survey teams working in Honduras, and other CITES teams operating in other countries, survey standardization is important so results can be compared and so surveys can be repeated in subsequent years. This section briefly outlines standard survey procedures and presents an example of the standard form used in the Honduras surveys. These standardized procedures were adhered to as closely as possible, yet left the survey teams with enough flexibility to adapt to local conditions.

Surveys were conducted at night. Survey teams were equipped with 6-volt headlamps as well as 200,000 candlepower spotlights operated off 12-volt automobile batteries to spot the reflected eyeshine of the caimans and crocodiles. The spotlight was used for long-distance spotting as well as navigation. The close approach of animals was best done using the less powerful headlamps. Each animal spotted was approached as closely as possible to distinguish caiman from crocodile, and to estimate its size.

Survey routes were first reconnoitered by day prior to conducting a nighttime survey so the personnel could become familiar with the river, submerged logs, snags, rocks and shoal areas. It also allowed notes to be made on habitat prior to conducting the survey. Where possible, the teams started these daytime reconnaissances from a downstream location and moved upstream making habitat notes and familiarizing themselves with the route. After nightfall, the actual census was made travelling downstream. For lakes or lagoons, survey routes were based on logistic feasibility. Again it was important to cover the survey route first during the day in order to note navigational hazards and to characterize the habitat types.

The surveys were done from a boat by a survey team usually composed of at least 3 people. Two survey teams were involved in the survey, one surveyed the northwestern and southern parts of Honduras and the other surveyed the north central and northeastern regions. Each team had one person, i.e., Mario Espinal or Carlos Cerrato, who served as spotter throughout the surveys.

On nocturnal surveys the spotter is responsible for sighting the crocodilians, estimating their lengths, and identifying the species, as well as helping the boat driver navigate around logs, rocks, and shallow areas. To become proficient at spotting, and particularly at size estimation, requires practice. Size estimates are not based on any one criterion. During a survey, the size or form of the head, or other exposed body parts, are usually all that can be used to estimate the total length of the animal. Estimating size is best practiced by capturing a sample of the animals seen on nighttime surveys, and then comparing their estimated lengths with their true lengths. Another alternative is to closely examine captive animals and practice estimating lengths of known individuals. Animals seen during the survey but not approached close enough to allow a size estimate to be made were classified as EO (= eyes only). At times it was possible to make a rough estimate of size. In these cases, animals were classified as EO greater than 1.8 m or EO less than 1.8 m total length.

To free the spotter from distractions that might cause him to miss an eyeshine, he verbally reported his sightings, species identifications, estimates of size, and location of the crocodilian in the water to a second person who recorded the data on the standard form. The second person also recorded the km distance or location along the survey route taken from maps of the area. If the spotter were to write down these data, he would not only be distracted from his spotting, but he also would suffer a temporary loss of visual acuity from looking at a brightly illuminated piece of paper. To avoid backlighting the spotter which would scare an animal being approached closely, the data recorder used a small flashlight to illuminate the census form. The third person drives the boat.

The spotter always remained in bow of the boat and avoided startling the crocodilians by suddenly illuminating part of the boat with his spotlight or headlamp. He made regular, slow sweeps of the spotlight beam along both shorelines (small rivers, streams) or along the shoreline and out into open water (large rivers, lakes, lagoons). Upon sighting an animal it was approached as closely as possible to estimate size as well as record pertinent ecological data. Animals were approached at moderate speed. Surveys were conducted with the minimal amount of noise possible. To keep talking to a minimum the spotter and driver worked out a system of hand signals to indicate where an animal was and how best to approach it. Although the survey teams planned to survey rivers only while travelling downstream to minimize motor noise, that was not always possible.

During every survey, a series of environmental parameters were recorded, e.g., water and air temperature, wind speed, water salinity, tidal phase, and time the survey was started and ended (see sample data sheet in Appendix). Important environmental parameters for each crocodilian sighting (e.g. habitat type, water depth, position or situation of crocodilian) were also recorded on these sheets. Members of the survey team became familiar with major wetlands vegetation types in order to characterize the habitat. Specimens were collected from important plant species that could not be identified and used for later identification.

Lagoons and some rivers were so wide that the spotlight beam could not reach both banks from midstream. When that occurred, one bank was surveyed upstream and an hour or so later, after the crocodilians had a chance to settle down, the other bank was surveyed downstream.

1. Estimating Population Size

Because much of the survey work was done in remote areas, under difficult logistical circumstances, and done as rapidly as possible, one area, which would serve as a point of comparison for all the other areas surveyed, was chosen for more detailed work. The population data collected in this detailed study provided the foundation against which data from all the other populations surveyed could be calibrated. The calibration study also provided the opportunity to practice and standardize censusing techniques. This experience proved invaluable once the general survey began. It also provided an opportunity to collect data on aspects of the ecology and behavior of the crocodilians which may have important conservation and management implications. All surveys were done using the series of standardized census procedures described above. This standardization is essential for drawing valid comparisons between areas when the censusing is done by different groups.

During an typical nocturnal survey, only a fraction of the crocodilians present in the area are seen. This fraction is variable, and may depend on a number of factors such as water level, the amount of aquatic vegetation, temperature, wind, rain, and even wariness of the animals resulting from past hunting. In addition, survey routes will only cover a small fraction of the habitat available to the crocodilians. Even in river systems, large areas of habitat usually are available in the form of oxbow lakes or other associated wetlands. Hence, one of the most important functions of the calibration study was to estimate the fraction of the total population seen during surveys.

The unseen fraction can be divided into two principal components, 1) crocodilians found along the survey route that were not seen (because they were underwater or otherwise hidden from view), and 2) crocodilians found in areas peripheral to the actual survey route.

The Unseen Fraction of Crocodilians - One of the best methods for estimating the spotting fraction of crocodilians is through repetitive surveys. This method is especially amenable to large scale nocturnal spotlight censusing programs such as the one conducted in Honduras. Using standard census methods (see Standardized Survey Procedures above), two predetermined sections of the calibration study area were repetitively surveyed a total of 20 times each. One of the sections was in a coastal lagoon, Laguna Bacalar, and the second was in a river, Río Sico (on maps indicated variously as the Río Sico, Río Tinto, Río Negro, and Río Sico Tinto o Negro, but hereinafter referred to as Río Sico). The number of crocodilians seen on any one survey depends on several factors. Studies in northern Australia (Messel, Vorlicek, Wells, and Green 1981) have demonstrated that under most conditions, the factor of overwhelming importance is water level, particularly in areas influenced by tides or seasonal changes in water regimes. The most crocodilians are seen during low water when they cannot easily hide under overhanging vegetation. Data on the relationship between water level and the sighting fraction are essential for some areas may have to be censused during high, or medium high water levels.

The data from the calibration survey permits the estimation of the sighting fraction, the probability of seeing crocodilians.

Ideally, the entire length of the Río Sico would have been included in the calibration survey. Unfortunately, fuel for outboard motors and for electrical generators to recharge spotlight batteries was unavailable locally and had to be shipped in to the base camp in Palacios by coastal freighter. This, in combination with the scant amount of time available to complete both the calibration and general surveys, limited the calibration runs to the lower 19.3 km of the Río Sico.

Peripheral Crocodilians - Although the majority of crocodilians should be found in the main lagoon or river channel, they also inhabit peripheral areas such as oxbow lakes or fringing wetlands.

An effort was made during the calibration surveys to visit a number of these wetlands identified from topographic maps or from interviews with local inhabitants.

2. Ecological Information

The calibration study and surveys provided good opportunities to collect data on the ecology and behavior of the crocodilians. During the surveys themselves, information was gathered on the crocodilian population size-class distribution (by estimating crocodilian lengths in 0.5 m intervals).

Additional information was collected on the natural reproduction of the American crocodiles, especially nesting data. Nesting areas located opportunistically during the surveys provided opportunities for studying aspects of nesting ecology. Observations also were made on the captive populations of American crocodiles on Honduran crocodile farms. These captive crocodiles were removed from the wild populations during the previous 4 years and supply important information on clutch size, egg dimensions and weight, fertility rates, location and size of nest hole, and the behavior of nesting females.

The ecological and behavioral data collected during the survey are not pertinent to this survey report and will be published elsewhere.

B. General Population Surveys

Surveys for crocodilians outside of the calibration study site of necessity was much less intensive. Survey routes were pre-selected to cover as large a percentage of the wetlands habitat types as possible within the time available. The work schedule and the choice of areas to be surveyed was heavily dependent on the logistical support obtainable. The country was divided into four basic regions: the northwestern coast, the north central coast, the northeastern coast (La Mosquitia), and the Pacific coast (Gulf of Fonseca).

Northwest Coast - The northwest coast region extends from the Río Motagua, which forms Honduras' border with Guatemala, east to the vicinity of the town of Trujillo. Most of the crocodilian habitat in this region is restricted to riverine flood plains and a narrow strip of coastal wetlands. The principal river system in the region is the Río Ulua-Río Chamelecón system. Although covering a large area, much of the northwest has been extensively developed for commercial cash crops (e.g., bananas, pineapple) and the rivers are extensively used by the rapidly growing human community. Nevertheless, caiman and a few crocodiles are still found in these rivers and surveys were conducted in a few of the less impacted areas. Additional survey sites included the inland Lago Yojoa, Honduras' largest lake, as well as the Laguna de los Micos, a large coastal lagoon, and Embalse Cajón, a hydroelectric reservoir. An effort was also be made to census representative areas of smaller coastal lagoons and rivers along the coast between Tela and Trujillo. Some evidence suggests that a small population of American crocodiles still occurs on some of the Bay Islands, particularly Guanaja, although the team did not survey the islands.

North Central Coast - The part of Honduras from Trujillo to the Río Sico is similar to the northwest coast with well-defined river flood plains and relatively little lowland coastal habitat. East of the Río Paulaya, an eastern tributary of the Río Sico, the extensive coastal plain of La Mosquitia is evident. Surveys concentrated on the major river systems in this region (e.g., Río Sico, Río Aguán, Río Chapagua) and several of the larger coastal lagoons (e.g., Laguna de Bacalar, Laguna de Guaimoreto, Laguna el Lirio).

La Mosquitia - The northeastern region of Honduras, referred to as La Mosquitia, contains the greatest amount of relatively undisturbed coastal wetlands in the entire country. This region, along with the north central coast, contains the largest populations of caiman in Honduras, and merited the greatest amount of attention in terms of survey work. In addition, the area is relatively remote and logistics were difficult. The region contains a vast complex of coastal lagoons (e.g., Laguna de Caratasca, Laguna de Tánsin, Laguna de Warunta, Laguntara, Laguna de Brus, and the Laguna de

Ibans) and rivers (e.g., three large rivers, Río Patuca, Río Platano, and Río Coco (also known as the Río Segovia), and numerous small rivers) which pass through savanna habitat. The Río Patuca is the largest river in Honduras. The present civil unrest in Nicaragua and bordering areas of Honduras prevented surveys of the large Río Coco that borders Nicaragua. It also prevented the survey team from repeating the crocodilian surveys done in 1976 and 1977 in the largest coastal lagoons, Lagunas de Caratasca, Tánsin, and Warunta (Klein 1976, 1977, 1979). Surveys concentrated mostly on the lagoons and rivers, but selected peripheral habitats were covered as well.

Pacific Coast - Crocodilian surveys were also undertaken in Honduras' Pacific drainage in the Gulf of Fonseca. The two principal rivers located wholly in Honduras, the Río Nacaome and the Río Choluteca, were surveyed, as were several of the smaller rivers and coastal lagoons located on the area.

C. Survey Timetable

Calibration surveys began in Laguna Bacalar and Río Sico in February 1989, and the general surveys continued throughout the remainder of Honduras until the end of June 1989. Carlos Cerrato led the surveys of the north central and northeast coasts, and Mario Espinal led the surveys of the remaining regions.

D. Habitat Types and Total Population Size

It is possible to estimate total numbers of crocodilians in an area if data are available both on the density of the species in a given wetlands habitat and on the total area occupied by that habitat. Because it was feasible to survey only a small fraction of the total coastal wetlands habitat, information on the extent of habitat is needed before an overall population size can be estimated. Detailed maps of habitat types and their distribution can be prepared from available topographic maps coupled with Landsat satellite imagery and on-site field inspections. Since most of the crocodilian censusing was done at night, part of the day was spent reconnoitering the survey route and recording the habitat types encountered along the route. These data are not discussed in this report as their analysis must await preparation of the habitat maps from satellite imagery. When this particular work is completed, the results will be a quantification of the crocodilian habitats of Honduras (including peripheral habitats) and reasonable extrapolations of the total crocodilian population.

E. Taxonomic Status

An important secondary goal of this study is to clarify the taxonomy of the Honduran caimans. The systematics of the genus *Caiman* is in a particularly confused state. Authorities variously refer to the Central American caiman as *Caiman crocodilus fuscus* or *Caiman crocodilus chiapasius*. This distinction is important as regulating international trade in skins requires a good understanding of the geographic variation in the species. Lack of such information has hindered enforcement of trade restrictions on illegal *Caiman* hides from central South America. The Honduras survey teams made a small collection of caimans from various parts of the country. Standardized morphological and color data were recorded for each specimens before it was preserved. Tissue samples were also collected for biochemical analysis. This collection was shipped to the Florida Museum of Natural History for further examination. Until this portion of the research is complete, this report follows King and Burke (1989) in applying the name *Caiman crocodilus chiapasius* to the caimans of Honduras.

F. Survey Personnel

Prof. F. Wayne King, Deputy Chairman, IUCN/SSC Crocodile Specialist Group, Florida Museum of Natural History, Gainesville, FL 32611, U.S.A., was overall coordinator of the project. Mario Espinal, Departamento de Vida Silvestre, Direccion General de Recursos Naturales Renovables, Comayaguela, D.C., Honduras, and Carlos A. Cerrato B., Departamento de Biologia, Universidad Nacional Autonoma de Honduras, Ciudad Universitaria, Tegucigalpa, D.C., Honduras[1], were field coordinators of the two survey teams. Ramon Zuniga served as a regular member of the team that surveyed the northwest and south coasts, and Renaldo Alvarez served as a member of the team that surveyed much of the north central coast.

RESULTS

A. Numbers and Population Densities

As stated above, a total of 20 repetitive calibration surveys were conducted on Laguna Bacalar and another 20 on the nearby Río Sico.

Laguna Bacalar is a shallow, mangrove-fringed, fresh to brackish water lagoon. The lagoon and its tributaries have approximately 52 km of surveyable shoreline and a midstream length of 25.6 km. It is typical of coastal lagoons throughout most of La Mosquitia. Four streams and creeks, fed by a large number of tributaries, empty into the lagoon. Near its eastern end the lagoon opens into the Caribbean Sea through the Barra de Río Palacios. Though the lagoon supports a large and varied salt and brackish water biota, e.g., red mangrove (*Rhizophora*), black mangrove (*Avicennia*), turtlegrass

TABLE 1. CALIBRATION SURVEYS OF CROCODILIANS IN LAGUNA BACALAR

Survey No.	*Caiman*	*Crocodylus*	Total
1	158	0	158
2	152	0	152
3	152	0	152
4	180	0	180
5	208	0	208
6	183	0	183
7	169	0	169
8	144	0	144
9	92	0	92
10	169	0	169
11	120	0	120
12	166	0	166
13	101	0	101
14	108	0	108
15	106	0	106
16	104	0	104
17	174	1	175
18	149	1	150
19	82	1	83
20	60	1	61
Totals	2,777	4	2,781
Mean	138.85	0.2	139.05
Std Dev	38.56	0.4	38.44

Calibration surveys were conducted over the 52 km survey route from February to May 1989.

[1] At the time of the survey, his address was: Programa Maestria en Manejo de Vida Silvestre, Apto. 86, Escuela de Ciencias Ambientales, Universidad Nacional, Heredia, Costa Rica.

TABLE 2. CALIBRATION SURVEYS OF CROCODILIANS IN RIO SICO

Survey No.	*Caiman*	*Crocodylus*	Total
1	58	2	60
2	36	3	39
3	173	1	174
4	224	1	225
5	254	0	254
6	259	0	259
7	247	1	249
8	227	1	228
9	235	0	235
10	264	0	264
11	257	0	257
12	235	1	236
13	266	0	266
14	292	0	292
15	264	0	264
16	284	2	286
17	302	7	309
18	267	5	272
19	270	3	273
20	260	3	263
Totals	4,674	31	4,705
Mean	233.7	1.55	235.25
Std Dev	67.88	1.86	67.86

Calibration surveys were conducted over the 19.3 km survey route from February to May 1989.

(*Thalassia*), mullet, snapper (*Lutjanus*), and bluecrabs (*Callinectes*), there is sufficient freshwater inflow from rain and from the streams and creeks that the surface water is fresh most of the year. Overhanging vegetation was not a major obstacle to sighting caimans and crocodiles along most of the shore. The 3.25 km long, almost canal-like, Río Palacios connects the eastern end of Laguna Bacalar with the Río Sico.

The Río Sico is in excess of 250 km in length, but only the lower 19.3 km of the river was surveyed. In this area, much of the shore vegetation has been cleared for milpas (slash and burn agriculture). The vegetation that remains on the 1-3 m high sandy banks consists largely of dense stands of wild cane grass and a variety of trees. Although a few giant trees remain as indicators of the former forest, most trees are second growth species, e.g., trumpet trees (*Cecropia peltata*). Logjams, brush piles, oxbow lakes, and associated marshes provide ideal habitat for young crocodilians. The Río Sico is typical of many of the rivers in Honduras.

Crocodiles and caimans have been hunted in both Laguna Bacalar and Río Sico in recent years. The discovery of 300+ caiman skulls and carcasses on the banks of a Laguna Bacalar tributary in 1988 made newspaper headlines in Honduras and led local people to refer to the location as a caiman cemetery.

The data from the two series of calibration surveys are shown in Tables 1 and 2.

Studies in northern Australia by Messel, Vorlicek, Wells, and Green (1981:267-271) have shown that the probability of seeing crocodilians, here termed the sighting fraction or 'p,' can be estimated based on the binomial distribution, using the following formula:

$$p = 1 - s^2/m$$

where:

p = sighting fraction for an average survey
s = standard deviation of the census totals
m = mean census value

Unfortunately, the number of caimans and crocodiles sighted varied so greatly between the individual surveys in the calibration series, that the data do not fit a binomial distribution. Data on total numbers of both species from the calibration surveys (Tables 1 and 2) yields the following:

Laguna Bacalar	Río Sico
$p = 1 - 38.44^2/139.05$	$p = 1 - 67.86^2/235.25$
$p = -10.62$	$p = -19.60$

The negative values for 'p' confirm that the variation between surveys was too great to allow the use of the formula. The exact cause of the variation has not been identified, but probably results from rains that occurred on some nights during the calibration survey series. During heavy rains, raindrops break up the beam of the spotlight and reflect light back into the eyes of the spotter, making it difficult to see reflected eyeshine. Normally, surveys are postponed until torrential rain passes. Unfortunately, during the period of the calibration surveys, it rained frequently.

Since the data on total numbers from the calibration surveys do not fit the binomial distribution, a second formula, which treats the largest number of crocodilians seen on a single night as though it was the total number of crocodilians present, was used to estimate the sighting fraction of crocodilians less precisely:

$$p = \bar{x} / m$$

where:

p = sighting fraction for an average survey

$\bar{x}$ = mean census value
m = maximum number seen during one survey

Tables 1 and 2 indicate that the largest number of crocodilians of both species seen in Laguna Bacalar was 208, and in the Río Sico it was 309, therefore:

Laguna Bacalar	Río Sico
$p = 139.05/208 = 0.668$	$p = 235.25/309 = 0.761$
$p = 67\%$	$p = 76\%$

Certainly some crocodilians were underwater or otherwise hidden from view as the surveyors passed by, so the maximum number seen is not actually equivalent to the total number of crocodilians present. Therefore, the above calculated sighting fractions undoubtedly are overestimates. It is not clear why the calculations indicate a much higher percentage of animals were sighted in the Río Sico than in the Laguna Bacalar.

The Río Sico survey counts trail off on either side of a mode in the range of 250-260 crocodilians sighted (see Table 2 above), which suggests a normal distribution. In a normal distribution, just over 95% of the population falls within two standard deviations of the mean, so if the total numbers of animals sighted on the 20 calibration surveys fit a normal distribution, the sighting fraction can be estimated by a third method using the following formula:

$$p = \bar{x}/(2s+\bar{x})1.05$$

where: p = sighting fraction for an average survey

$\bar{x}$ = mean census value
s = standard deviation

Therefore:

Laguna Bacalar	Río Sico
$p = 139.05/(2x38.44+139.05)1.05 = 0.6076$	$p = 235.25/(2x69.62+235.25)1.05 = 0.5983$
$p = 61\%$	$p = 60\%$

These seem more reasonable estimates of the sighting fraction of all crocodilians. They are slightly lower than the second set of calculated sighting fractions, which, as indicated above, are overestimates. The large difference between the sighting fractions estimated for the Laguna Bacalar and Río Sico populations using the second method above also has been eliminated. Using the same formula for a normal distribution, the calculated sighting fractions for the populations of *Caiman* and of *Crocodylus* in Laguna Bacalar and Río Sico are:

	Laguna Bacalar	Río Sico
Caiman crocodilus	61%	60%
Crocodylus acutus	19%	28%

These data suggest that, compared to caiman, a smaller proportion of the American crocodile population was seen. In addition, the difference between the percentage of crocodiles seen in the lagoon and in the river might reflect ecological differences or past hunting pressures. However, so few *Crocodylus acutus* were sighted during the calibration surveys that sampling error alone can account for the observed differences between the crocodile and caiman populations, and between the lagoon and river populations of crocodiles. If these are real differences, they will only be documented through continued monitoring and more detailed habitat analysis. In the meantime, for the purposes of this survey report, 60% is the sighting fraction used to estimate population size and density for both *Caiman crocodilus chiapasius* and *Crocodylus acutus*.

Figures 1 through 16 outline most the larger waterways surveyed. Detailed maps are on file with the Florida Museum of Natural History and the Departamento de Biologia, Universidad Nacional Autónoma de Honduras.

The results of the surveys are presented in Tables 3 and 4. The numbers of caimans and crocodiles sighted and the 60% sighting fraction calculated above provides the basis for estimating population sizes. Densities are calculated on the basis of the number of caimans and crocodiles within the survey route (i.e., number sighted/survey length = sighted density/km, and the estimated population/survey length = estimated density/km). The length of the area surveyed is presented as midstream length (Messel *et al* 1977, 1981) or shoreline distance. Use of midstream length for linear habitats such as most rivers, streams, and creeks is readily understandable. However, bends in the courses of rivers and streams, and coves and embayments in their banks, may make the actual km of shoreline surveyed (i.e., the banks on both sides of the waterway) considerably more than the midstream length. Midstream length can also be used for lagoons, lakes, and peripheral habitats, though it may be inappropriate if they are very wide. Crocodilians are found more frequently near shore than in open water far from shore, and when the two sides (opposite banks) of the waterway are parallel and close enough to each other that a crocodilian can easily swim from one side to the other, the entire width of the waterway can be considered inhabited by the same population. However, the waterway may be so wide that most crocodilians move along the shore rather than swim across the open water to the opposite side. When that happens, the opposite shore can be considered inhabited by a separate population and the shoreline length used for surveys, rather than midstream length. In this report, survey lengths and estimated density of crocodilians is calculated on the basis of the midstream distance for rivers, creeks, and peripheral areas, and shoreline length for lagoons. Within each habitat category, all the surveyed areas are listed in an east to west direction.

Table 3 reveals that *Caiman crocodilus* apparently is so rare as to be effectively absent from the Pacific drainages (e.g., Nacaome, Choluteca, Negro) of Honduras, is scarce in the northwestern region (e.g., Chamelecón, Ulua, Motagua, Micos, Yojoa, El Cajon) of the country, and is most abundant in the north central and northeastern regions (e.g., Patuca, Sico, Brus, Ibans, Bacalar). By contrast, Table 4 indicates that *Crocodylus acutus* occurs throughout Honduras, but presently is most abundant in the larger bodies of water (e.g., Aguan, El Cajón) and absent from smaller peripheral habitats (e.g., Tinguitara, Tampatingni, Plaplaya, Gabú Dende).

Figures 17-19 illustrate the size classes of caimans and crocodiles encountered during the surveys.

Where crocodilians are hunted, large specimens learn to submerge or move into vegetation at the first sign of danger such as the sweep of a spotlight or the sound of an outboard motor. The ones that do not hide do not survive; they become novelty leather products. As a consequence, large size class caimans and crocodiles probably are under represented in Figures 17-19.

B. Population Trends and Biology

Caiman crocodilus chiapasius and *Crocodylus acutus* have been over-exploited in Honduras. Few breeding size animals were encountered during the surveys. This scarcity of breeding adults depresses the potential reproductive rate of the population making it difficult to replace the animals killed by hunters. A valuable resource is being squandered.

However, professional management could return these populations to former abundance and allow their sustained utilization to contribute significant foreign exchange to the economy of Honduras.

The crocodilians of eastern Honduras, particularly in and around Laguna Caratasca, were surveyed in 1977 (Klein 1976, 1977, 1979). Because of civil unrest in the region, the present surveys did not recensus those populations surveyed 12 years earlier. Even if it had been possible to survey Laguna Caratasca, it would not have been possible to repeat the 1977 surveys exactly since the starting points (i.e., precise latitude and longitude), directions, and lengths of those earlier survey routes were not available to our survey teams. However, the results of the earlier surveys in Mosquitia (Klein 1977, 1979) are of interest when compared to the results of the present survey.

In 1977, the majority of specimens of both species were less than 1.5 m total length, with the *Caiman* population having a sighted density varying from 0/km to 41.9/km and a mean of 6.17/km, while the *Crocodylus* population had a sighted density of 0/km to 2.4/km and a mean of 0.51/km. In 1989, the majority of both species censused again were less than 1.5 total length, with the *Caiman* population having a sighted density of from 0/km to 85.5/km and a mean of 1.3/km, while the *Crocodylus* population had a sighted density of from 0/km to 1.4/km and a mean of 0.34/km. In both 1977 and 1989, there were few large sexually mature individuals of either species present in the wild populations. Large caimans and crocodiles survive hunting pressure by being wary, by submerging when they see spotlights or hear the sound of outboard motors, by disappearing long before hunters get close. The ones that are not cautious do not survive. For this reason, the large size classes (>2.0 m) may be under represented in these survey results.

Recognizing that extrapolating from a survey of one population to surveys of other, geographically different, populations more than a decade later might not be reasonable, nevertheless, the results suggest that the average sighted density of caiman populations might have declined almost 80% in the 12 years since Laguna Caratasca was surveyed, despite some of the small populations surveyed in 1989 having densities significantly greater. The average sighted densities suggest the American crocodile population declined almost 30%.

TABLE 3. SURVEYS OF *CAIMAN CROCODILUS* IN HONDURAS

Waterway	Survey length(km)	Caimans sighted	Sighted density/km	Estimated population	Estimated density/km
Atlantic drainage rivers					
Patuca	35.0	311	8.9	518.3	14.8
Plátano	50.0	95.3	1.9	158.8	3.2
La Criba	6.5	124	19.1	206.7	31.8
Sico	19.3	233.7[a]	12.1	389.5	20.2
Aguán	33.0	6	0.2	10.0	0.3
Chapagua	29.0	38	1.3	63.3	2.2
Salado and Cuero	34.5	7	0.2	11.7	0.3
Chamelecón	31.0	1	0.03	1.7	0.1
Ulua	25.0	1	0.04	1.7	0.1
Motagua	20.0	0	0	0	0
Atlantic drainage major lagoons and lakes					
Brus	64.5	99	1.5	165.0	2.6
Ibans	46.5	176	3.8	293.3	6.3
Bacalar	52.0	138.9[a]	2.7	231.5	4.45
El Lirio	25.0	60	2.4	100.0	4.0
Guaimoreto	47.5	6	0.1	10.0	0.2
Micos	40.0	0	0	0	0
Yojoa	54.0	0	0	0	0
El Cajón	465.7	0	0	0	0
Atlantic drainage peripheral habitat					
Laguna Tinguitara	2.0	13	6.5	21.7	10.8
Laguna Tampatingni	3.0	4	1.3	6.7	2.2
Laguna Paptatingni	8.8	16	1.8	26.7	3.0
Criques Las Flores	1.4	48	34.3	80.0	57.1
Criques Plaplaya	0.4	15	37.5	25.0	62.5
Crique La Culebra	1.1	94	85.5	156.7	142.4
Canales Jolamaya	3.2	8	2.5	13.3	4.2
Crique Gabú Dende	0.9	9	10.0	15.0	16.7
Puentes Río Aguán	0.3	13	43.3	21.7	72.2
Pacific drainage rivers					
Nacaome	15.0	0	0	0	0
Choluteca	17.0	0	0	0	0
Estero La Berberia	10.0	0	0	0	0
Negro (Estero San Bernardo)	20.0	0	0	0	0
Totals	1,161.6	1,510.9		2,528.3	
Mean densities/km			1.3		2.2

[a] Mean calculated from calibration surveys.

TABLE 4. SURVEYS OF *CROCODYLUS ACUTUS* IN HONDURAS

Waterway	Survey length(km)	Crocodiles sighted	Sighted density/km	Estimated population	Estimated density/km
Atlantic drainage rivers					
Patuca	35.0	0	0	0	0
Plátano	50.0	0	0	0	0
La Criba	6.5	0	0	0	0
Sico	19.3	13[a]	0.7	21.7	1.1
Aguán	33.0	45	1.4	75	2.3
Chapagua	29.0	9	0.3	15	0.5
Salado and Cuero	34.5	14	0.4	23.3	0.7
Chamelecón	31.0	3	0.1	5.0	0.2
Ulua	25.0	6	0.2	10.0	0.4
Motagua	20.0	11	0.6	18.3	0.9
Atlantic drainage major lagoons and lakes					
Brus	64.5	11	0.2	18.3	0.3
Ibans	46.5	0	0	0	0
Bacalar	52.0	3[a]	0.06	5.0	0.1
El Lirio	25.0	11	0.4	18.3	0.7
Guaimoreto	47.5	0	0	0	0
Micos	40.0	7	0.2	11.7	0.3
Yojoa	54.0	0	0	0	0
El Cajón	465.7	246	0.5	410.0	0.9
Atlantic drainage peripheral habitat					
Laguna Tinguitara	2.0	0	0	0	0
Laguna Tampatingni	3.0	0	0	0	0
Laguna Paptatingni	8.8	4	0.5	6.7	0.8
Criques Las Flores	1.4	1	0.7	1.7	1.2
Criques Plaplaya	0.4	0	0	0	0
Crique La Culebra	1.1	0	0	0	0
Canales Jolamaya	3.2	0	0	0	0
Crique Gabú Dende	0.9	0	0	0	0
Puentes Río Aguán	0.3	0	0	0	0
Pacific drainage rivers					
Nacaome	15.0	4	0.3	6.7	0.4
Choluteca	17.0	6	0.4	10.0	0.6
Estero La Berberia	10.0	2	0.2	3.3	0.3
Negro (Estero San Bernardo)	20.0	4	0.2	6.7	0.3
Totals	1,161.6	400		666.7	
Mean densities/km			0.34		1.7

[a] Maximum number of distinctly different individuals identified during calibration surveys.

C. Current Management

Although Honduras did not file its instrument of ratification with the CITES Secretariat until March 1985, ratification actually occurred six or seven years earlier through Acuerdo No. 16 of 20 Junio 1978 and approved by Decreto Ley No. 771 (La Gaceta, 24-25 Septiembre 1979 (Fuller, Swift, Jorgenson, and Brautigam 1987). Both of Honduras' crocodilians are protected under CITES; *Caiman crocodilus* on Appendix II, and *Crocodylus acutus* on Appendix I.

Caiman crocodilus hides were exported from Honduras under annual export quota. Article IV 2a and 3 of CITES requires that the export of Appendix II species shall be granted only when the Scientific Authority has determined that:

1) the export will not be detrimental to the survival of the species, and
2) the magnitude of the exports is not so great as to make the species a candidate for inclusion in Appendix I, or to prevent it from performing its role in the ecosystems in which it occurs.

Since Klein's (1976, 1977, 1978) surveys 12 years earlier, no determinations had been made by RENARE, the Honduras Scientific Authority, as to what impact the quota was having on the wild population. Under Resolución No. 066-88, on 16 March 1988, RENARE prohibited exports of *Caiman crocodilus* hides until this survey was completed (Adan Antonio Benavides, pers. comm.). Without adequate limitations on hunting seasons and on the numbers and sizes of *Caiman crocodilus* that could be killed through the years prior to this export ban, the populations were overhunted. Despite these failings, the species occurs in suitable habitat throughout most of northeastern Honduras, particularly in Mosquitia. The hunting has removed most large caimans; relatively few caimans more than 1.5 m in length were encountered during the surveys. In Venezuela, *Caiman crocodilus crocodilus* males mature at about 1.7 m total length and reach a maximum of about 2.8 m total length (John Thorbjarnarson, personal communication; Medem 1981); females mature at 1.2 m and reach 1.8 m total length. The Central American caiman, *Caiman crocodilus chiapasius*, matures at a slightly smaller size; it is estimated here that females mature at about 1.2 m total length and reach a maximum size of about 1.6 m, while males mature at about 1.5 m total length and reach a maximum size of 2.5 m. If hunting in Honduras were limited to caimans 1.6 m or greater in total length, only large males would be killed and virtually all the adult females and the smaller mature males would be left unharmed to maintain the breeding potential of the population. If hunting were limited to caimans 1.6 m or greater in total length, the depleted populations would recover as the smaller caimans matured. The result would be maximum sustained utilization of the wild caiman populations of Honduras.

In late 1989, after the survey fieldwork was completed but before this report was finished, RENARE set an interim export quota of 6,000 caiman hides.

The *Crocodylus acutus* populations of Honduras are endangered. None of the American crocodile populations can be characterized as abundant or near carrying capacity. Illegal hunting of crocodiles still occurs with little or no fear of government interference, and *Crocodylus acutus* hides have been exported within the last 5 years. Although exports of crocodile hides have been stopped, the uncontrolled development of crocodile farms is posing a new threat to the survival of the species in Honduras.

1. Farming

Article III of CITES prohibits international trade in Appendix I species if the trade is primarily for commercial purposes. Even if the trade is not primarily for commercial purposes, it is still prohibited if it would be detrimental to the survival of the species in the wild. However, Article VII 4 allows commercial trade provided the Appendix I animal species involved was bred in captivity for commercial purposes, in which case animals or products from those captive breeding programs shall be treated as though they were an Appendix II species.

The first Honduran farm for *Crocodylus acutus* was established near Trujillo in late 1985. It is owned and operated by Agropecuario de Colon, S.A. The stock for this farm was captured from nearby rivers, primarily the Aguán and Chapagua. By mid-1986, the farm had collected a group of approximately 100 crocodiles varying in size from 0.5 m to 3.5 m total length. By early 1987, a breeding group of approximately 55 females (varying in size from 1.8 to 3.8 m) and 16 males (1.9 to over 3 m) had been assembled and the first breeding, nesting, and hatching occurred. Additional young crocodiles and at least three pods of hatchlings were collected from the wild bringing the total number of crocodiles on the farm to nearly 400. The breeding adults are maintained in a freshwater lagoon several hectares in size which is enclosed in an chainlink fence. The young animals are reared in concrete pools in grow out buildings. The entire stock is fed the offal from a cattle slaughterhouse operated by the owner. The deputy chairman of the IUCN/SSC Crocodile Specialist Group has advised on the development and operation of the farm.

In early 1989, construction was started on a second, much larger crocodile farm near San Pedro Sula. The farm, Clal-Continental Crocodile Farm, is a joint venture between Banco Continental (Honduras) and Clal Crocodile Farms (Israel). When completed, it will be the world's largest high-technology crocodile farm. Plans call for a breeding group of 1,200 *Crocodylus acutus* and a large number of controlled environment roundhouses for rearing young to commercial size. Capture of breeding stock from the wild commenced in 1989 and has continued to date. Collecting occurred opportunistically in many of Honduras' waterways, but concentrated in the northern rivers and lagoons. By late 1989, it became clear that it would be difficult, if not impossible, to collect 1,000+ wild mature crocodiles in Honduras.

In mid-1989, a third farm was started by Grupo Ganadero Industrial (GGI) near Choluteca. By June 1989, GGI had obtained approximately 90 adults from rivers in the vicinity of Trujillo. Because the animals were traumatized during capture, improperly transported, and initially maintained without adequate husbandry, an estimated 30 died. More captures were planned, and GGI staff has been exploring the possibility of exporting stock to yet another farm GGI is considering developing in Costa Rica.

More farming operations are certain to be started in the next few years. The development of a captive propagation program for *Crocodylus acutus* in Honduras is to be commended. However, without professional guidance and governmental regulation, this development can destroy the wild populations. The capture of mature adult American crocodiles for stocking farms has exactly the same effect on the wild populations as killing them would have. It depresses the breeding potential of the wild population until young crocodiles in the population can mature and replace the breeders that were removed. It has the potential of causing the extinction of local populations if the young animals are removed as fast as they mature. RENARE needs to promulgate regulations that will assure the operation of crocodile farms does not threaten the resource upon which the developing industry depends.

As stated above, Article VII 4 of CITES allows commercial trade provided the Appendix I animal species involved was bred in captivity for commercial purposes, in which case those captive propagated animals and products shall be treated as though they were an Appendix II species. To assure that Appendix I animals traded under the provisions of Article VII 4 are truly products of captive propagation, the farms must be registered by the CITES Secretariat. To accomplish that for the Honduras farms, the American crocodiles being traded must have been hatched from eggs laid in captivity as the result of matings of the parents in captivity as required under CITES Conference Resolution 2.12. In addition, the farms must use husbandry techniques that have been shown reliably to produce a F_2 generation in captivity. The Agropecuario de Colon farm qualifies for registration, having bred *C. acutus* for three years using husbandry techniques that reliably have produced F_2 generations on alligator farms in Florida and crocodile farms in Africa and Asia. However, under CITES Conference Resolution 6.21, registration of the first farm for an Appendix I species requires approval of a two-thirds majority of the Parties to the CITES. No farm for *Crocodylus acutus* has yet been registered so approval of the Honduras farm or farms must come from the Parties. In March 1989, RENARE requested that the CITES Secretariat bring the registration of the Agropecuario de Colon farm before the 7th Conference of the Parties to CITES in Lausanne, Switzerland, in October 1989. That request apparently was lost in the mail and by the time the loss was discovered and a second request sent, the '150 days prior to the conference' deadline for receipt of such proposals had passed. As a consequence, the issue of registering the Honduras farm, the first commercial farm for

Crocodylus acutus, never came before the Conference of the Parties. Now the farm cannot be registered until approved by the Parties either at the next conference in 1992, or through a postal vote. Without registration, the farm cannot export hides. In the meantime, the farm has run out of room for housing the increasing number of American crocodiles that are hatched each year from its captive propagation program.

2. Ranching

Since *Crocodylus acutus* is endangered in Honduras and is listed on CITES Appendix I, export of ranched hides is prohibited. Before ranching could be approved under the provisions of CITES Conference Resolutions 1.2 and 3.15, RENARE would have to demonstrate through surveys that the populations of *Crocodylus acutus* are sufficiently large to allow their transfer to Appendix II for ranching purposes. Alternatively, RENARE would have to seek an annual export quota for ranched hides under provision of CITES Conference Resolution 7.11. Nevertheless, the World Bank funded a study on ranching crocodiles in Honduras. The report, prepared by Elconsult De Centroamerica, P.O. Box 1944, Tegucigalpa, D.C., Honduras, is very poorly done. Despite receiving excellent advice from consultants (Woodward, Hines, and David 1988), the final three volume report is full of superfluous, plagerized material, and lacks data on the status of the wild populations. Yet the fact that the report was funded at a cost of more than U.S. $100,000 clearly demonstrates that governmental and intergovernmental agencies believe there are major economic gains to be made from the captive rearing of crocodilians.

RECOMMENDATIONS

The following recommendations reflect both the results of the 1989 survey and the goal of establishing a sustainable program for the maximum utilization of the Honduras caiman and crocodile resource. However, the recommendations are constrained by long-established practices in the international caiman hide trade.

Caiman crocodilus chiapasius - An annual hunt quota for caiman can be made more effective by combining it with a size limit that restricts the harvest to large males. If such a quota were too large it would not endanger the caiman population because only large males would be killed, not the breeding females or smaller breeding males. However, if the quota was so large that it could not be filled in Honduras, it could provide an avenue by which illegal caiman hides from other nations could enter international trade. Foreign hides could be smuggled into Honduras and then enter the trade when dealers claim the hides originated within Honduras. The CITES Secretariat has documented numerous instances in which illegal hides have been transshipped through other nations to provide them with legal export papers. Such 'laundering' of illegal hides has occurred through several Central American nations.

A large hunt quota combined with a size limit would hurt the local caiman population if the size limit were not rigorously enforced.

Whether or not either of these things could happen in Honduras, the following recommendations avoid the potential problems by proposing realistic but conservative export quotas for *Caiman crocodilus chiapasius*.

Crocodylus acutus - Whether for farming or ranching, it is natural that commercial programs for rearing crocodiles in captivity in Honduras look to wild populations as a source from which to acquire their stock. Since CITES prohibits the export of both Appendix I and Appendix II species if the export would be detrimental to the survival of the species, it would be improper for the government to allow the farms or ranches to destroy the resource through excessive collections from the wild population. Collection of all the eggs or hatchlings produced in the wild would be difficult if not impossible. Some would be missed and grow up to contribute to later generations. In the meantime, the breeding adults continue to produce more eggs and hatchlings each following year. By contrast, removal of very many breeding adults has a more immediate effect by depressing the reproductive potential of the wild population. To avoid that, many government sanctioned programs in Africa and North America only permit collection of wild eggs and hatchlings to stock farms and/or ranches. Capture of breeding adults is prohibited. In addition, some programs mandate that crocodile and alligator ranches return a percentage of their yearlings to the wild. Typically a majority of wild crocodiles are lost to predators during their first two years of life. Releasing crocodiles when they are one or two years old and no longer vulnerable to natural predators would replace the ones collected for the farm. Actually, the ranches are not always required to return the animals. As long as government operated monitoring programs indicate that the wild populations are stable or increasing, the ranches are allowed to keep all their yearlings. However, the farm yearlings are available for restocking in the event the monitoring indicates a decrease in the wild populations. A second major loss occurs among subadult crocodiles 1-1.5 m in length, that are killed by large, mature territorial males, which is one reason why crocodile populations take so long to recover after being severely depleted.

As stated above, registration of the Honduras farms by CITES must await approval of the Parties at the 1992 CITES Conference or through a postal vote prior to then. Until that happens, American crocodile hides may not be exported under provisions of CITES Article VII 4. In addition, hides of ranched American crocodiles cannot be exported until the Parties to CITES approve a transfer of the Honduras populations to Appendix II or approve an annual export quota of ranched hides from Honduras.

However, while it was applying to CITES for a transfer of its crocodile populations or for an export quota, RENARE could allow farms to operate as open-cycle ranches by collecting wild eggs and hatchlings. From 18 to 36 months are required to rear hatchling American crocodiles to slaughter size, so crocodiles hatched from eggs collected this year will not be ready for export as hides before 1992. This interval is sufficiently long for RENARE to implement its caiman and crocodile conservation program and to apply for a transfer of its populations of *Crocodylus acutus* to Appendix II or for an annual export quota for ranched *Crocodylus acutus* hides under CITES Conference Resolution 7.11.

Finally, although *Crocodylus acutus* is a large crocodile, it generally is recognized as a relatively non-aggressive species. Nevertheless, should American crocodiles become abundant near areas regularly frequented by humans or livestock, local people will complain and call for the removal of such nuisance crocodiles. The presence of one or two nuisance crocodiles should not be used as justification for a widespread campaign to eliminate all crocodiles in an area. The individual animals causing the problem can be killed or captured for stocking farms. A number of countries have programs for the capture and/or killing of nuisance crocodiles when the wildlife authorities receive complaints.

Protected Populations - There should be one or more populations of *Caiman crocodilus chiapasius* and *Crocodylus acutus* in Honduras which are not subject to hunting, where the species can be studied and the populations monitored. This would provide a base against which to measure the status of the populations from which eggs are collected. One of the protected populations could be the caimans and crocodiles living in the nuclear zone of the Río Platano Biosphere Reserve, which includes Laguna Ibans and the Río Platano. Unfortunately, RENARE has been unable to provide the staff needed to protect the reserve adequately. By contrast, the Embalse El Cajon population of American crocodiles enjoys de facto protection because access to the reservoir is restricted.

To manage the Honduras populations of *Caiman crocodilus chiapasius* and *Crocodylus acutus* for maximum sustainable utilization, RENARE should:

1) establish an annual census program to monitor the status of the wild populations of *Caiman crocodilus chiapasius* and *Crocodylus acutus* in Honduras;
2) prohibit the commercial hunting of *Caiman crocodilus chiapasius* except under license from RENARE;
3) establish an annual hunting and export quota of 10,000 *Caiman crocodilus chiapasius*;
4) prohibit the capture or killing of all wild *Crocodylus acutus* adults and subadults, except for the removal of nuisance crocodiles under permit from RENARE;

5) prohibit the collection of all wild *Crocodylus acutus* eggs and juveniles for stocking farms and ranches except under permit from RENARE;
6) prohibit the operation of crocodile farms and ranches except under license from RENARE;
7) prohibit all buying and exporting of crocodilian hides except under license from RENARE;
8) require as a condition of the caiman hunting license:
   a) that the licensed commercial hunter only kill caimans more than 1.6 m in total length, which will yield full belly hides 1.6 m total length or longer or flanks 85 cm total length or longer,
   b) that no more than 10% of the caiman hides may be under the size limit to allow for the occasional slightly undersized animal the licensed hunter might kill by mistake,
   c) that the licensed caiman hunter tag all *Caiman crocodilus chiapasius* hides at the time the caiman is killed with locking serially-numbered tags supplied by RENARE in compliance with CITES Conference Resolution 5.16, and
   d) that the commercial hunting of caiman is prohibited during the nesting season from 1 June to 1 October;
9) require as a condition of the nuisance crocodile capture/hunting permit:
   a) that the trappers demonstrate competence in the live capture, handling, and transport of American crocodiles,
   b) that no crocodile may be captured or killed unless the hunter has received a written instruction from RENARE based upon a complaint of a specific nuisance crocodile that poses a threat to local people or their livestock, and
   c) that the trapper must attempt to capture alive the specific crocodile causing the nuisance complaint, and no other crocodile, for transport and sale to a licensed crocodile farm,
   d) that if the trapper is unable to capture the specific crocodile causing the nuisance complaint, he may kill it, and
   e) that, immediately upon its being captured or killed, the live crocodile or its hide must be tagged in the tip of the tail with a locking serially-numbered tag supplied by RENARE in compliance with CITES Conference Resolution 5.16;
10) require as a condition of the crocodile egg and juvenile collection permit:
   a) that the collectors demonstrate competence in the collection, handling, and transportation of live eggs and juvenile crocodiles,
   b) that no eggs and juveniles be captured unless the collector has received a written requisition from a licensed crocodile farm or ranch (this will discourage collection of eggs and juveniles when there is no buyer), and
   c) that no eggs or juveniles may be collected in areas where the annual census program indicates the population is declining in numbers;
11) require as a condition of the crocodile farm and ranch license:
   a) that the operators demonstrate competence in the handling of crocodiles, proper husbandry techniques, including understanding the basics of crocodile behavior, egg incubation, nutrition, and sanitation,
   b) that the operators have proper incubation, rearing, and breeding facilities, and an ample supply of food for the numbers of crocodiles on hand,
   c) that 10% of the farm's yearling crocodiles be available for restocking depleted populations if requested by RENARE,
   d) that licensed crocodile farm and ranch operators maintain complete records of the crocodiles captured from the wild, including adults, young, and hatchlings, the number of eggs collected from the wild, the number of nests built and the number of eggs laid in captivity, the number of eggs that hatch, the number of crocodiles that die from disease or injury, and the number that are killed for hides or meat,

e) that, after May 1990, licensed crocodile farms and ranches may acquire eggs of wild crocodiles only from the holder of a valid egg and hatchling collection permit issued by RENARE,

f) that, after May 1990, no licensed crocodile farms may acquire adult or subadult crocodiles from the wild, except for nuisance crocodiles captured by a permitted nuisance crocodile trapper on instruction from RENARE, and

g) that licensed crocodile farms tag all *Crocodylus acutus* hides produced on the farm or ranch with locking serially-numbered tags supplied by RENARE in compliance with CITES Conference Resolution 5.16;

12) require as a condition of the hide buyer/exporter license:

a) that no *Caiman crocodilus* hides may be purchased if more than 10% of the belly hides are less than 1.6 m in total length or if more than 10% of the flanks are less than 85 cm total length,

b) that no hides or meat from wild *Crocodylus acutus* may be purchased, except for nuisance crocodiles killed by a permitted nuisance crocodile trapper on instruction from RENARE,

c) that no *Caiman crocodilus chiapasius* or *Crocodylus acutus* hides may be purchased or exported unless they bear the locking serially-numbered tags supplied by RENARE in compliance with CITES Conference Resolution 5.16, and

d) that the buyer/exporter must explain to the hunters the biological basis of the size limit which will protect the breeding caimans and assure a future supply of hides;

13) establish Embalse El Cajon and the nuclear zone of the Río Platano Biosphere Reserve as inviolate sanctuaries for *Crocodylus acutus* and *Caiman crocodilus*, where the ecology of these species can be studied and the populations monitored;

14) rigorously enforce all these regulations;

15) apply to CITES, in time for the 1992 Conference of the Parties, for an annual export quota of ranched *Crocodylus acutus* hides, and

16) apply to CITES, in time for the Conference of the Parties that follows the 1992 meeting, for a transfer of the Honduras populations of *Crocodylus acutus* to Appendix II, if the data generated from the annual census program and the ranching and farming program indicate the populations are recovering.

If RENARE is unable to implement and enforce a program that addresses the concerns outlined in these management observations, then all collection and capturing of American crocodiles and their eggs should be prohibited without exception, and an annual hunting and export quota of 5,000 Central American caimans should be imposed.

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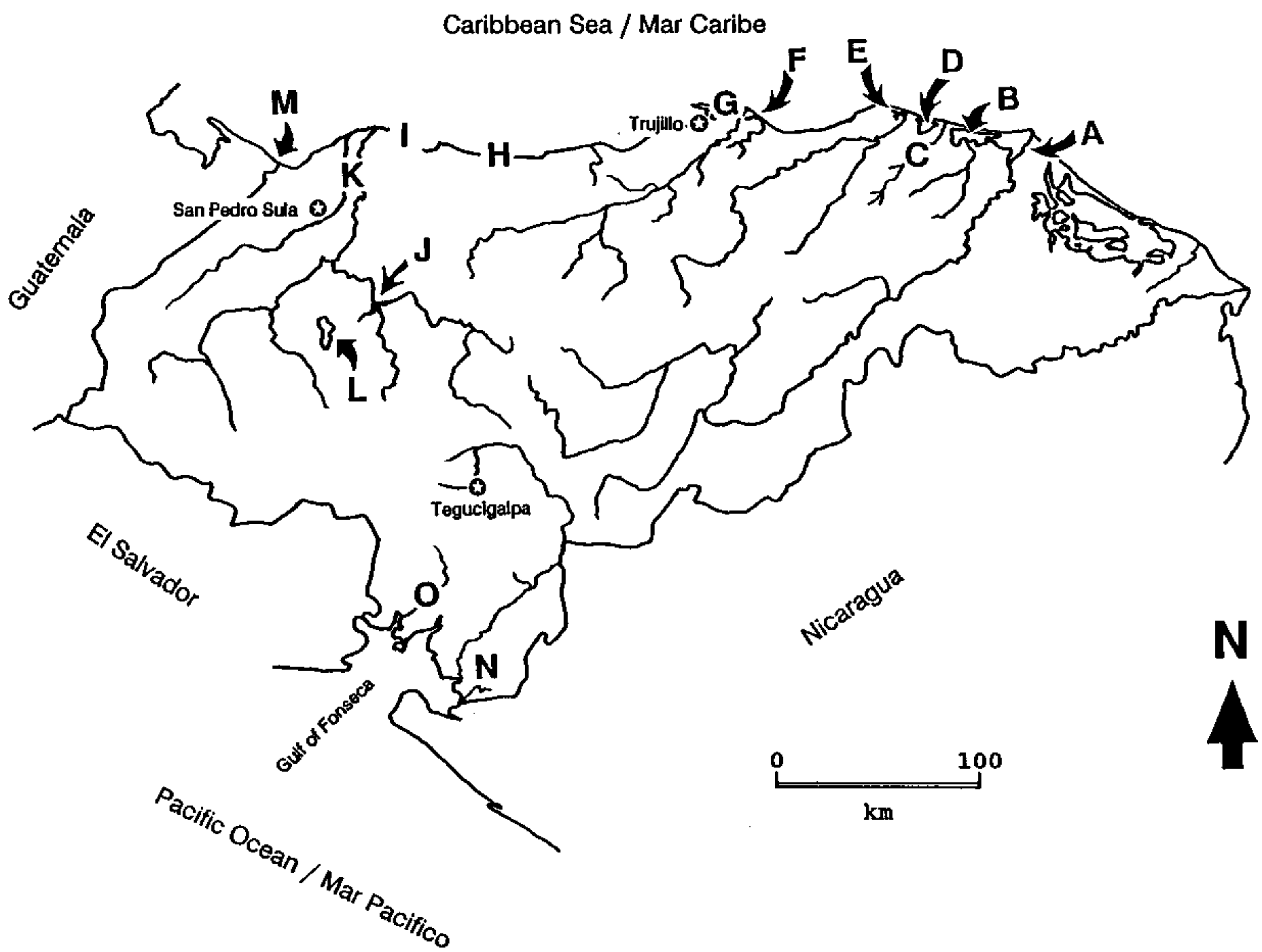


Figure 1. General location of survey sites: A, Río Patuca; B, Laguna de Brus; C, Río Plátano; D, Laguna de Ibans; E, Río Sico and Laguna Bacalar; F, Río Aguán and Río Chapagua; G, Laguna Guaimoreto; H, Río Salado and Río Cuero; I, Laguna de los Micos; J, Embalse El Cajon; K, Río Ulua and Río Chamelecón; L, Lago de Yojoa; M, Río Motagua; N, Río Negro and Río Choluteca; O, Río Nacaome. See Figures 2 to 16 for detail maps.

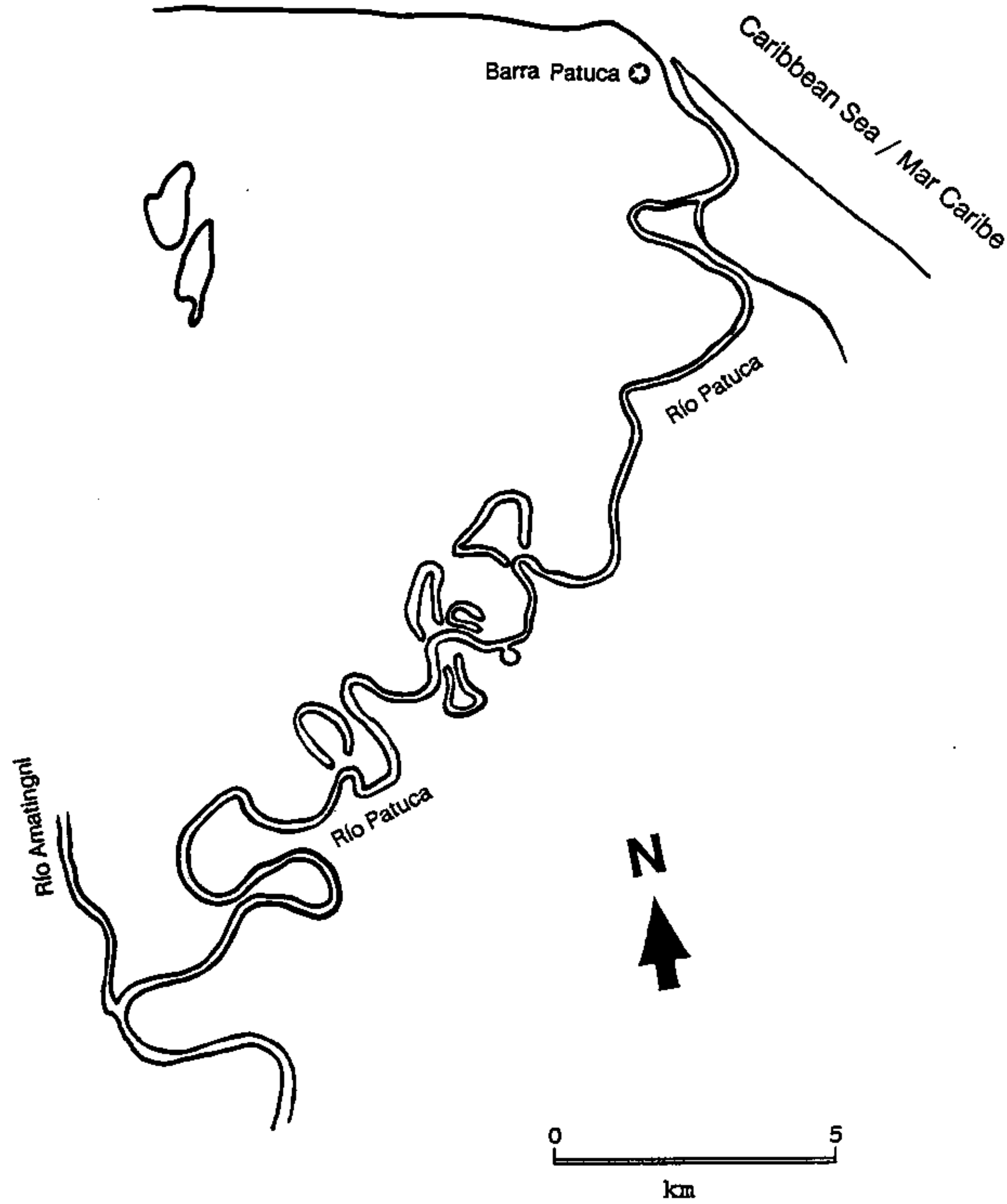


Figure 2. Río Patuca.

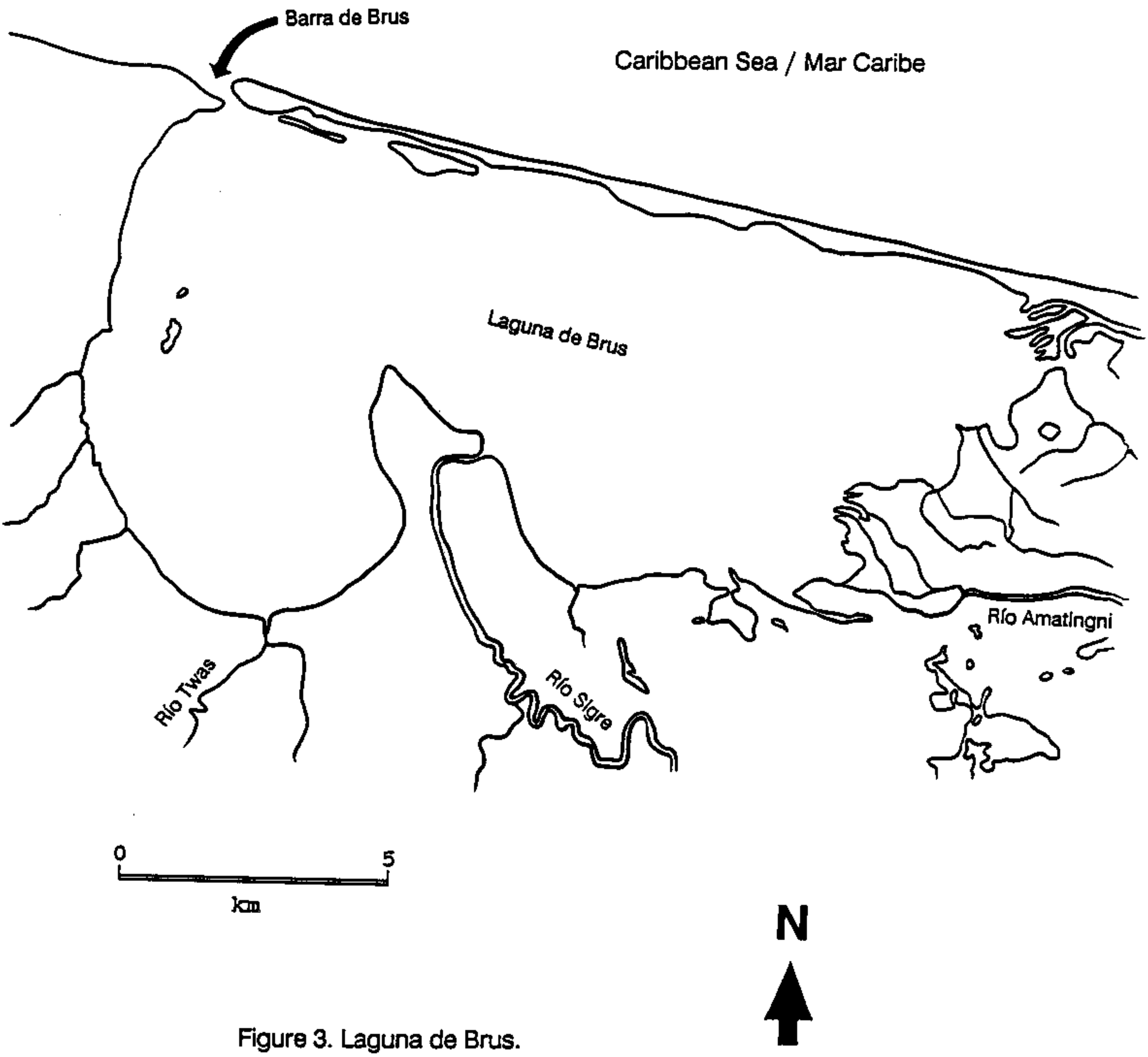


Figure 3. Laguna de Brus.

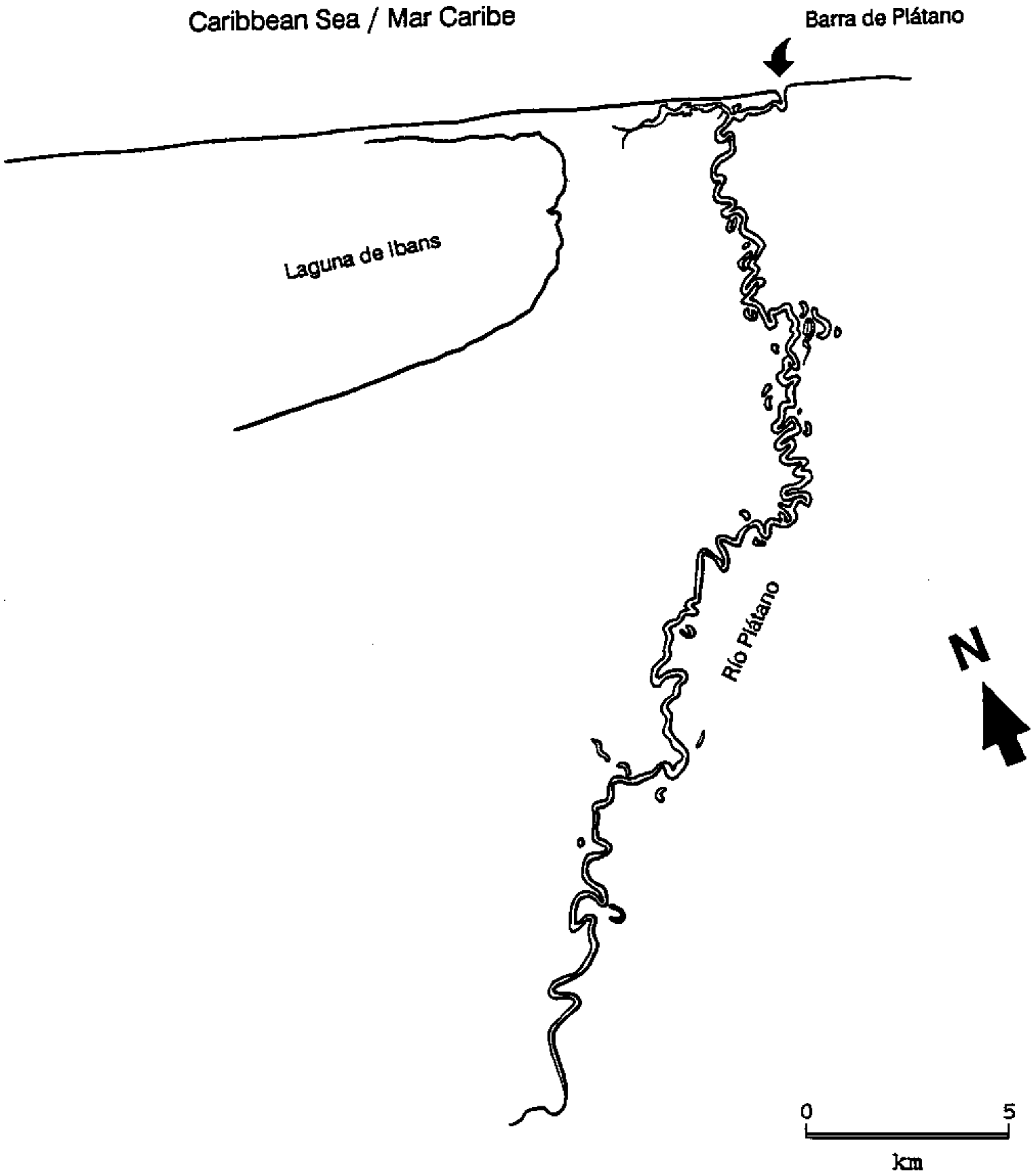


Figure 4. Río Plátano.

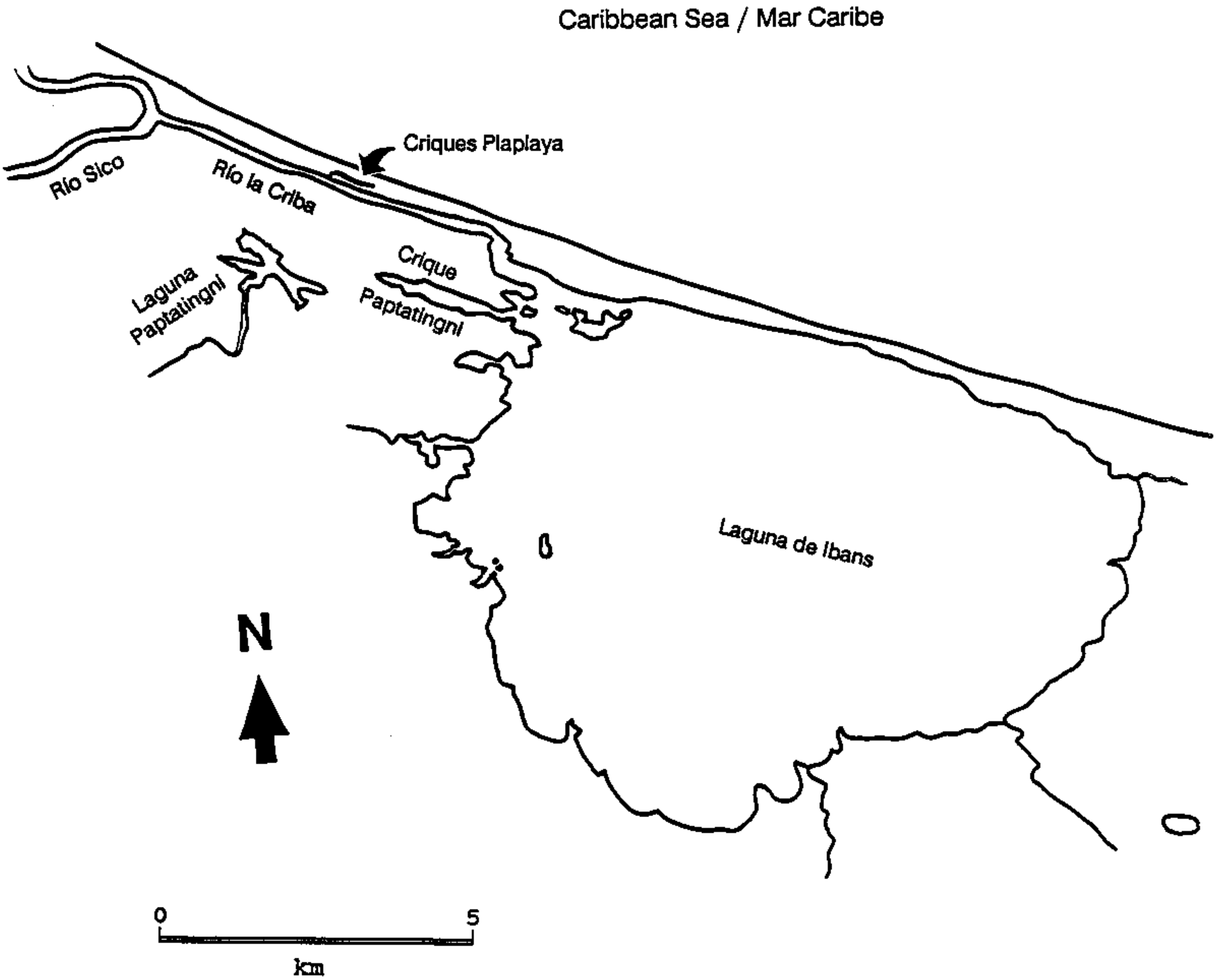


Figure 5. Laguna de Ibans, including Río La Criba, Crique Paptatingni, and Criques Plaplaya.

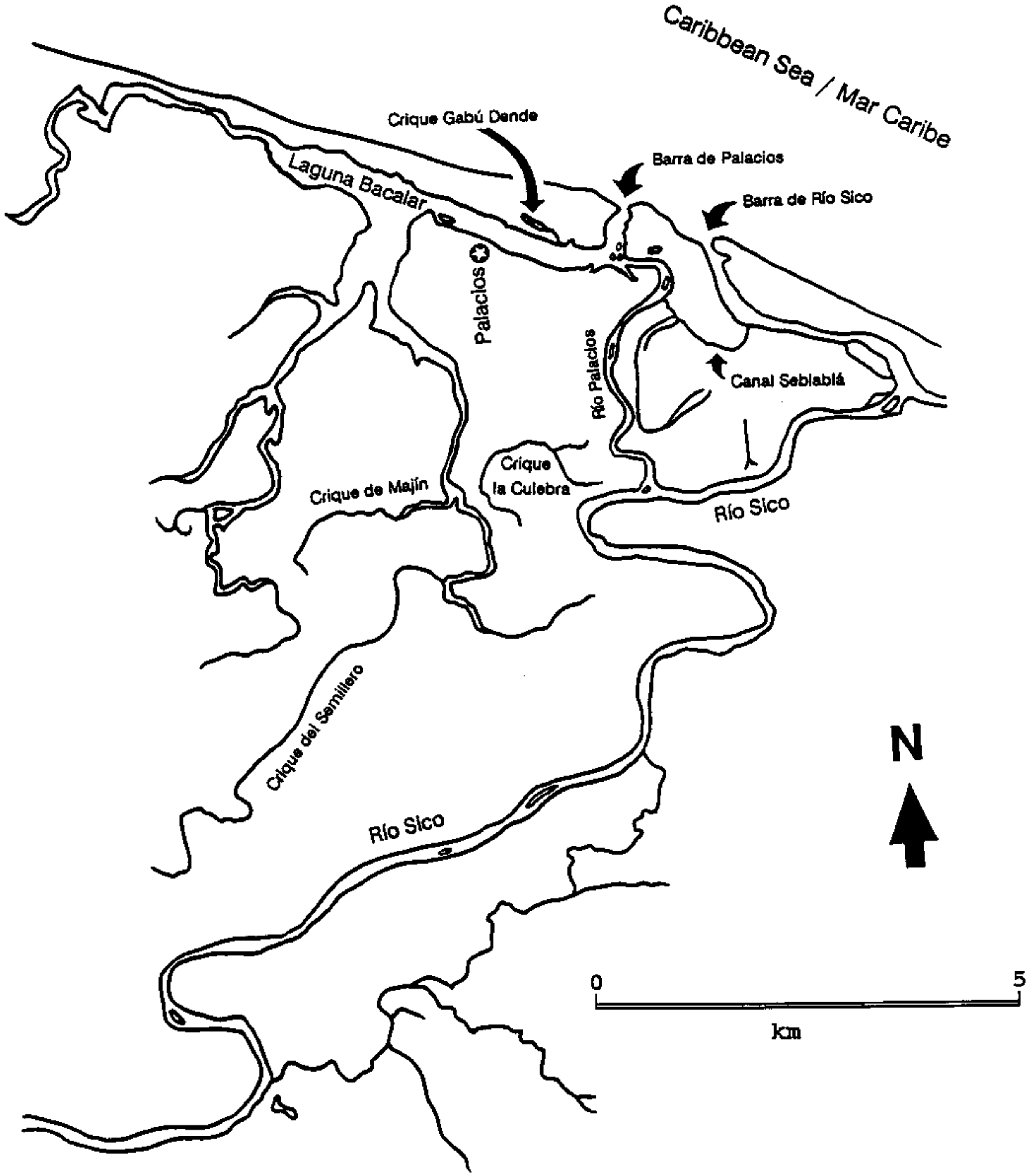


Figure 6. Río Sico and Laguna Bacalar, including Crique Gabú Dende and Crique la Culebra.

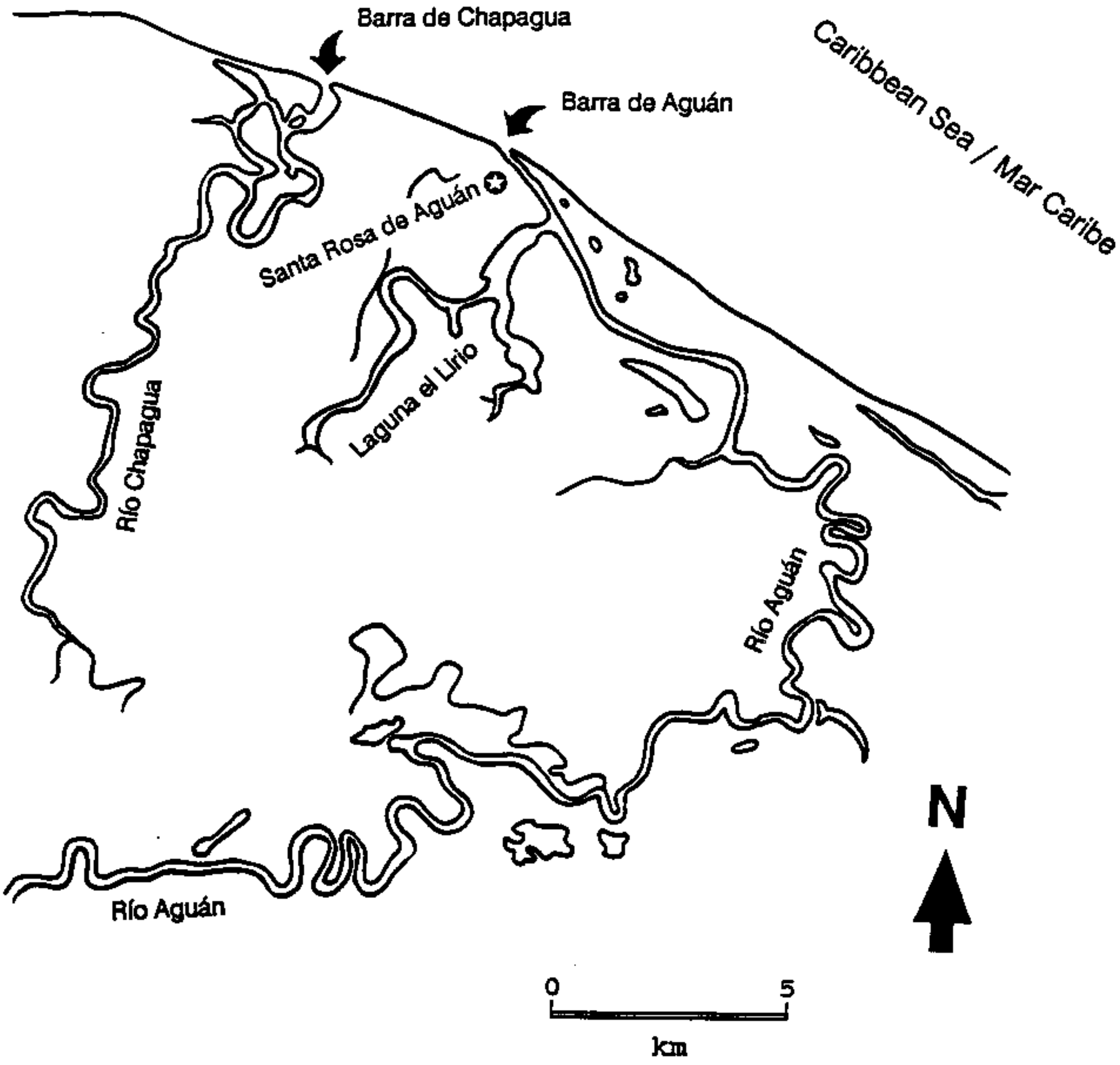


Figure 7. Río Aguán and Río Chapagua, including Laguna el Lirio.

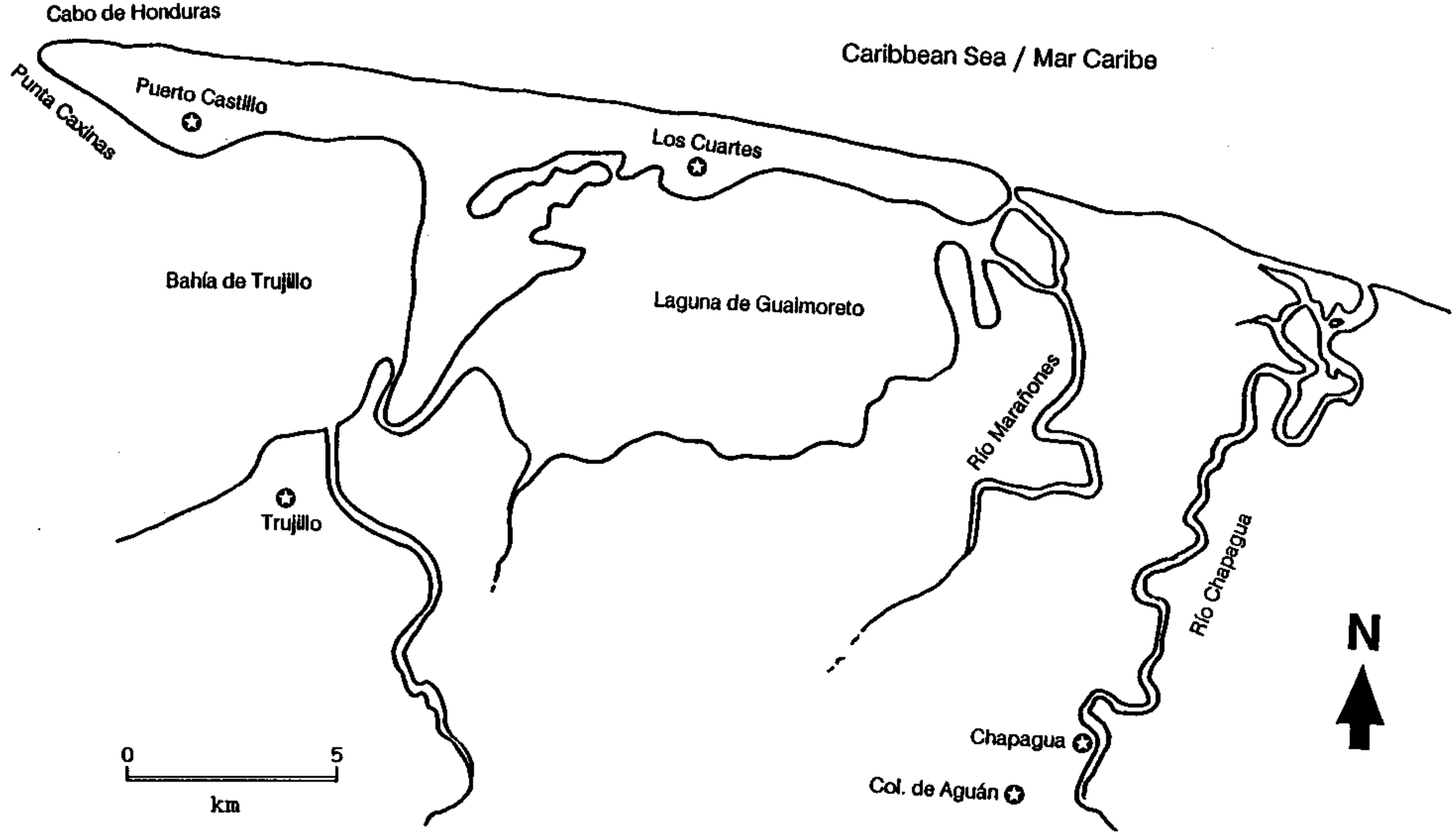


Figure 8. Laguna de Guaimoreto.

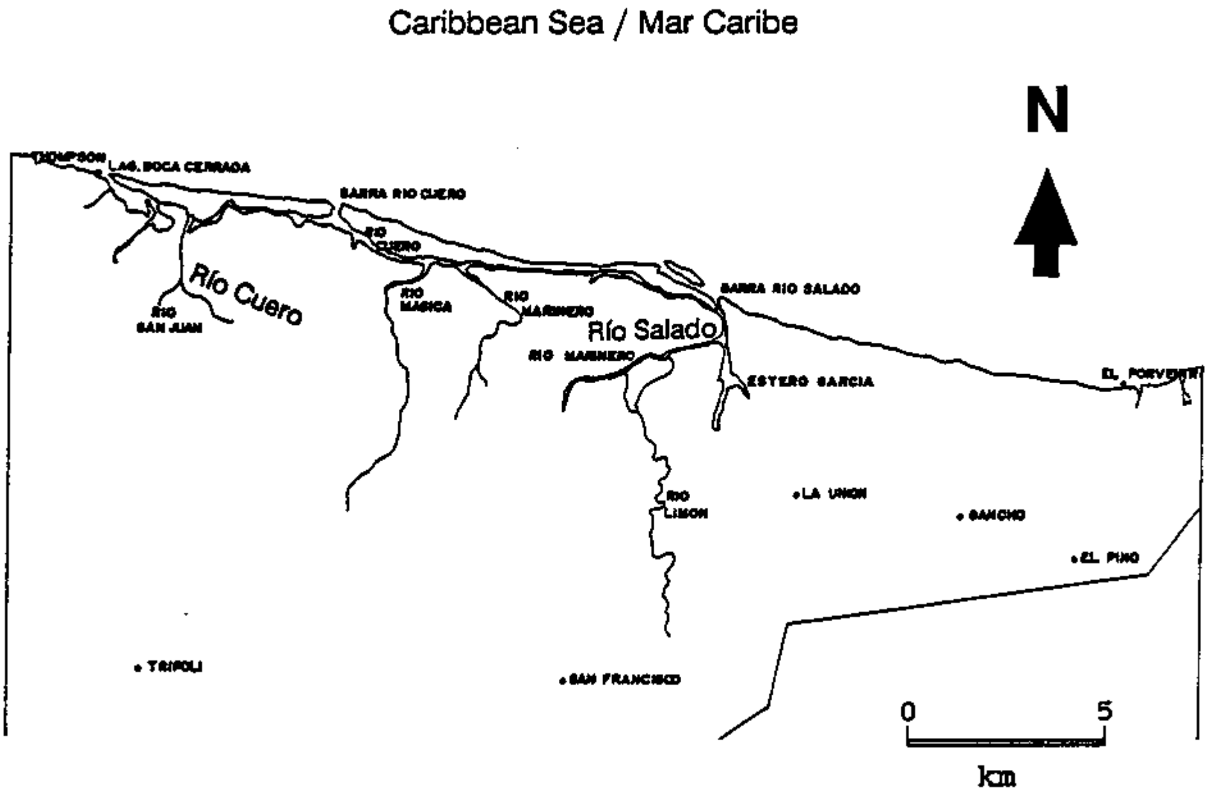


Figure 9. Río Salado and Río Cuero.

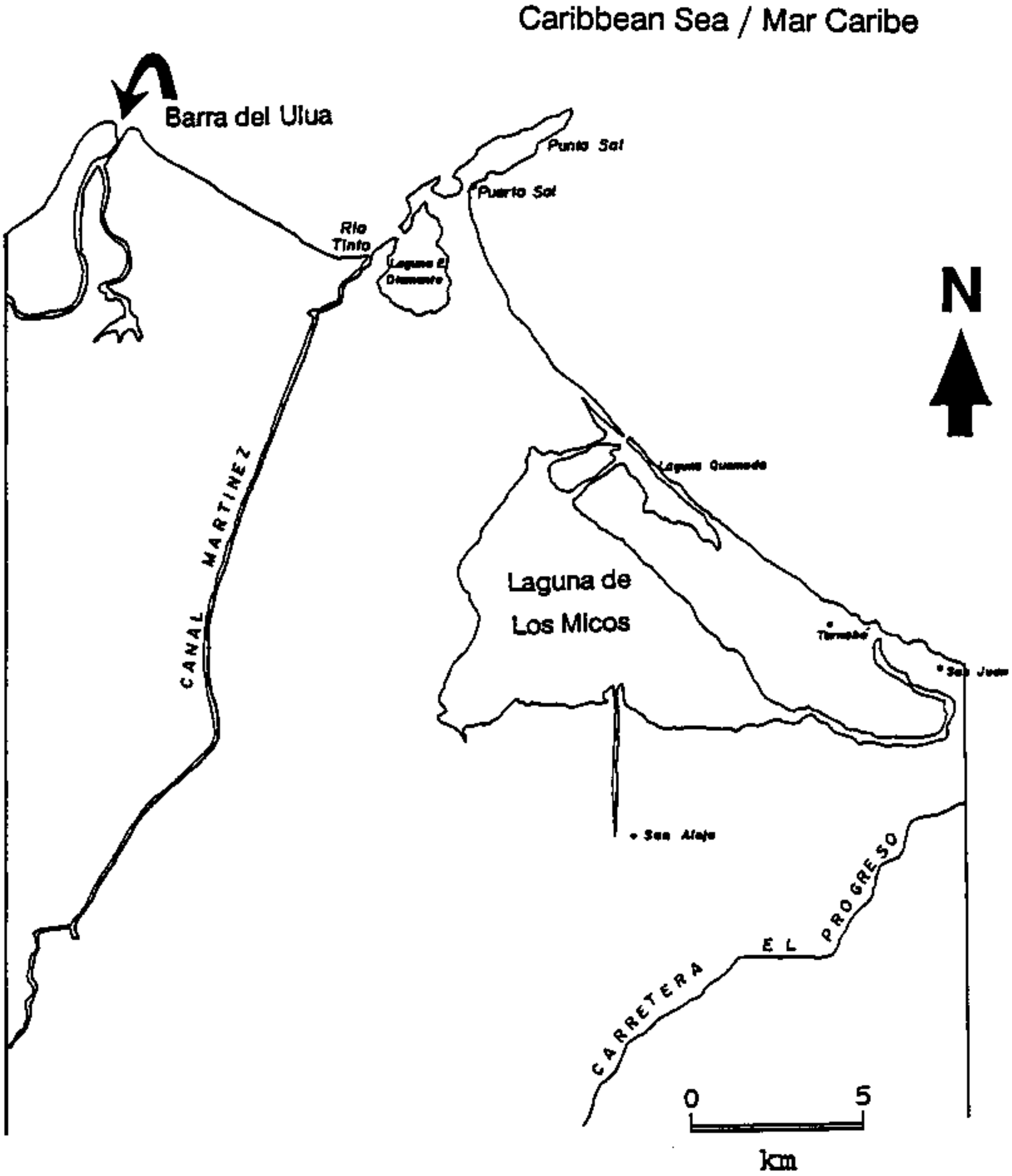


Figure 10. Laguna de los Micos.

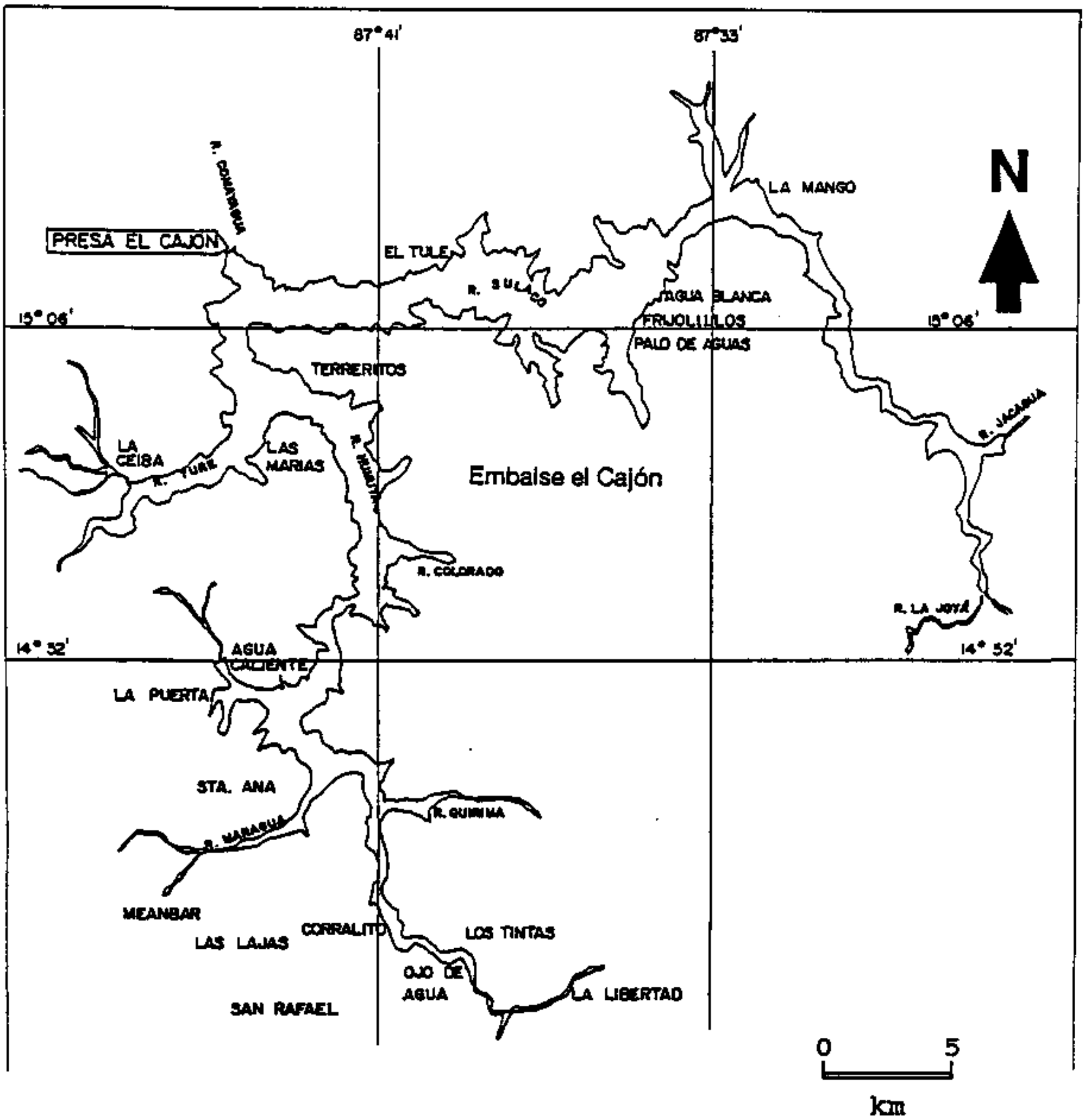


Figure 11. Embalse El Cajon.

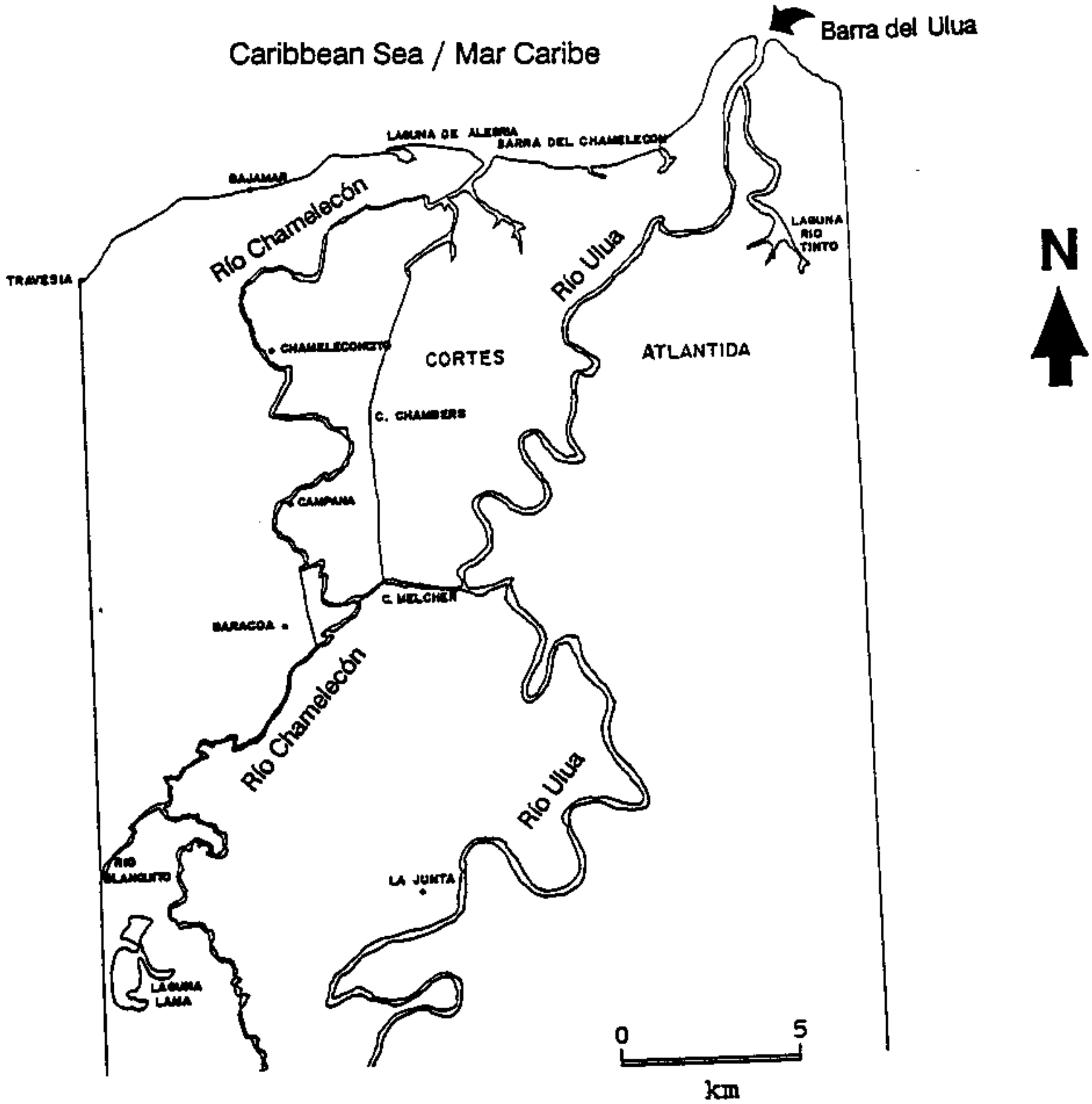


Figure 12. Río Ulua and Río Chamelecón.

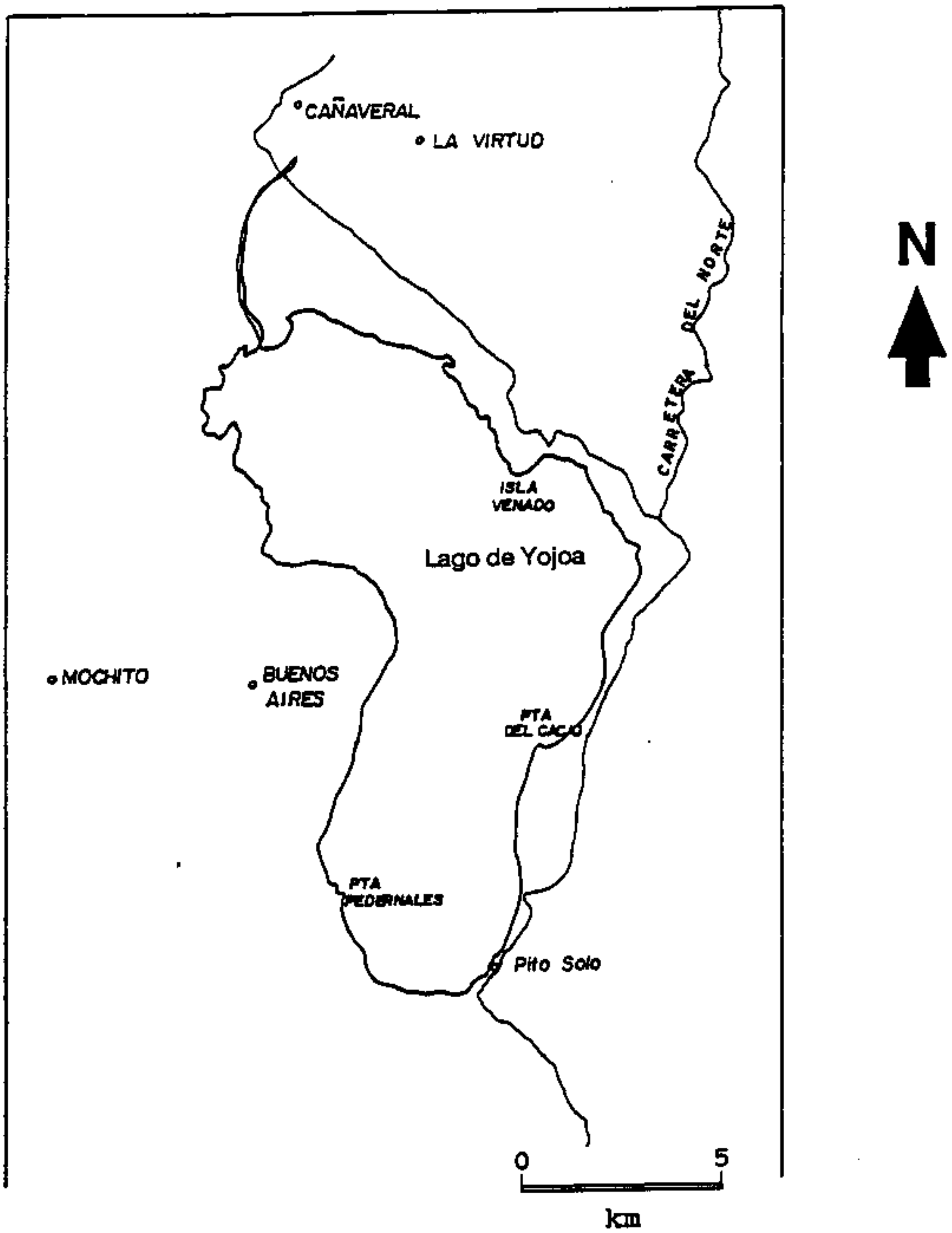


Figure 13. Lago de Yojoa.

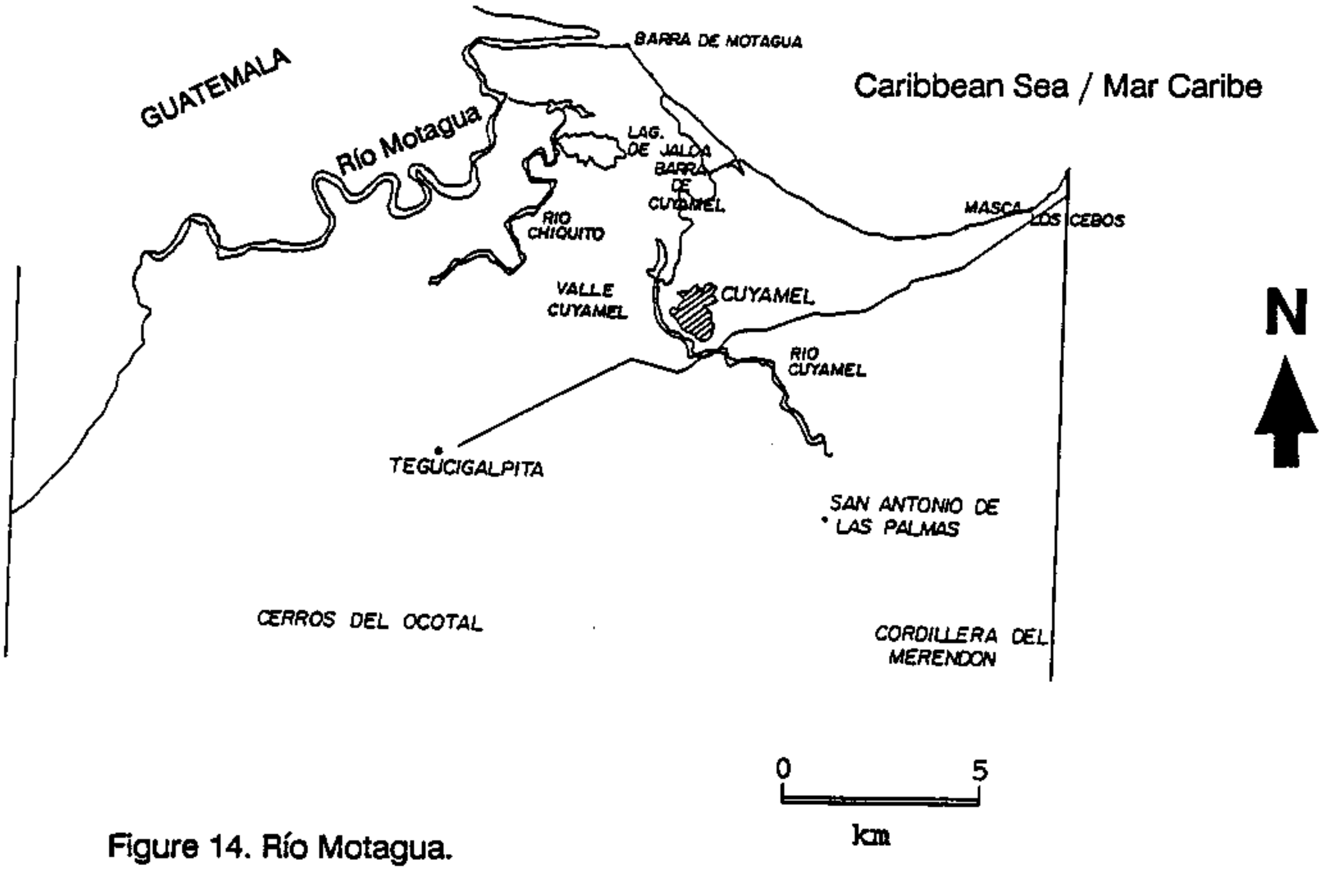


Figure 14. Río Motagua.

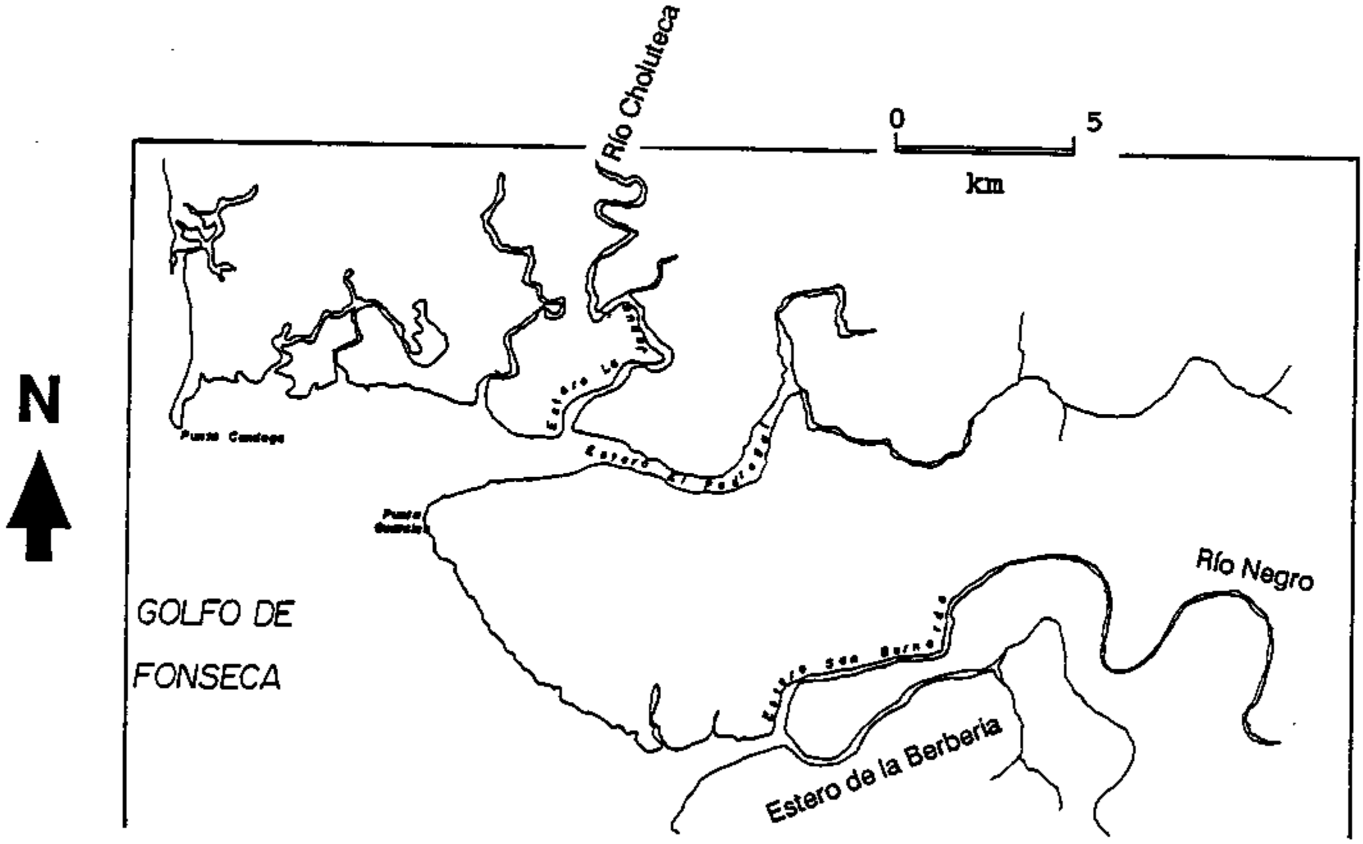


Figure 15. Río Negro and Río Choluteca, including Estero La Berberia.

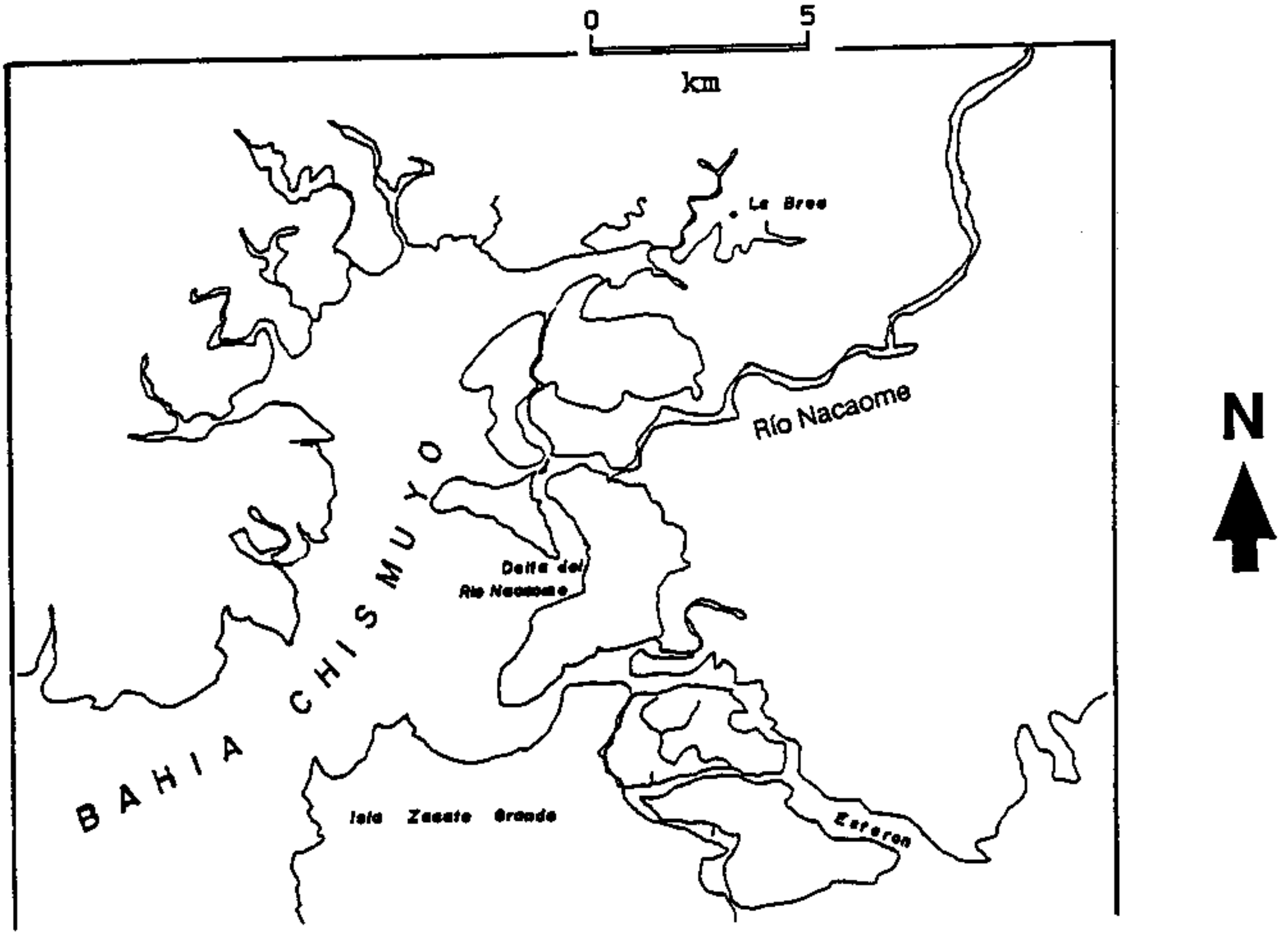


Figure 16. Río Nacaome.

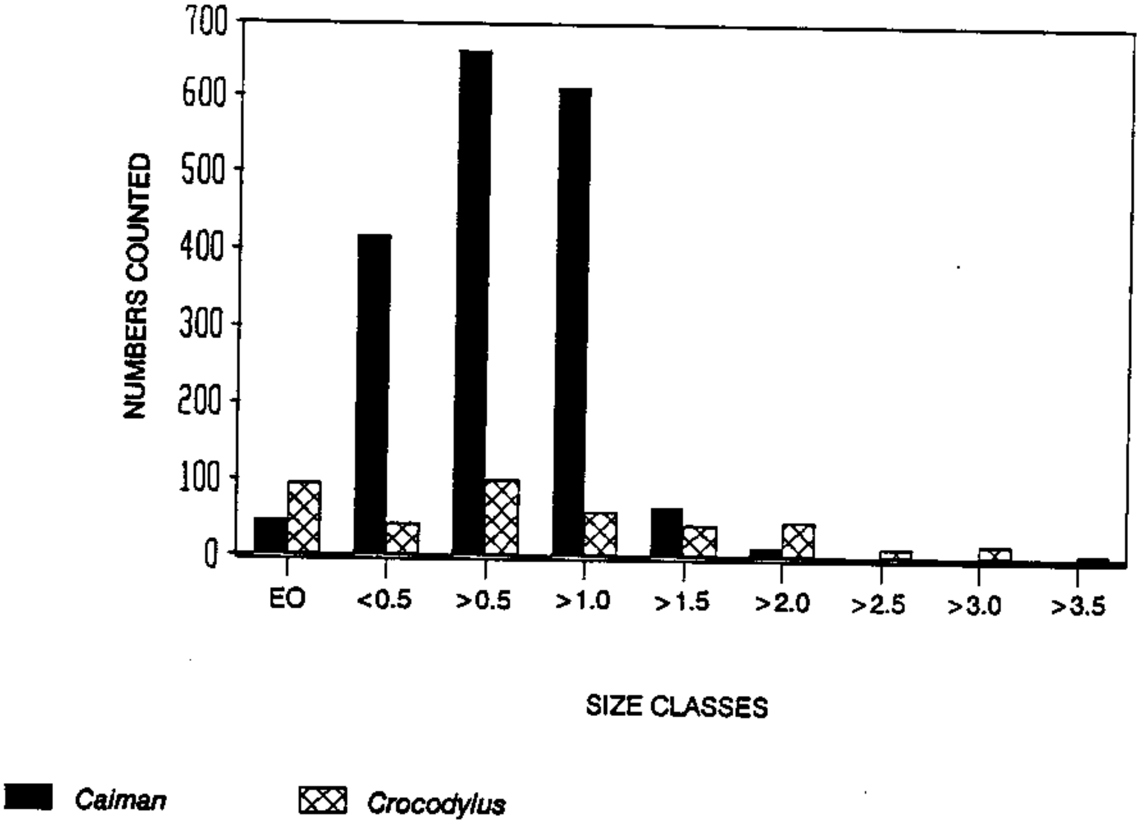
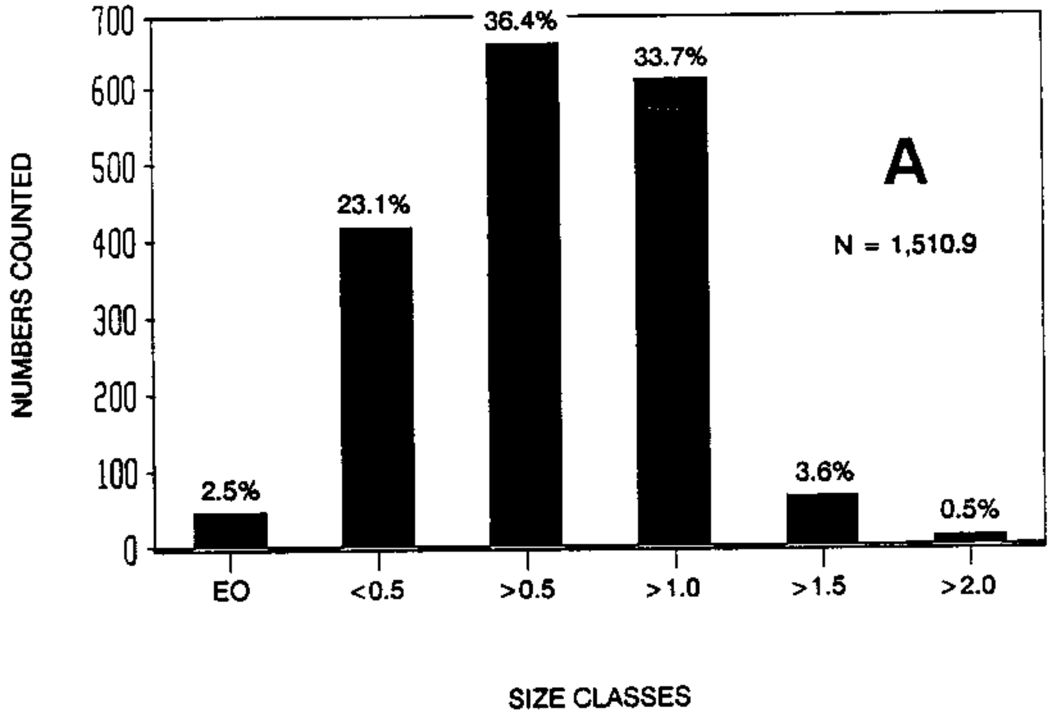


Figure 17. Total numbers of *Crocodylus acutus* and *Caiman crocodilus chiapasius* counted in each size class (meters). EO (= eyes only) are those animals which were sighted but could not be approached close enough to estimate their sizes.



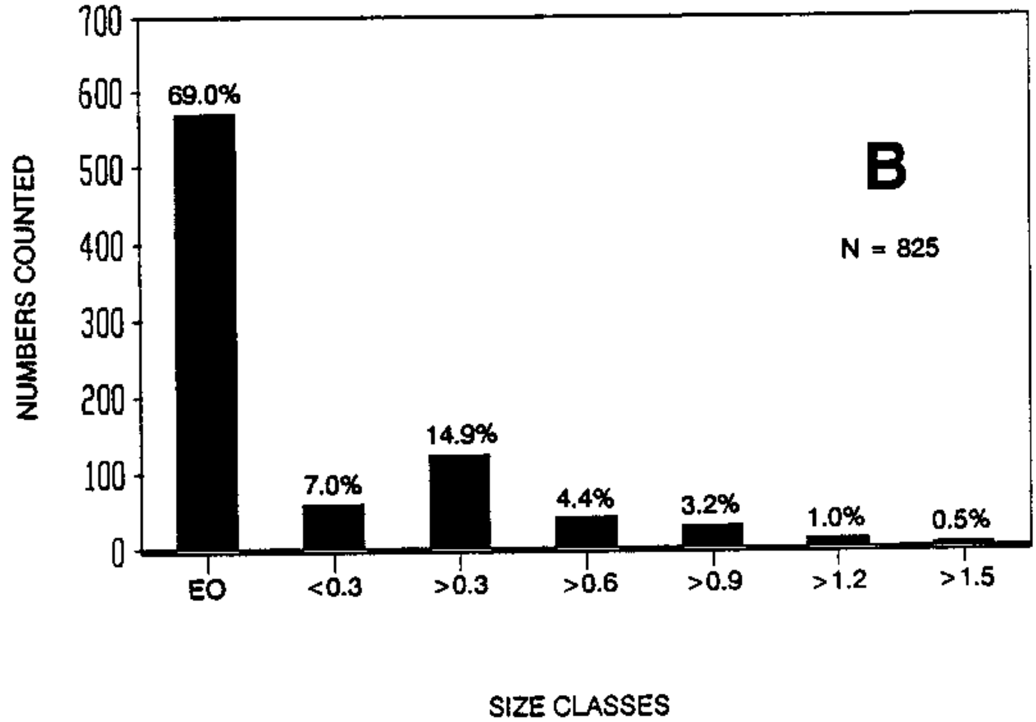


Figure 18. Total numbers of *Caiman crocodilus chiapasius* counted in each size class (meters) and percentage of total each size class represents. A. 1989 survey. B. 1977 survey (adapted from Klein 1977).

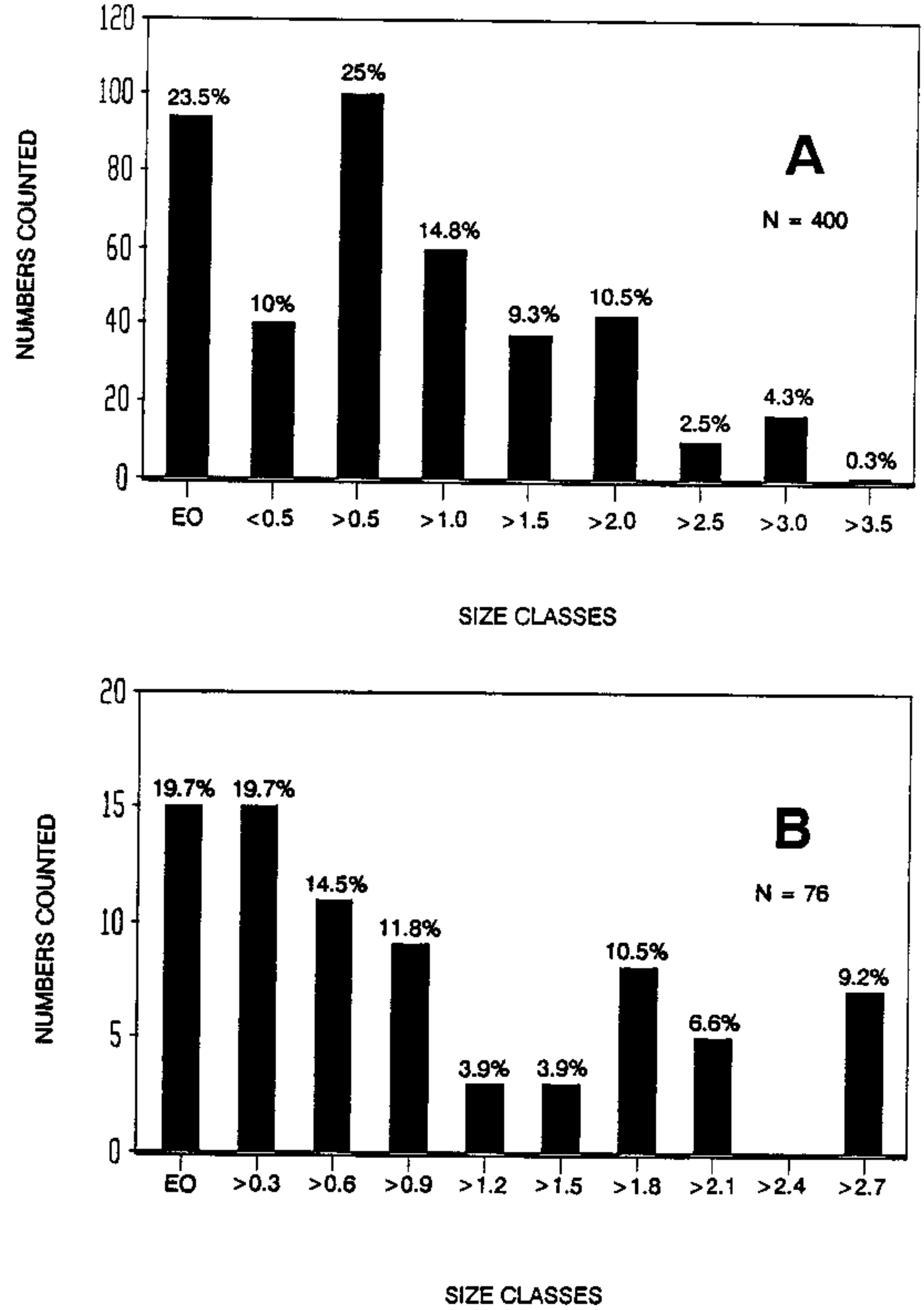


Figure 19. Total numbers of *Crocodylus acutus* counted in each size class (meters) and percentage of total each size class represents. A. 1989 survey. B. 1977 survey (adapted from Klein 1977).

Appendix A. Standardized Census Forms

Survey Location: Date:

Area Surveyed:

Time Start: Time Finish:

Personnel:

Habitat Type:

General Habitat Description:

C° air: C° water:

Wind: Cloud Cover:

Moon Phase: Precipitation:

Water Salinity: Water Clarity:

Water Level: Tide Phase:

CENSUS DATA

Survey Section:

Size-Class (cm TL)

	EO	<0.5	>0.5	>1.0	>1.5	>2.0	>2.5	>3.0
Species A								
Species B								

Survey Section:

Size-Class (cm TL)

	EO	<0.5	>0.5	>1.0	>1.5	>2.0	>2.5	>3.0
Species A								
Species B								

Survey Section:

Size-Class (cm TL)

	EO	<0.5	>0.5	>1.0	>1.5	>2.0	>2.5	>3.0
Species A								
Species B								

Survey Section:

Size-Class (cm TL)

EO	<0.5	>0.5	>1.0	>1.5	>2.0	>2.5	>3.0
Species A							
Species B							

Survey Section:

Size-Class (cm TL)

EO	<0.5	>0.5	>1.0	>1.5	>2.0	>2.5	>3.0
Species A							
Species B							

Survey Section:

Size-Class (cm TL)

EO	<0.5	>0.5	>1.0	>1.5	>2.0	>2.5	>3.0
Species A							
Species B							

Survey Section:

Size-Class (cm TL)

EO	<0.5	>0.5	>1.0	>1.5	>2.0	>2.5	>3.0
Species A							
Species B							

Survey Section:

Size-Class (cm TL)

EO	<0.5	>0.5	>1.0	>1.5	>2.0	>2.5	>3.0
Species A							
Species B							