

New York City is also the nation's financial center, the center for the fabrication and distribution of crocodilian products, and the home of many fashion designers, advertising agencies, and fashion magazines. The effect was dramatic, and crocodilian products all but disappeared from the nation's boutiques and shops. Highly specialized reptile tanneries perished, while fabricators turned to other materials. The U.S. had been importing and exporting exotic hides and products to many countries. Japan, for example, depended on the U.S. for 16.3 percent of its crocodilian products in 1970. This figure had fallen to zero percent by 1978 (Duplaix, 1979).

French, German, Italian, and Spanish markets continued uninterrupted, although not without feeling the loss of the U.S. industry. France alone emerged as the world's leading producer of quality crocodilian leather, and by 1981 accounted for 96 percent of the traffic in endangered crocodilian species (TRAFFIC [USA], 1982b).

Under the protection of independent governments, and international agreement, some species began to recover. Others, such as the black caiman (Melanosuchus niger), remain at the brink of extinction and continue to be exploited after years of nearly total protection. In contrast, the American alligator (A. mississippiensis), under total effective protection for almost ten years, recovered remarkably. The species was to become the vehicle for the United States' re-entry into the world crocodilian products market.

In order to achieve the goal of re-vitalizing the U.S. crocodilian trade industry with the American alligator as its basis, Federal and state regulations had to be changed to allow the transport, fabrication, and sale of what was touted as the "uniquely American product." The American consumer also had to be "re-educated" after years of indoctrination that crocodilians were endangered and commerce was bad for animals. Proponents for utilization were told that the world was hungry for the finest of all crocodilian leathers. In a period of economic depression, leather merchants, tanners, and fabricators in New York and around the nation pressed legislators for the necessary regulatory changes. In New York City, the repeal of the ban on trade in crocodilian leather was heralded with the announcement that 13 new fabricating factories would provide 1000 new jobs for the unemployed (Mathews, 1980). Concerns that the re-introduction of the American alligator into the market, estimated to be between 10,000 and 20,000 hides a year, would stimulate further utilization of other endangered species, were put aside as unfounded (Ashley, 1980).

A major stumbling block to the millions of dollars which could be infused into the U.S. economy was the fact that conservationists had saved the alligator and protected the crocodilians of the world, but had killed the U.S. industry. Only three U.S. tanneries had survived the lean years. European crocodilian product experts advised that these tanneries could neither process the annual volume nor produce a quality

product that could compete on the world market with European tanners. Representatives of the leading French tanners appeared to have had the solution. U.S. alligator hunters and farmers would realize the maximum prices for their raw hides if the export of untanned American alligator skins were allowed (Ashley, pers. comm.).

The newly formed (1978) National Alligator Association, representing hunters, farmers, buyers, and dealers in hides and skins, initiated a campaign that was supported by the Louisiana State legislature to legalize alligator hide export. Funds to form a lobby to secure the export legislation were supplemented by \$3,000 in "seed money" and a promise of \$1.25 per skin purchased, as dues, from the leading French tanning company (Ashley, in litt.). On 12 October 1979, the Federal regulations were changed to allow the export of the raw untanned skins of the American alligator. The fate of the U.S. tanning industry, and ultimately the crocodilian products market, was practically sealed. U.S. tanners would never be capable of competing with the larger foreign companies, already geared for large volume production. Nor would there be any foreign incentive to infuse expertise or technology into the U.S. industry or utilize U.S. labor. Proposals to limit alligator exports to those countries that had signed the CITES agreement or had not taken exception to the ban on utilizing endangered species were not enacted. To do so would have precluded the export of skins to countries that were to provide the greatest market, including France.

The 1979 harvest of 15,000 American alligator hides from Louisiana was the first to be exported (T. Joanen, pers. comm.). A major fashion promotion was launched, aimed at the U.S. consumer and directed at the 1980-1981 fashion season. Similar European promotions were also underway. U.S. fashion magazines declared "alligators are back," "crocodile look is in," and alligator leather was the fashion of the season. The title "alligator" was indiscriminately placed on products made from the hides of caiman and black caiman.

The effect on the utilization of other species of crocodilians is difficult to determine. However, excluding the hides of American alligator, U.S. imports of crocodilian hides and products rose from 10,303 pieces in December of 1979, to 44,790 between July and September of 1980, and to 60,601 pieces in January to March of 1981 (TRAFFIC [USA], 1982c). Shipments of reptile imports through the Port of New York, including all crocodilian hides and products rose from 236 shipments in March of 1980 to 416 in November 1980, 619 in June 1981, and 998 in October of 1981 (D. Mack, TRAFFIC [USA], pers. comm.). Examinations by the U.S. Fish and Wildlife Service showed significant inclusions of Grocodylus niloticus, Melanosuchus niger, Caiman latirostris, and Caiman c. yacare. Surprisingly, handbags fabricated from the hornback of Tomistoma schlegelli and Grocodylus johnsoni were also represented.

In 1981, 29,598 raw alligator hides were exported from the U.S., primarily to France and Italy. Hunters received an average of \$119 per

skin (T. Joanen, pers. comm.). The skins averaged 2 m in length and 56 cm in belly width. These hides were exported at a declared value of \$157.45 per hide and were composed of 1980 and 1981 harvests. In 1981, 13,744 hides were imported into the United States from France and Italy in nearly equal numbers (N. Roeper, TRAFFIC [USA], pers. comm.). These hides, now tanned and finished, were declared to be valued at an average of \$131.53 per skin. Presuming these comprised the 1979 harvests, averaging \$97.50 paid to the hunter and experiencing the same dealer/exporter mark-up of an average of \$38.45, then the value of these skins should have been at least \$135.95, had they still been raw skins. Tanned and finished, these appear to be valued at \$4.42 per skin less than their value in their raw state. United States' fabricators did not benefit from such savings and paid approximately \$16.00 per belly inch. Based on an average 2 m long hide with a belly width of about 56 cm, the average hide cost fabricators \$352. Manufacturing, wholesaling, and distribution costs may double prices at each change of hands. Finally, at the retail level, the product is offered to the consumer at an additional one to three-fold mark-up. A ladies' purse or handbag, depending on the reputation of the manufacturer, the quality of the fittings and linings, and the selection of portions of hides used, commands prices ranging from \$1100 to \$4000. A pair of men's shoes could cost \$500 to \$900, and a billfold \$150 to \$250. Prices for crocodile products closely parallel those for American alligator.

Designers and merchandisers reported that for any fashion to be successful the product should have a three level market appeal. The top of the line should be superbly made goods of high quality, commanding high prices, and appealing to the affluent trend-setting consumer. The second tier would be a good quality line of goods with appeal to the consumer of taste, willing to spend a moderate sum. The third tier would be composed of a line of products of poor to fair quality, cheaply manufactured at a low price, with appeal to the general public with modest means. The lattermost category had historically been filled by cheap products made from the flanks of Caiman crocodilus. But in the shadow of the "alligator look" caiman hides and products were offered at nearly the same prices as alligator products to the retailers. A pair of men's shoes composed of pieced-together caiman flanks carried price tags of from \$450 to \$550.

With the demand for the "crocodile look," there was an increase in the numbers of caiman shipments imported from Paraguay and Bolivia (U.S. Fish and Wildlife Service, pers. comm.). Irregularities in shipping documents, CITES permits, and difficulties identifying the hides and flanks of non-endangered species from those of Yacare caiman led the U.S. Fish and Wildlife Service to refuse to allow entry to those species from Bolivia and Paraguay in August 1981 (TRAFFIC [USA], 1982a). The ban continues, and precludes the U.S. industry from participating in a large part of the fabrication of products.

Many importers and fabricators, assured by their European suppliers that the hides and products shipped to them were "legal," lost hundreds

of thousands of dollars worth of hides and products seized on Endangered Species violations. In November 1981, the U.S. Lacey Act was amended and penalties increased to \$20,000 and five years in prison on felony charges for trade in violation of state or foreign laws. Defense fees, loss of business because of the inability to meet orders, and a sense of confusion led many to turn away from crocodilian products.

The American consumers played the most significant role. In the 60's and 70's, they had rallied to save species of wildlife they would never see, and had hardly heard of. The slaughter of whales brought international condemnation. The public spent millions of dollars, and many individuals risked arrest and prison to protect the environment from nuclear waste. These were also the people the industry expected to crave the killing of alligators in order to wear them on their feet and carry them as purses and key chains. The high cost of living had left the consumer with little money to spend on the luxury of a \$2000 purse. The industry appeared again to have miscalculated; the consumer was not buying.

In order to assess the current state of the crocodilian products markets and evaluate the prospects for the near future, more than 30 shops, boutiques, department stores, fabricators, fashion designers, and merchandisers were surveyed in July and August 1982 in New York State, New York City, and Washington, D.C. In all but one shop, crocodilian products were offered at some discount, but were not selling. A \$425 pair of caiman shoes might be discounted 10 to 15 percent, but further discounts generally were not possible because of the high prices paid by the retailer for the product. Alligator, crocodile, and caiman attache cases, discounted to \$1900, had remained on the shelves for over a year. All merchandisers reported low inventories that they wished they could dispose of, without the loss of investments. None indicated they intended to renew inventories of anything but the very minimum levels needed to remain competitive.

Of the three U.S. tanneries that survived the interruption to the hide industry, none experienced the benefits of a vital new market. One tannery was destroyed by fire in 1980, and a second is rumored to be contemplating discontinuing the tanning of crocodilian hides. The third continues to produce mediocre quality American alligator hides in small quantities. In New York City, no new factories were opened, and, in fact, several which were in operation at the start of the "alligator look" have closed. The prospect of increased job opportunities never materialized. Reptile hide and product imports through the Port of New York (imports of reptile products and hides through the Port of New York make up approximately 85 percent of the U.S. imports), including crocodilians, began to fall. In June 1982, 407 reptile shipments arrived, compared to 619 in June of 1981, and this figure remained at 402 for July-August 1982. These shipments were composed largely of snake and lizard skins and fabricated items (U.S. Fish and Wildlife Service, pers. comm.).

French supporters have also changed position, refusing to pay \$15,000 in dues to the National Alligator Association (D. Ashley, in litt.). Additionally they did not bid on hides harvested in Florida in 1981 (T. Joanen, pers. comm.). However, when compared to their American counterparts, it appears that foreign tanners have benefitted the most from the short life of the "alligator look."

A little more than a year ago, fashion magazines ran numerous advertisements for crocodilian products. Times have changed! Of 28 leather shoe advertisements featured in the July 1982 issue of Vogue magazine, the nation's leading fashion forecaster, only two promoted reptile leather--and snake skin at that! The fashion look for the 1983 season? It would be polished calfskin. The wane can be summarily attributed to several major factors: lack of consumer interest, high product cost limiting its appeal, the difficulties importers experience in complying with wildlife regulations, and perhaps most importantly, the international economic recession.

Crocodilian products will not disappear entirely from U.S. shops. But, the time for the "alligator look" is past. Perhaps in a few years fashion designers will again turn to quality reptile products for "that new and exciting look."

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PROBLEMS IN THE IDENTIFICATION OF COMMERCIAL CROCODILIAN
HIDES AND PRODUCTS, AND THE EFFECT ON LAW ENFORCEMENT

Peter Brazaitis

Department of Herpetology, New York Zoological Park

ABSTRACT: Most processed crocodilian hides and products enter the market devoid of identifying characteristics and traceable marks or tags. The ability of customs agents and wildlife inspectors to determine the presence of endangered species or confirm documentation is limited. The state of the art is discussed.

With the signing of the Convention on International Trade in Endangered Species (CITES) agreement in 1973, customs and wildlife agencies around the world were faced with the problem of identifying rare and endangered species, including crocodilians, from raw skins, processed hides, and a wide variety of manufactured products. Most of the available literature on the identification of reptile leather had been published by processing and tanning technicians, and dealt primarily with the problems of tanning, finishing, and tanning chemistry (Fuchs, 1974).

The commercial identification of crocodilian species had long been based on general characteristics which tended to lump hides of similar forms and quality together. These hides were given colloquial names to describe them. The names were often based on the common name in use in the region from which most of a particular type of skin came, or simply a shipping point. Terms such as "Singapore," "Java," or "Thailand small scale" all referred to Crocodylus porosus skins. The term "Tinga" meant any member of the genus Caiman, from anywhere in tropical America. Caiman latirostris could be referred to separately as "Overo," or any one of four other names. Additionally, local people often sold the skins of Crocodylus acutus, Crocodylus intermedius, and Crocodylus rhombifer as "Cayman."

The commercial sorting and subsequent marketing of tanned hides by broadly similar characteristics is not uncommon. Belly hides with "squiggle"-like scale patterns from the Orinoco River would be combined with all skins bearing the same patterns from different origins. The patterns are actually the trails of a parasitic nematode genus Paratrichosoma (Ashford and Muller, 1978), and are

found on the ventral scales of at least four species of crocodilians from completely different parts of the world. Combined, all may be marketed as "Orinoco Crocodile" (King and Brazaitis, 1971).

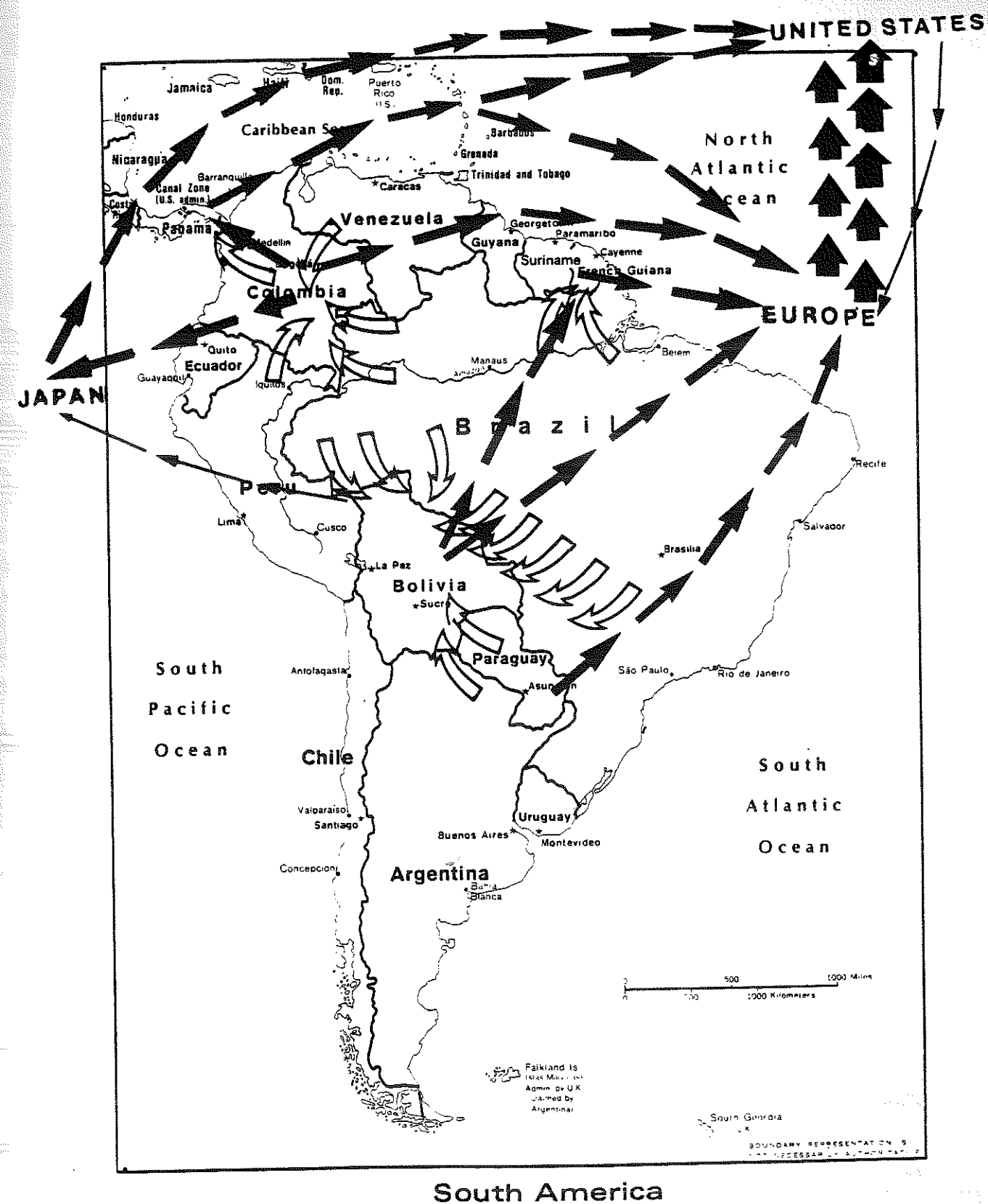
Raw skins are collected through a network of local hunters, foraging far into the field, with little regard for political boundaries. The possibility of encountering a wildlife officer is remote. It is usually at the place of export that collected skins are given a cursory examination, usually for the purpose of collecting duties rather than species identification. Even at this time, Tinga skins may only be represented by flank skins and tails. Skins from various collection sites may then be combined with other skins, of the same type but not necessarily the same species (Fig. 1). These are then processed together at the tannery, provided they require the same treatments. Final sorting for market is based on commercial type. All Tinga skins would be processed together. Other sorting categories would include belly width, dyed color, and grade. Grade I designates a perfect hide, free of holes and major blemishes; grade II with some small holes, and so on, depending on the degree of damage.

Hide documentation is a significant problem. Several hundred or thousand Tinga skins or flanks may be placed in a tanning container together, representing caiman skins from several countries, and more than one race. Once finished and sorted, they may be shipped with documents indicating the origin of a sample of those hides, but not necessarily the same hides shipped. As the skins were unmarked and are not traceable, the validity of the documentation cannot be substantiated. Tinga hides, invoiced as Caiman crocodilus with documentation indicating the country of origin as Paraguay, may be seized upon entry as an endangered species violation. Caiman c. yacare, a U.S. listed endangered species, is the only caiman endemic to Paraguay. Similar confounded documentation involving unmarked and non-traceable caiman skins from Bolivia has led the U.S. Fish and Wildlife Service to refuse entry to shipments from that country and Paraguay effective August 1981 until the problem can be resolved. On the other hand, C. crocodilus may be acceptable with Colombian documentation, although they may have been taken illegally in Brazil.

The wildlife or customs inspector has no way of corroborating the documentation of unmarked skins, and often cannot identify the species involved; nor can an importing fabricator of crocodilian products. Manuals for the identification of crocodilian hides and products pose differing views on speciation. Industry manuals tend to arbitrarily assign hide types to different distributions, without scientific foundation, or taxonomic review. The hides illustrated are often indistinguishable from each other (Fuchs, 1974). Such manuals are widely used and duplicated within the industry. Importers who may rely on these manuals and the taxa they describe

FIGURE 1. Trade routes for South American crocodilian skins.

Open arrows indicate direction of transportation from areas of origin to South American tanning centers or major points of export. Dark arrows indicate direction of shipment out of South American to Japan, Europe, and indirectly, the United States. Heavy black arrows indicate direction of movement of the bulk of finished caiman skins from Europe to the U.S.



may experience delays and seizures of goods. The wildlife officer, utilizing manuals based on established biological taxa, may discover that few tanned incomplete hides, or products, can be readily identified without a strong background in crocodilian morphology and classification (King and Brazaitis, 1971). With limited time, and the knowledge that the hides are often untraceable, the inspector has little choice in many instances but to accept the documentation at face value.

Ports of entry of wildlife are often understaffed. Large numbers of shipments are processed, contain many individual items, and arrive in short periods of time. Agents and inspectors are called upon to complete volumes of paper work to support seizures and violation charges, in addition to enforcing local wildlife regulations, answering queries from the general public, and inspecting export shipments.

In 1981, 7,186 reptile shipments entered through the Port of New York. TRAFFIC (U.S.A.) reported that 117,506 crocodilian products, and 93,679 skins entered the U.S. through the Port of New York in 1981 (Roeper and Hemley, this volume), excluding those of American alligator. The figure represents 85 percent of all of the crocodilian imports into the United States during that period. The port was staffed by six agents, a trainee, and seven inspectors, including supervisors. The inspectors would have had to have examined about 40 reptile shipments per person per day plus individually shipped items. Crocodilian shipments were given priority, and nearly all shipments were given some scrutiny. Seventy-eight shipments alone were referred to one independent forensic examiner for corroborative identification.

Nearly all commercial crocodilian products lack skulls, complete body scutellation, and documented collecting data. The examiner is usually presented with an incomplete, unmarked processed hide or raw skin, pieces of hide, or a finished product composed of a number of pieces of hide. The pieces may represent one or more animals and species. The examiner may not damage or dismantle the product to establish the identity of its components. In order to maintain the examiner's objectivity, he/she is deprived of all knowledge of the item's origins, and the name of the species cited in the documentation.

The examiner's first step is to establish that the product is composed of genuine hide, rather than embossed crocodile pattern on domestic leather, or plastic. Artificial skin is distinguished by the repetition of scalation, lack of seams as the scales of one type blend with other scales from a different body region, and the loss of natural variation and detail in the creases and folds of the fine skin. Careful examination can save the examiner considerable embarrassment in court at a later date. Next in importance is to

determine the part of the crocodilian's body from which the sample was derived in order to determine which definitive characteristics of identification may apply. Not every part of every crocodilian bears identifiable characteristics. Many characteristics are evident on those body parts which are most often used in the manufacture of products, such as the ventral tail, ventral belly and osteoderms, and flanks. It is often necessary to examine numerous samples before one is found which bears an identifiable characteristic.

Sensory pits are found on the ventral and flank scales of all crocodylids and gavialids, and are absent from the scales of all alligatorids. Crocodylus siamensis has midventral tail inclusions and Crocodylus moreleti has transverse ventral tail inclusions in addition to sensory pits. Osteolaemus tetraspis and Crocodylus johnsoni both have additional ventral osteoderms, and unique flank and nuchal patterns often utilized in products. Crocodylus niloticus and Crocodylus cataphractus bear somewhat reduced osteoderms in the gular, pectoral, and midventral regions respectively. Among the alligatorids which lack body sensory pits, Alligator mississippiensis frequently has reduced single osteoderms in the gular and pectoral scales, while Melanosuchus niger and Gaiman have compound ventral osteoderms and variations in surface skin pitting after tanning. Lateral or flank scales vary considerably between species, but the races of C. crocodilus are virtually impossible to identify as cut pieces incorporated into a manufactured product. Most manufactured products do not display specific single characteristics by which the species of the crocodilian involved can be determined by simple morphological examination (King and Brazaitis, 1971; Brazaitis, 1973).

In order to deal with the problems more effectively, the U.S. Fish and Wildlife Service has proposed the development of a forensic laboratory as part of its recently formed division of Forensic Science. The laboratory will deal with the identification of all forms of wildlife, and would make forensic services available to state and local wildlife authorities.

The international traffic in millions of completely unmarked crocodilian hides and products poses one of the greatest obstacles to the effective enforcement of national and international endangered species regulations. Hides and skins frequently cannot be traced to their source or country of origin. Legally harvested or farmed animals cannot readily be distinguished from those clandestinely exported from illegal sources. Tariffs may be lost when export quotas are exceeded without controls, or are not substantiated by adequate records.

Of the 19 species and subspecies of crocodilians regularly utilized by the leather industry, only the hide of the American

alligator bears a tag of identification, placed on it at the time the animal is killed, and maintained intact until the hide is manufactured into a product. As mandated by CITES, it is the only species of crocodilian where the origin and date of harvest, size, and passage from hunter to manufacturer can be substantiated through a system of numbered, color-coded tags. The reptile leather industry has resisted such markings as too costly, cumbersome, and ineffective. Yet, the system is working, and tags placed at the time of capture are still intact after processing and transport overseas and back. The use of dyes, roll marking, and infusion of detectable chemical tracers has yet to be fully explored.

A critical need exists to develop internationally acceptable methods of marking individual hides and products, in conjunction with a comprehensive monitoring and data retrieval system. In the meantime, countries which take exception or refuse to abide by the CITES agreement will continue to profit from the taking of endangered species. The traffic in illegal crocodilian hides and products will continue as long as law enforcement agencies lack the tools and means to execute their responsibilities. It is not enough to hope that the fashion world will change its interests.

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REPORT ON THE STATUS OF THE CAPTIVE BREEDING PROGRAM FOR THE CHINESE ALLIGATOR *Alligator sinensis* IN THE UNITED STATES

Peter Brazaitis

Superintendent, Department of Herpetology, New York Zoological Park

Ted Joanen

Research Leader, Rockefeller Wildlife Refuge, Grand Chenier, Louisiana

In 1975, the New York Zoological Society joined with the National Zoological Park and the Louisiana Department of Wildlife and Fisheries, Rockefeller Wildlife Refuge, and established the first captive Chinese alligator, *Alligator sinensis*, breeding program (Behler, Brazaitis, and Joanen, 1982). Other contributing or cooperating institutions have since included the Beijing and Guangzhou Zoos of the People's Republic of China; the Munich, Stuttgart, and Budapest zoological parks; and the San Diego and Houston Zoos in the United States. An official captive breeding studbook, the first for a reptile species, was established in May 1982, naming John Behler, Curator of Reptiles at the New York Zoological Park, Studbook Keeper and Program Coordinator.

Breeding facilities were established at the Rockefeller Wildlife Refuge, Grand Chenier, Louisiana, under the management of Ted Joanen, and at the New York Zoological Park, where adults are maintained. The program was expanded in 1980 to include the Houston Zoo as a potential additional breeding facility.

Chinese alligator breeding groups presently include a pair of young adults from the Guangzhou Zoo and a 1.2 m female from Munich, of undetermined age, which are maintained at the New York Zoological Park. The Rockefeller group consists of an original pair of animals from the New York Zoological Park, now in excess of 40 years of age, a young male from the Beijing Zoo, and an older female from the Budapest Zoo. The Rockefeller group also had included an original pair from the National Zoo, also believed to be in excess of 40 years of age, which have since expired.

To date, only the eldest 40 year old+ New York and National Zoo (Davenport, 1982) animals have bred, and only at the Rockefeller Refuge. Breeding occurred in 1977, the spring following their initial liberation

into spacious outdoor breeding facilities, and in 1978, 1979, and 1980 (Behler and Joanen, 1982). No offspring were produced in 1981, 1982, or 1983. The breeding took place prior to the acquisition of and introduction into the program of the European and Chinese specimens in 1983. The present living offspring include three males hatched in 1979 (including one dwarfed animal that will not play a role in future breeding programs), and 18 juveniles hatched in 1980 (Fig. 1). Of the 18, 14 are being reared at the Reptile House at the New York Zoological Park, which is the primary rearing facility for the program. Four additional animals reside in temporary quarters at the Houston Zoo.

The 17 juvenile animals at the New York Zoological Park (except for the dwarf of 1979) are now maintained in an exhibit area approximately 5 m long and 3 m wide, of which approximately 2/3 consists of an 80 cm deep pool heated by continuously running water at 28 to 30°C. Food consists of freshly killed mice, small chicks, and an abundance of live freshwater fish, offered two to three times weekly. Although no supplementary vitamins are administered, the animals are fed only whole, unfrozen, live, or freshly killed foods. In addition, the young alligators have been reared under ultraviolet light, in the 310 to 400 nm range. All individuals display well developed teeth and bones with good physical conformation, and average approximately 1 m in length as of early 1984.

Figure 1 shows the group of 1980 animals soon after hatching in September of that year. The coloration is basically black with yellow-white crossbands with some orange-yellow highlights. Each animal bears a characteristic "X" shaped marking on the snout. Markings are crisp and well defined. Figure 2 shows the typical coloration of a one year-old juvenile at about 50 cm in total length. Numerous light spots have appeared which have begun to diffuse the hatchling patterns. The characteristic "X" on the snout is nearly obliterated. By three years of age, the animals had become almost uniform gray in coloration with some lighter crossbanding remaining, primarily on the sides of the body and tail.

Preliminary sexing indicates that most of the 1980 hatchlings are females while those hatched in 1979 are males. Some 1979 and 1980 individuals began to respond to adult vocalizations in 1984, and engage in courtship activities such as pre-copulatory mounting.

Losses have included some of the animals which had been maintained in zoological collections for many years and which were estimated to be between 30 and 40 or more years of age upon acquisition and introduction into the breeding groups. These include the original pair acquired from the National Zoo, a single female from Stuttgart, and a female from Budapest. Losses among hatchlings included one animal which expired soon after hatching in November 1980 at the New York Zoological Park and two 1980 animals at the Houston Zoo in April and June 1981.

Figure 1. 1980 hatchlings, *Alligator sinensis*



Figure 2. Yearling Alligator sinensis

The future breeding potential for the Chinese alligator in the United States is promising. Both the New York Zoological Society and the Louisiana Department of Wildlife and Fisheries, in concert with other participating institutions, continue to maintain a longterm commitment to the preservation of the species through captive management programs. Additional breeding facilities are currently under consideration. Many other zoological institutions have expressed a willingness to join in the effort. A worldwide survey is underway to identify potential recruits to add to the breeding program.

The captive reproductive potential for the species has increased with the addition of young breeding stock from the People's Republic of China, and the maturing of juveniles hatched in 1979 and 1980 within the next several years. New and intensive captive efforts within the People's Republic of China will also serve to insure the survivorship of the species. The Chinese alligator breeding program is a model of cooperation upon which other programs involving seriously endangered species of crocodilians can benefit.

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CROCODILE AND ALLIGATOR TRADE BY THE UNITED STATES 1981

Nancy Roeper and Ginette Hemley

TRAFFIC (USA), 1601 Connecticut Avenue, N.W., Washington, D.C. 20009

INTRODUCTION

The order Crocodylia contains 21 species of alligators, caimans, crocodiles, and gavials, and includes the largest living reptiles. Possessing thick, durable hides, crocodilians are in great demand by the leather industry for the production of shoes, handbags, and other leather products. There is also some demand for baby caimans for the pet trade. All crocodilians currently receive some degree of protection. For example, all three families in the order are listed on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)--trade is allowed if a permit has been obtained from the exporting country. Fifteen species and an additional two subspecies are listed on CITES Appendix I (see Appendix A)--commercial trade of these species is prohibited. Thirteen species and another seven subspecies are protected by the U.S. Endangered Species Act, which also prohibits commercial trade.

As the market for crocodilian products grows and suitable habitat decreases, the pressure on remaining crocodilian populations increases. In 1981 alone, the value of crocodilian skins, products, and live animals imported to the U.S. was over US \$9 million. More stringent controls may be required if present population levels are to be maintained.

This report summarizes the quantities, value, and origin of crocodile and American alligator skins, products, and live animals commercially traded by the U.S. during 1981, and discusses country of origin and species discrepancies.

U.S. Imports of Live Crocodilians, excluding American Alligators

In 1981, the United States imported 15,553 live crocodilians in 17 shipments. In comparison, over 112,000 and 137,000 were imported in 1970 and 1971, respectively, illustrating nearly a ten-fold decline in just over a decade (Table 1).

It is also apparent that both the number of species and the number of countries supplying live crocodilians has decreased since 1970 (Tables 1 and 2). Nine species were imported in 1970 and ten were imported in

Table 1. U.S. live crocodilian imports 1970, 1971, 1979-1981, arranged by country of origin.

Country of origin	Year				
	1970	1971	1979	1980	1981
Argentina	4				
Brazil	1				
Cameroon		28			
Canada	2				
Colombia	105,982	136,665		5,280	15,521
Costa Rica		3			
Curacao	6,020			4,700	
Dahomey	1	10			
Egypt	1				
Guyana	276	64		590	
El Salvador				60	
Haiti		5			
Ghana	2	7			
Guatemala			780	10,012	
Japan				275	
Indonesia		10	50		
Liberia		7			
Malaysia	8	2			
Netherlands		1			
Nicaragua	10	190			
Pakistan		4			
Panama		32	50,588		
Paraguay		72			
Poland	1				
Singapore	52	73			
Sri Lanka	5	3			
Suriname					20
Thailand	33	25	1		
Trinidad		1			
United Kingdom		1			
Unknown					12
TOTAL	112,398	137,203	51,419	20,917	15,553

Sources:

- 1970, 1971 - Busack, 1974.
- 1979 - U.S. CITES Annual Report.
- 1980, 1981 - TRAFFIC (U.S.A.) analysis of 3-177 Declaration of Importation/Exportation forms, Law Enforcement Division, Fish & Wildlife Service, U.S. Department of the Interior.

1971, compared to only two in 1979 and three in 1981 (Table 2). The U.S. received crocodilians from 15 countries in 1970, 20 in 1981, but from only four in 1979, six in 1980, and two in 1981 (Table 1).

The data in Table 2 suggest that the spectacled caiman, *Caiman crocodilus*, has been the major species imported by the U.S. over the last 12 years. In 1981, *Caiman crocodilus crocodilus* from Colombia accounted for 99.9% of all crocodilian imports. The major source of live caimans in 1980 was Guatemala (10,012 specimens or 47.9%), although Colombia and Curacao* each provided approximately 5,000 caimans. In 1979, Panama was the source of nearly all live caimans imported by the U.S., supplying 98.3% of the total for that year (Table 1).

The decrease in the number of live crocodilians imported by the U.S. is probably due to export restrictions implemented by many countries over the last decade. For example, Panama, the major exporter of caimans to the U.S. in 1979, banned the export of all wildlife and wildlife products in January 1980 (Resolution DIR. 002-80). Consequently, the U.S. did not import any caimans with Panama declared as the country of origin in 1980 or 1981. Guatemala, the major exporter of caimans in 1980, is currently enforcing existing export regulations (Swift, in press). As a result, no live crocodilians entered the U.S. in 1981 with Guatemala as the declared country of origin. Colombia provided over 100,000 live caimans to the U.S. in 1970 and again in 1971. The number of caimans exported to the U.S. has declined since then because of a 1974 Colombian ban on the export of most live animals, including crocodilians (Donadio, 1982). This law has not been adequately enforced, however, as evidenced by all the shipments of live caimans imported by the U.S. between 1979 and 1981 accompanied by Colombian permits.

U.S. Imports of Crocodilian Skins and Manufactured Products, Excluding American Alligators

a. Declared Origins

In 1981, the U.S. imported 107,179 crocodilian skins and 143,727 crocodilian products in 1,129 shipments. The largest number of raw skins originating from a single country were derived from Bolivian caimans (31.4%). Skins of Paraguayan and Colombian caimans made up an additional 29.6% and 16.5% of the trade respectively (Table 3).

Import figures demonstrate a change in the countries supplying the majority of caimans over the last three years. Most of the skins imported in 1980 were of Panamanian (56.5%), Paraguayan (12.9%), and Colombian (12.8%) origin (TRAFFIC [USA], unpubl. data). In 1979, most skins were of Paraguayan (61.3%) or unknown (35.2%) origin (1979 U.S. CITES report).

* Caimans do not occur in Curacao (Groombridge, 1981).

Table 2. U.S. live crocodilian imports, 1970, 1971, 1979, 1981, arranged by species.

Species	Year			
	1970	1971	1979	1981
<i>Alligator sinensis</i>		1		
<i>Caiman crocodilus</i>	112,212	136,996	55,571	15,531
<i>Caiman</i> spp.	1			
<i>Melanosuchus niger</i>		8		
<i>Paleosuchus trigonatus</i>	32	2		14
<i>P. palpebrosus</i>				8
<i>Crocodylus acutus</i>	52	21		
<i>C. moreletti</i>	2			
<i>C. niloticus</i>	1	7		
<i>C. porosus</i>	13	24	51	
<i>C. siamensis</i>	39	48		
<i>Crocodylus</i> spp.	3			
<i>Osteolaemus tetraspis</i>	3	46		
<i>Tomistoma schlegelii</i>	44	46		
TOTAL	112,402	137,199	55,622	15,553

Sources:

- 1970, 1971 - Busack, 1974.
- 1979 - 1979 U.S. CITES Annual Report.
- 1980, 1981 - TRAFFIC(U.S.A.) analysis of 3-177 Declaration of Importation/Exportation forms, Law Enforcement Division, Fish & Wildlife Service, U.S. Department of the Interior.

Table 3. 1981 U.S. imports of crocodilian skins, products and live animals, arranged by country of origin and country of export.

Declared Country of Origin	Country of Export	Live	Raw or Tanned Skin	Manufactured Products	Declared Value (US \$)
Argentina	France		2	22	933
	Italy		10	118	6,700
	Spain			189	2,307
	West Germany			105	3,235
	SUBTOTAL		12	434	13,175
Bolivia	Bolivia		33,611		263,646
	France			2,074	26,626
	Greece			946	20,141
	Hong Kong			2,702	50,750
	Italy			2,432	83,880
	Korea			30	643
	Switzerland			10	78
	United Kingdom			115	1,970
	West Germany			85	17,429
	SUBTOTAL		33,611	8,394	465,163
Brazil	Austria			117	2,934
	France			208	19,492
	Italy			15	2,280
	Japan		4		138
	Switzerland			5,709	49,647
	West Germany			88	8,065
	SUBTOTAL		4	6,137	82,556
British West Indies	France		1,500	1,561	39,709
	Switzerland			16,659	49,553
	SUBTOTAL		1,500	18,220	89,262
Colombia	Austria			20,893	127,968
	Colombia	15,521	9,864	9,744	193,032
	France			3,908	73,255
	Italy		7,753	32,472	1,180,485
	Japan			252	11,189
	Netherlands			399	1,567
	Spain			1,470	25,733
	Switzerland			619	2,358
	West Germany		18	536	49,301
	Unknown			30	2,475
	SUBTOTAL	15,521	17,635	70,323	1,667,363

Table 3. (continued)

Declared Country of Origin	Country of Export	Live	Raw or Tanned Skin	Manufactured Products	Declared Value (US \$)
Costa Rica	Unknown			4	210
	SUBTOTAL			4	210
France	France		50		13,325
	West Germany	12			2,400
	SUBTOTAL	12	50		15,725
French Guiana	France		9,599	365	285,104
	Italy			419	85,261
	Spain			5,292	151,087
	United Kingdom			2	77
	SUBTOTAL		9,599	6,078	521,529
Guyana	France			200	16,783
	SUBTOTAL			200	16,783
Hong Kong	Hong Kong			601	13,530
	SUBTOTAL			601	13,530
India	Unknown			6	595
	SUBTOTAL			6	595
Indonesia	France		1,729	1	385,924
	Italy			72	14,760
	West Germany			1	874
	SUBTOTAL		1,729	74	401,558
Italy	Italy			133	3,868
	Spain			26	574
	SUBTOTAL			159	4,442
Madagascar	France			24	5,937
	SUBTOTAL			24	5,937
Malaysia	Italy			4	1,983
	West Germany			35	12,403
	SUBTOTAL			39	14,386
Nigeria	Italy			147	4,546
	Nigeria			13	120
	SUBTOTAL			160	4,666

Table 3. (continued)

Declared Country of Origin	Country of Export	Live	Raw or Tanned Skin	Manufactured Products	Declared Value (US \$)
Panama	Italy			1,833	170,148
	Panama			725	8,732
	Switzerland			120	8,381
	SUBTOTAL			2,678	187,261
Papua New Guinea	Austria			9	1,596
	France		10,633	2,072	3,150,790
	Italy			5,069	798,004
	Japan		12	4	1,625
	Mexico		2		819
	Spain			249	57,096
	Switzerland			3,769	52,004
	United Kingdom			39	8,657
	West Germany			393	40,354
	SUBTOTAL		10,647	11,604	4,110,945
Paraguay	Austria			19	488
	Canada			1,151	7,842
	France		6,823	47	192,278
	Italy		14	8,142	419,196
	Japan		174	45	9,253
	Paraguay		24,689		40,117
	Spain			417	24,941
	Switzerland			30	62
	United Kingdom		20		811
	Uruguay			50	1,137
	West Germany			62	14,558
	SUBTOTAL		31,720	9,963	710,683
Peru	France			8	8,700
	Switzerland			4,856	343,407
	SUBTOTAL			4,864	352,107
Senegal	Senegal			2	6
	SUBTOTAL			2	6
Singapore	France			25	20,031
	Greece			284	4,686
	Italy			1	456
	Singapore		33	851	17,696
	West Germany		138	186	14,743
	SUBTOTAL		171	1,347	57,612

Table 3. (continued)

Declared Country of Origin	Country of Export	Live	Raw or Tanned Skin	Manufactured Products	Declared Value (US \$)
South Africa	Italy			9	3,789
	Unknown			12	
	SUBTOTAL			21	3,789
Suriname	Italy			1,294	87,713
	Suriname	20			1,698
	SUBTOTAL	20		1,294	89,411
Thailand	Thailand			1	263
	SUBTOTAL			1	263
Venezuela	Italy			140	28,350
	Spain			324	2,241
	SUBTOTAL			464	30,591
Unknown	France			178	33,469
	Italy		500	52	7,794
	Mexico			4	100
	South Africa			2	25
	Switzerland			331	101,905
	Thailand			3	180
	Unknown			27	2,900
	SUBTOTAL			597	144,947
United States	France			40	8,782
	SUBTOTAL			40	8,782
				401	113,767
GRAND TOTAL		15,553	107,17	143,727	9,014,703

Source: TRAFFIC (USA) analysis of 3-177 Declaration of Importation/Exportation forms, Law Enforcement Division, Fish & Wildlife Service, U.S. Department of the Interior.

Over 60% (68,165) of the skins imported by the U.S. in 1981 came directly from the declared country of origin, rather than from re-exporting countries. Bolivia supplied over 33,000 skins, 49.3% of the total skins imported directly (Table 4). The final destination of these skins is unknown, as U.S. companies probably could not process them all (68,165)* and most of these skins did not appear as 1981 U.S. re-exports.

In 1981, products made of Colombian caiman skins were imported in the greatest numbers (70,323) and constituted 48.9% of all crocodilian products imported. Lesser quantities were manufactured from skins of British West Indies[†] caimans (12.7%) and Papua New Guinea crocodiles (8.1%; Table 4).

It is difficult to detect any shifts in the product trade in 1981 compared to the two previous years because in past years, many shipments of crocodilians were imported with no country of origin declared. In 1981, only 0.4% of the crocodilian manufactured products were imported with no declared country of origin. By contrast, in 1980 most of the manufactured products were of unknown (60.3%), Bolivian (20.7%) or Colombian (8.5%) origin (TRAFFIC [USA], unpubl. data). In 1979, most manufactured products were from unknown countries of origin (80.2%) and Mexico (10.8%) (1979 U.S. CITES report).

b. Species in Trade

Hides of the spectacled caiman, Caiman crocodilus, accounted for 89.1% of the skins and 89.7% of the manufactured products imported to the U.S. in 1981 (Table 5). Brazaitis (1973) has taxonomically divided the spectacled caiman into four subspecies, three of which appeared in trade in 1981. The most frequently imported subspecies was declared as Caiman c. crocodilus; over 95,000 raw or tanned skins and more than 122,000 products entered the U.S. in 1981 (Table 5). Much smaller quantities of both skins and products declared as the brown caiman, C. c. fuscus, and the yacare caiman, C. c. yacare, were imported.

The New Guinea crocodile, Crocodylus novaeguineae, was the next most commonly declared species, making up 10.6% of the crocodilian skins and 7.4% of the manufactured products in trade. Minor quantities of seven other species were also imported (Table 5).

Declared Value of Crocodilian Imports--Excluding American Alligators

The declared value of all crocodilian skins, manufactured products and live animals imported to the U.S. in 1981 was over US \$9 million

*The U.S. has a very limited capacity to process crocodilian hides (Brazaitis, pers. comm.).

[†]Caimans do not occur in the British West Indies (Groombridge, 1981).

Table 4. 1981 U.S. direct imports of crocodilian skins, products, and live animals, arranged by country of origin.

Country of Origin*	Live	Manufactured Products	Raw Skins	Value (US \$)
Bolivia			33,611	263,646
Colombia	15,521	9,744	9,864	193,032
Nigeria		13		120
Panama		725		8,732
Paraguay			24,689	40,117
Senegal		2		6
Suriname	20			1,698
Thailand			1	263
TOTAL	15,541	10,484	68,165	\$507,614

*These figures do not include crocodilians imported with declared countries of origin of France, Hong Kong, Italy, and Singapore where crocodilians are not known to occur in the wild.

Source: TRAFFIC (U.S.A.) analysis of 3-177 Declaration of Importation/Exportation forms, Law Enforcement Division, Fish & Wildlife Service, U.S. Department of the Interior.

Table 5. 1981 U.S. imports of crocodilian skins and products--arranged by species and country of origin.

Species	Declared Country of Origin	Skins	Manufactured Products
<u>Caiman crocodilus</u> <u>crocodilus</u> (Spectacled caiman)	*Argentina	12	226
	Bolivia	33,611	7,960
	Brazil	4	6,109
	*British West Indies	1,500	18,220
	Colombia	17,575	67,426
	French Guiana	9,599	6,078
	Guyana		200
	*Hong Kong		600
	*Indonesia	500	
	*Italy		133
	*Nigeria		51
	*Panama		845
	Papua New Guinea	513	192
	*Paraguay	31,432	9,403
	Peru		4,864
	*Singapore	33	851
	Suriname		1,294
	*U.S.A.		40
	Venezuela		140
	South America		8
	Unknown	500	186
	SUBTOTAL	95,279	124,826
<u>Caiman crocodilus</u> <u>fuscus</u> (Brown caiman)	*Argentina		208
	*Bolivia		2
	Colombia	60	2,581
	Panama		1,793
	*Paraguay		115
	Venezuela		324
	SUBTOTAL	60	5,023
<u>Caiman crocodilus</u> <u>yacare</u> (Yacare caiman)	Bolivia		127
	*Colombia		6
	*Italy		26
	*Nigeria		96
	Paraguay	174	192
	SUBTOTAL	174	447
<u>Caiman crocodilus</u> (Spectacled caimans)	Bolivia		300
	Colombia		312
	Costa Rica		4
	*Malaysia		4
	Paraguay		210
	SUBTOTAL		761

Table 5. (Continued)

Species	Declared Country of Origin	Skins	Manufactured Products
<u>Paleosuchus</u> sp. (Smooth-fronted caimans)	*Paraguay		40
	Colombia		98
	SUBTOTAL		138
<u>Crocodylus</u> <u>acutus</u> (American crocodile)	Papua New Guinea		1
	*Paraguay		3
	SUBTOTAL		4
<u>Crocodylus</u> <u>niloticus</u> (Nile crocodile)	Senegal		2
	South Africa		6
	SUBTOTAL		8
<u>Crocodylus</u> <u>novaeguineae</u> (New Guinea crocodile)	*Bolivia		5
	*Brazil		28
	*France	50	
	*Hong Kong		1
	Indonesia	1,229	62
	*Madagascar		24
	*Malaysia		35
	*Panama		40
	Papua New Guinea	10,130	9,871
	*Singapore		490
	Unknown		77
	SUBTOTAL	11,409	10,633
<u>Crocodylus</u> <u>porosus</u> (Salt-water crocodile)	Indonesia		12
	Papua New Guinea	4	1,540
	*Singapore		6
	SUBTOTAL	4	1,558
<u>Crocodylus</u> <u>siamensis</u> (Siamese crocodile)	Thailand	1	
<u>Osteolaemus</u> <u>tetraspis</u> (West African dwarf crocodile)	Nigeria		7
	*South Africa		6
	Africa		6
	SUBTOTAL		19
<u>Crocodylus</u> spp. (Crocodile)	Nigeria		6
	South Africa		9
	Unknown		289
	SUBTOTAL		304

Table 5. (Continued)

Species	Declared Country of Origin	Skins	Manufactured Products
<u>Gavialis gangeticus</u> (Gavial)	India		6
	TOTAL	107,179	143,727

*Species not found in this country (Brazaitis, pers. comm.; Groombridge, 1981).

Source: TRAFFIC (U.S.A.) analysis of 3-177 Declaration of Importation/Exportation forms, Law Enforcement Division, Fish & Wildlife Service, U.S. Department of the Interior.

(Table 4). Crocodilian skins and products re-exported from France to the U.S. accounted for over US \$4 million, and those from Italy were valued at nearly US \$3 million.

Skins of Papua New Guinea crocodiles were the most valuable; the average declared value was US \$261 per skin. These skins represented only 4.0% of all crocodilian items imported, but 30.8% of the total value of all imported items. The value of these skins is reflected in the declared value of products manufactured from Papua New Guinea crocodiles. The average declared value of US \$115 per product was more than the value of products made from any other country's crocodilians. The total value of all skins and products of Papua New Guinea crocodiles was over US \$4 million.

Skins, products, and live animals of Colombian origin accounted for the second highest total declared value of all crocodilian items imported in 1981. This amounted to over US \$1.5 million, representing 18.5% of the total value of all crocodilian imports.

Trade Routes

Seventeen countries re-exported crocodilian skins and products to the U.S. in 1981. France re-exported the largest number of skins (30,336), and Italy supplied the largest quantity of manufactured products (52,352; Table 6). Italy was the only other major re-exporter of skins. Other significant re-exporters of products include Switzerland, Austria, and France.

Based on declared origins on import documents, the major supply routes in 1981 for all crocodilian items from the source, to the processing country, to the U.S. were:

- 1) Colombia-- Italy-- U.S.
- 2) Colombia-- Austria-- U.S.
- 3) British West Indies-- France-- Switzerland-- U.S.

Many crocodilian skins passed through at least two European countries before reaching the U.S. as manufactured products (Table 7). Switzerland, for example, often imports crocodilian products from other European countries before exporting them to the U.S. The routing of crocodilian skins and products through so many countries before reaching the U.S. may, in part, explain the large volumes of imports with country of origin discrepancies.

Ports of Entry

The majority of both crocodilian skins (87.4%) and products (81.5%) entered through the Port of New York. The only other port of significance was Miami, where 9.1% of the products, 9.2% of the skins, and 100% of the live animals entered the U.S. Between 2% and 3% of the

Table 6. 1981 U.S. imports of crocodilian skins, products, and live animals, arranged by country of export.

Declared Country of Export	Live	Raw or Tanned Skin	Manufactured Products	Declared Value (U.S.\$)
Austria			21,038	132,986
Bolivia		33,611		263,646
Canada			1,151	7,842
Colombia	15,521	9,864	9,744	193,032
France		30,336	10,733	4,280,425
Greece			1,230	24,827
Hong Kong			3,303	64,280
Italy		8,277	52,352	2,898,500
Japan		190	301	22,205
Korea			30	643
Mexico		2	4	919
Netherlands			399	1,567
Nigeria			13	120
Panama			725	8,732
Paraguay		24,689		40,117
Senegal			2	6
Singapore		33	851	17,696
South Africa			2	25
Spain			7,967	263,405
Suriname	20			1,698
Switzerland			32,103	607,395

Table 6. (continued)

Declared Country of Export	Live	Raw or Tanned Skin	Manufactured Products	Declared Value (U.S.\$)
Thailand		1	3	443
United Kingdom		20	156	11,515
Uruguay			50	1,137
West Germany	12	156	1,491	163,362
Unknown			79	8,180
TOTAL	15,553	107,179	143,727	9,014,703

Source: TRAFFIC (U.S.A.) analysis of 3-177 Declaration of Importation forms, Law Enforcement Division, Fish & Wildlife Service, U.S. Department of the Interior.

Table 7. 1981 U.S. imports of crocodilian products, arranged by country of origin, source country*, and country of re-export.

Country of Origin	Source* Country	Country of Re-export	Quantity
Bolivia	France	W. Germany	51
	Italy	W. Germany	34
	Italy	Switzerland	3
	U.S.	Greece	338
Brazil	France	Switzerland	4,768
British West Indies	France	Switzerland	11,614
Colombia	France	Switzerland	619
	France	W. Germany	29
	Italy	W. Germany	74
Malaysia	France	W. Germany	28
Papua New Guinea	France	Switzerland	2,343
	France	Italy	28
	France	W. Germany	5
	Switzerland	W. Germany	41
	Singapore	France	55
	U.S.	France	3
Paraguay	Italy	Switzerland	24
	France	W. Germany	39
Peru	Italy	Switzerland	2,466
	France	Switzerland	1,042
Singapore	France	W. Germany	162
	Italy	W. Germany	2
TOTAL			38,521

*Source Country - the country that supplied the skins or products to the re-exporting country.

Source: TRAFFIC (U.S.A.) analysis of 3-177 Declaration of Importation/Exportation forms, Law Enforcement Division, Fish & Wildlife Service, U.S. Department of the Interior.

skins and products passed through each of the ports of Chicago, Honolulu, and Los Angeles (Table 8).

Declared Country of Origin and Species Discrepancies

Many crocodilian shipments entered the U.S. with declared countries of origin that are not within the reported range of the species declared. It cannot be determined whether the countries of origin or the species names were incorrectly listed. For example, the spectacled caiman, Caiman crocodilus crocodilus, occurs in only nine South American countries and Trinidad and Tobago (Brazaitis, pers. comm.). Eleven countries where these caimans do not occur, however, also appeared on the 3-177 forms as the country of origin (Table 5). Imports from these countries accounted for 30,561 manufactured items, or 21.3% of all crocodilian manufactured products imported.

More than 65,000 skins and over 17,000 manufactured items of C. c. crocodilus were declared as Bolivian or Paraguayan in origin. C. c. crocodilus does not occur in Paraguay and, according to caiman specialists, is not found in large enough quantities to be commercially exploited in Bolivia (Brazaitis, pers. comm.). The items were most likely C. c. crocodilus illegally taken in Brazil (Brazaitis, pers. comm.) or yacare caimans, C. c. yacare, a subspecies found in both Bolivia and Paraguay. Caiman c. yacare is listed on the U.S. Endangered Species Act and is prohibited from import into the U.S. Pending further investigation of the current ranges of all C. crocodilus subspecies, the U.S. stopped accepting shipments of C. c. crocodilus skins and products of Bolivian and Paraguayan origin in August 1981.

The British West Indies and Argentina were also declared as countries of origin for imports of C. c. crocodilus skins and products. The American crocodile, Crocodylus acutus, an endangered species, is the only species known to occur in the British West Indies (Groombridge, 1981). C. c. yacare and the broad-nosed caiman, C. c. latirostris are the only crocodilians known to occur in Argentina (Brazaitis, pers. comm.). Both are prohibited from import by the U.S. Endangered Species Act. Additionally, domestic legislation in Argentina prohibits the export of crocodilians (TRAFFIC [USA], 1982).

Crocodilian Shipments Denied Entry

Thirty-four commercial shipments consisting of 1,607 manufactured and 296 raw crocodilian items were denied entry in 1981. Most seizures were of crocodilians declared to be spectacled caimans, but seven other species and eleven countries of origin were also involved (Table 9). The shipments usually lacked proper CITES documents, but many Caiman crocodilus were denied entry because they were believed to be C. c. yacare, a subspecies banned from import by the U.S. Endangered Species Act.

Table 8. 1981 U.S. imports of live crocodilians, skins, and products, arranged by port of entry.

Port of Entry	Live	Raw or Tanned Skins	Manufactured Products
Boston			308
Chicago		500	3,043
Dallas/Ft. Worth		930	1,048
El Paso		2	
Honolulu			3,359
Houston			6
Laredo			4
Los Angeles			3,162
Miami	15,553	9,864	12,921
Minneapolis			5
New Orleans			330
New York		93,679	117,506
San Francisco			655
Seattle			96
Other		2,204	1,284
TOTAL	15,553	107,179	143,727

Source: TRAFFIC (U.S.A.) analysis of 3-177 Declaration of Importation/Exportation forms, Law Enforcement Division, Fish & Wildlife Service, U.S. Department of the Interior.

Table 9. Crocodilian skins and products denied entry into the U.S. in 1981, arranged by species, country of origin, and country of export.

Declared Species	Declared Country of Origin	Country of Export	Quantity	Type
<u>Caiman crocodilus crocodilus</u>	Argentina	France	20	manuf
	Bolivia	France	91	manuf
	Nigeria	Italy	3	manuf
	Paraguay	Austria	19	manuf
		Italy	107	manuf
		Switzerland	30	manuf
	Singapore	Singapore	499	manuf
		Singapore	21	raw
<u>Caiman c. yacare</u>	Bolivia	Italy	127	manuf
	Nigeria	Italy	96	manuf
	Paraguay	Japan	174	raw
		Spain	108	manuf
		Uruguay	50	manuf
		Unknown	100	raw
<u>Caiman crocodilus</u>	Costa Rica	Unknown	4	manuf
	Malaysia	Italy	4	manuf
	Paraguay	Spain	210	manuf
	Unknown	South Africa	2	manuf
		Switzerland	24	manuf
<u>Crocodylus acutus</u>	Paraguay	Italy	3	manuf
<u>Crocodylus niloticus</u>	Senegal	Senegal	2	manuf
	South Africa	Unknown	6	manuf
<u>Crocodylus novaeguineae</u>	Papua New Guinea	France	8	manuf
		Italy	3	manuf
		Switzerland	1	manuf
<u>Crocodylus porosus</u>	Indonesia	Italy	12	manuf
	Singapore	France	5	manuf
<u>Crocodylus siamensis</u>	Thailand	Thailand	1	raw
<u>Osteolaemus tetraspis</u>	Nigeria	Unknown	7	manuf
	South Africa	Unknown	6	manuf
	Africa	Africa	6	manuf
<u>Gavialis gangeticus</u>	India	Unknown	6	manuf

Table 9. (continued)

Declared Species	Declared Country of Origin	Country of Export	Quantity	Type
Crocodile	Nigeria	Unknown	6	manuf
	Unknown	France	66	manuf
		Mexico	4	manuf
		Switzerland	72	manuf
			<hr/>	
TOTAL			1,903	

Source: TRAFFIC (U.S.A.) analysis of 3-177 Declaration of Importation/Exportation forms, Law Enforcement Division, Fish & Wildlife Service, U.S. Department of the Interior.

American Alligator Trade

The American alligator, Alligator mississippiensis, is one of two crocodilians indigenous to the U.S. and is the only U.S. species that may be commercially exploited for the skin trade. Because of declining populations in past years as a result of excessive hunting and poaching, the American alligator was classified as Endangered throughout its range in 1967 under the U.S. Endangered Species Act. Effective management and enforcement of laws resulted in the partial or complete recovery of many alligator populations. Subsequently, the species was reclassified over a period of five years (1975-1979) to "Threatened" or "Threatened by Similarity of Appearance" status in some areas (Fed. Reg., 1979, 1981). In 1979, the American alligator was transferred from CITES Appendix I to Appendix II at the second meeting of the Parties. As a result, American alligator skins could again enter international trade.

The export of American alligator skins resumed in 1979, when a total of 5,404 skins were shipped from the U.S. (Table 10). The number of skins exported climbed to 29,449 in 1981 with France maintaining its status as the primary receiver of skins for the third consecutive year. France was the sole importer of American alligator skins in 1979. In 1981, France received over 16,000 skins, while Italy and Japan imported 9,684 and 3,186 skins, respectively. Other countries importing alligator skins directly from the U.S. in 1981 included the United Kingdom, Hong Kong, and West Germany. The 1981 total declared value of American alligator skin exports amounted to US \$4,660,258 (Table 10).

A large portion of all American alligator skins are tanned in France and Italy, and many skins are then re-imported by the U.S. for the manufacture of leather goods. The U.S. re-imported 7,451 tanned skins from France and 6,290 from Italy in 1981. The number of skins imported amounted to almost half as many as were exported during the year and had a declared value of US \$1,807,752 (Table 11).

While trade in American alligator skins is substantial, few manufactured products are exported or re-imported by the U.S. The total U.S. trade of American alligator products amounts to less than 5% of total imports and exports of raw or tanned skins. Still, the quality of the skin makes A. mississippiensis one of the most valuable reptiles to the leather industry worldwide.

SUMMARY

U.S. imports of live crocodilians decreased from over 112,000 in 1970 to about 15,000 in 1981. Imports of crocodilian skins and manufactured products, however, have increased over the last two years. The most frequently exploited species in 1981 was the spectacled caiman, Caiman crocodilus; it accounted for over 99% of the live animals and nearly 90% of both the skins and manufactured products imported. Colombia directly exported to the U.S. almost all of the live

Table 10. Exports of American alligator skins in 1979 and 1981, arranged by country of import.

Country of Import	Number of Skins		Declared Value (US \$; 1981 only)
	1979	1981	
France	5,404	16,290 (+ 3,895 lbs.)	2,799,693
Hong Kong		38	10,450
Italy		9,684	1,412,532
Japan		3,196	407,650
United Kingdom		246	29,462
West Germany		5	471
Total	5,404	29,449 (+ 3,895 lbs.)	4,660,258

Table 11. Imports of tanned American alligator skins in 1981, arranged by country of re-export.

Country of Re-export	Number of Skins	Declared Value (US \$)
France	7,451	1,518,318
Italy	6,290	289,434
TOTAL	13,741	1,807,752

Source: TRAFFIC (U.S.A.) analysis of 3-177 Declaration of Importation/Exportation forms, Law Enforcement Division, Fish & Wildlife Service, U.S. Department of the Interior.

crocodilians imported in 1981, and was the country of origin of nearly 50% of the products imported. Bolivia was the country of origin of most of the raw skins imported. Italy and France were the largest exporters of skins and products to the U.S. in terms of both the total number of items and the total value of all goods imported. Most items entered the U.S. through the Port of New York. Approximately one third of the caimans arrived with declared countries of origin outside the natural range of the species. This may be a serious problem, since these declarations may be concealing the importation of endangered species. The American alligator entered international trade again in 1979, after a series of changes in its legal status. Almost 30,000 skins were exported from the U.S. in 1981.

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Appendix A. Status of all Crocodilian Species listed on the U.S. Endangered Species Act (ESA), the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), and the IUCN Red Data Book (RDB).

Species	ESA	APP.	RDB	Species	ESA	APP.	RDB
FAMILY: Alligatoridae							
<u>Alligator mississippiensis</u>	E/T/ T(S/A)*	II	O	<u>Crocodylus acutus</u>	E	I	E
American alligator				American crocodile			
<u>Alligator sinensis</u>	E	I	E	<u>Crocodylus cataphractus</u>	E	I	E
Chinese alligator				African sharp-nosed crocodile			
<u>Caiman crocodilus apaporiensis</u>	E	I	E	<u>Crocodylus intermedius</u>	E	I	E
Rio Apaporis caiman				Orinoco crocodile			
<u>Caiman crocodilus crocodilus</u>		II	E	<u>Crocodylus johnsoni</u>		II	V
Spectacled caiman				Johnson's crocodile			
<u>Caiman c. yacare</u>	E	II	E	<u>Crocodylus moreletii</u>	E	I	E
Yacare caiman				Morelet's crocodile			
<u>Caiman c. fuscus</u>		II	E	<u>Crocodylus niloticus</u>	E	I	V
Brown caiman				Nile crocodile			
<u>Caiman latirostris</u>	E	I	I	<u>Crocodylus novaeguineae</u>	E	I	I
Broad-nosed caiman				mindorensis			
<u>Melanosuchus niger</u>	E	I	E	Philippines crocodile			
Black caiman				<u>Crocodylus n. novaeguineae</u>		II	V
<u>Paleosuchus palpebrosus</u>		II	V	New Guinea crocodile			
Dwarf caiman				<u>Crocodylus palustris kimbula</u>	E	I	V
<u>Paleosuchus trigonatus</u>		II	V	Ceylon mugger crocodile			
Schneider's smooth-fronted caiman				<u>Crocodylus porosus</u>	E**	I**	V
				Salt-water crocodile			

KEY TO SYMBOLS

ESA

E = Endangered
T = Threatened
T(S/A) = Threatened by
Similarity of Appearance

RDB

E = Endangered
T = Threatened
V = Vulnerable
I = Indeterminate
O = Out of Danger

CITES

I = Appendix I listing
II = Appendix II listing

<u>Crocodylus rhombifer</u>	E	I	E
Cuban crocodile			
<u>Crocodylus siamensis</u>	E	I	E
Siamese crocodile			
<u>Osteolaemus tetraspis</u>		I	E
West African dwarf crocodile			
<u>Tomistoma schlegelii</u>	E	I	E
False gavia			
FAMILY: Gavialidae			
<u>Gavialis gangeticus</u>	E	I	E
Gavial			

* Different populations of the American alligator are listed on the U.S. Endangered Species Act as Endangered, Threatened, or Threatened by Similarity of Appearance.

**Populations of Papua New Guinea are not included in these listings. Salt-water crocodiles from Papua New Guinea are listed on CITES Appendix II.

CROCODILE MANAGEMENT AND HUSBANDRY IN PAPUA NEW GUINEA

Mark Rose

FAO/UNV Regional Crocodile Manager, Crocodile Management
Department of Primary Industry
Box 417, Konedobu, Papua New Guinea

INTRODUCTION

The National Crocodile Project in Papua New Guinea was initiated in direct response to dwindling exports of crocodile skins reflecting a decline in the population following hunting pressure by expatriates in the 1950s and 1960s (Whitaker, 1980).

Policies were formulated (Downes, 1968, 1971, 1974), the main objectives of which were:

- To assist the people of Papua New Guinea living in remote areas that are unsuitable for most types of conventional forms of agricultural practice;
- To increase foreign exchange earnings on exported skins;
- To evaluate and monitor the effects of cropping on the wild population with a view towards the goal of maximum sustained yield cropping.
- To encourage local participation in decision making about management utilization of the local wildlife resource.

The strategy which seemed most appropriate to the Papua New Guinea situation, as stated by Downes (1971), was based on the procurement of young crocodiles from the wild. They would then be reared in a network of village holding pens and technically sophisticated farms (see Fig. 1). Essentially the policy recognized (Bolton, 1979):

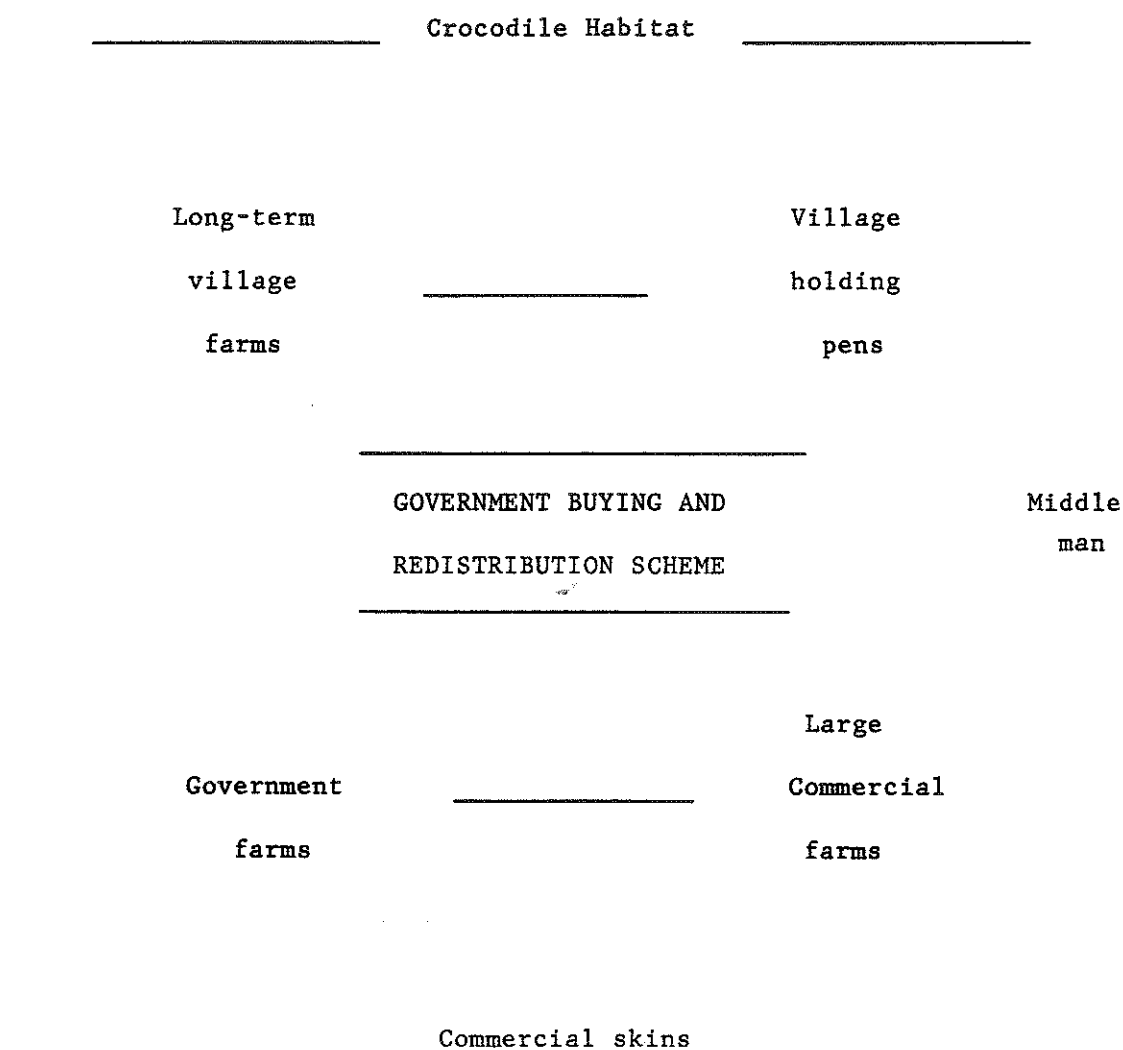
- The existing wastage and inevitable downhill trend of skin hunting with its emphasis on killing wild survivors;
- The high natural mortality of young crocodiles;
- The ultimate replacement of skin hunting with pen rearing of young wild crocodiles.

FIGURE 1

A SCHEMATIC DIAGRAM

SHOWING

THE CROCODILE NETWORK IN P.N.G
(after De Vos, March 1979)



This policy met with the approval of the Papua New Guinea Government, FAO/UNDP, CITES, and members of IUCN SSC Crocodile Specialist Group (Pooley, 1977; Medem, 1977).

In 1977 with the assistance of FAO/UNDP (PNG/74/029) the policy was implemented. During the life of the project progress has been monitored in six monthly reports by each regional wildlife manager. These have been the working papers upon which management decisions, resulting in change in emphasis, were placed.

PROGRESS TO DATE

Management

Between 1977 and 1979 the main drive was towards establishing the village rearing system. This was carried out by means of extension work and the improvement and establishment of government demonstration farms. During this period three FAO/UNDP experts were contracted, and eight United Nations Volunteers plus the corresponding number of national counterpart staff were involved in extension work. Demonstration farms were situated at Lake Murray and Balimo in Western Province, Pagwi, and Angoram in East Sepik Province, and Kikori in Gulf Province.

The role of the extension worker was to assist and advise villagers in basic crocodile husbandry and help overcome other problems associated with crocodile farming, i.e., business management. By the end of 1979 over 180 farms had been established, but very few of these could be considered successful (extrapolated from Progress Reports, 1977 to 1979, Bolton and Balson). A review (Burgin, 1980) showed that the stock numbers on these farms had shown a decline indicating a lack of interest in farming. In most areas the majority of skins were still coming from wild caught specimens, and even by 1981 under 1,000 crocodiles had been grown to culling size on village farms (Whitaker, 1981).

The reasons for the decline can be attributed to the following:

- a) Seasonal and regional shortages of food and water supplies.
- b) People found it hard to abandon subsistence agriculture in favor of relatively modern farming methods.
- c) Villagers tended to become apathetic in the face of the long term nature of crocodile rearing, i.e., cash reward is not available on a day to day basis. This results in the neglect of stock, and when this happens growth rates are slowed and the problem compounded.
- d) In Gulf and Western Provinces villagers were initially encouraged to form large business groups (a criteria for Development Bank loans). This meant that any returns would be spread over large numbers of people, most of whom were

unproductive (Rose, 1980). In the Sepik the reverse was true. The independent nature of villagers tended to prevent them pooling their resources in an attempt to overcome food and water shortages (Bolton, 1979).

It became apparent that in order to achieve the major objectives of the project a more appropriate strategy had to be put into effect. This was carried out by placing more emphasis on the commercial rearing rather than the village farming of crocodiles. Integral to this was the expansion of the crocodile buying and redistribution service. By early 1980 the methods of packing and transporting crocodiles had been successfully worked out, and the system became fully operational. It should be noted that a successful purchase network had been established by a commercial farm operating out of Lae.

To date the scheme has been a success. Figure 2 shows that there has been an increase in the numbers of crocodiles passing through the buying scheme with a subsequent increase in total captive stock. The scheme is advantageous in that (a) there is less wastage of the crocodile resource, (b) a cash reward (averaging \$8 US per crocodile) is spread over a wider population, i.e., those persons who were excluded from crocodile rearing due to lack of a suitable site can now be involved, (c) it relieves the villagers of the responsibilities of maintaining stock, and (d) it puts Papua New Guinea in a better position to respond to market requirements.

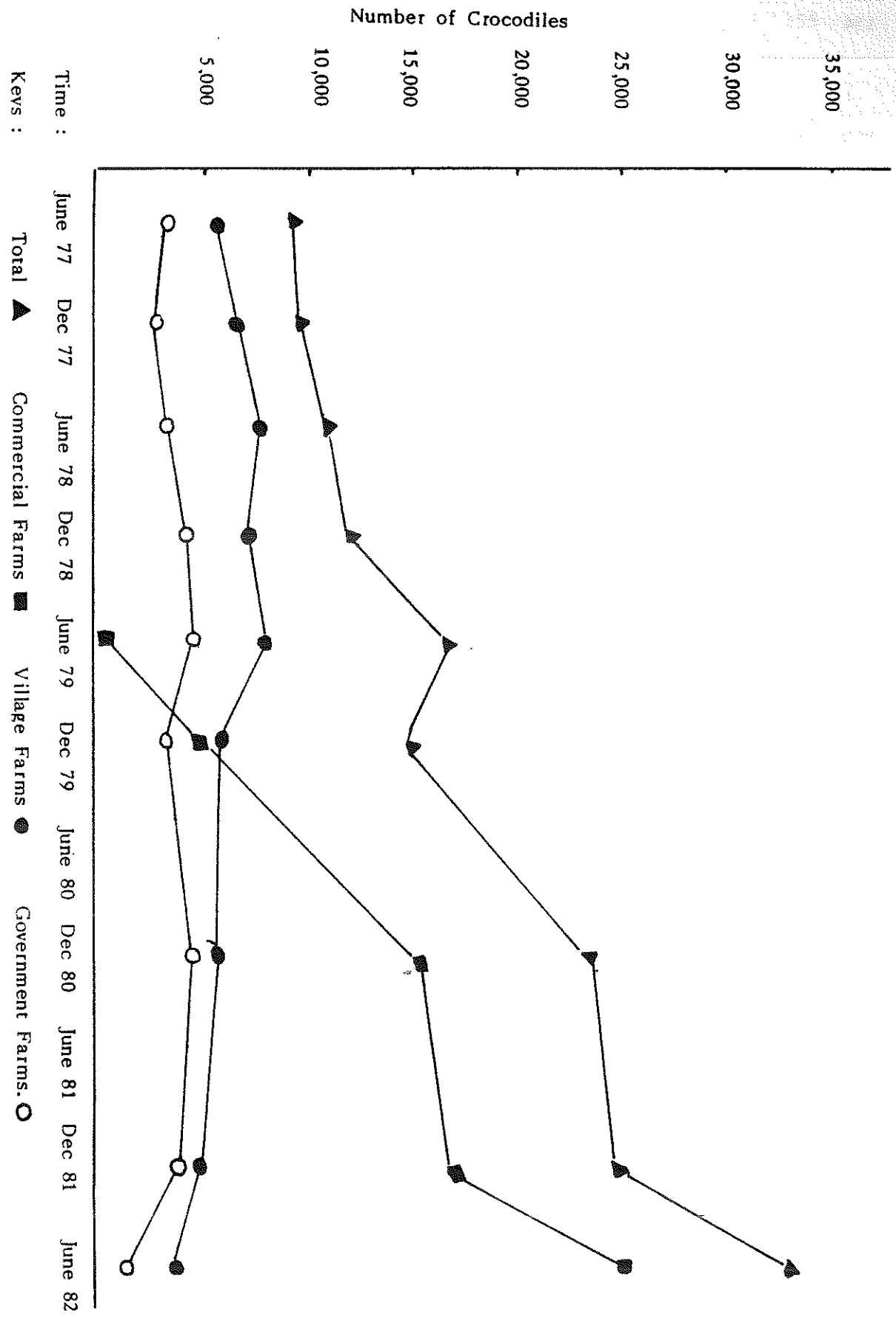
Husbandry

A comprehensive account of crocodile husbandry to date in Papua New Guinea has been prepared (Bolton, 1981). The purpose of this section is to summarize some of the more important aspects of that report and supplement it with additional information from other sources where applicable.

1. Pen Design and Construction

This varies according to local conditions, requirements, and resources, i.e., types of materials available and finance. At the village level a 10 m by 10 m pen with a U-shaped pond 1 m deep has been found to be the most successful unit. The U-shaped pond appears to give the optimum water to land ratio and gives more bank area (the area most utilized by crocodiles) than the conventional round-shaped pond. This is thought to reduce stress amongst young crocodiles (Lever and Balson, 1978) and reduces fighting among 4th year crocodiles (Bolton, 1981). Fencing materials normally consist of roughly cut posts bound together with split cane. The most successful post (pers. obs.) being the rosewood (*Terecarpus indicus*). After cutting and placement, this species continues to grow and therefore needs little maintenance, only periodic pruning. Water channels are not normally lined, except in some cases where drought and leaching are a problem. Most farms, however, are built either in tidal areas or where there is a continuous water supply, such as small creeks.

FIGURE 2. A Graph to Show the Distribution of Captive Crocodile and Total Stock Figures from July 1977 - June 1982.



In large farms, such as government redistribution stations, a similar pen design is used, but normally the pens are larger to hold more stock. Burrowing in unlined water channels has been found to cause problems (Bolton, 1981) both in regard to maintenance and mortalities. The problem has been partly solved by the placing of split timber or large stones along the channel walls. Neither has proved very effective. The use of Reno mattresses is currently being investigated.

In commercial farms pen design is also based on the U-shaped water channel, and here again pens are normally larger (30 x 30 m) and fencing constructed from more permanent materials, such as wire or concrete. All water channels are lined with waterproof cement. Provision of shade has been found to be paramount to successful rearing and is normally in the form of permanent vegetation. Although food plants such as bananas and cassava have the advantage of being easy and quick to grow as well as providing food for the owner, they also have distinct disadvantages, i.e. bananas have a tendency to fall over after fruiting, facilitating escapes, and cassava radiates from the base, making it difficult to catch stock. Here again rosewood has proved successful both in providing a fast growing canopy and a discrete base.

2. Segregation

Segregation by size is thought to be an important factor in successful pen rearing (Bolton, 1981; Balson, 1981; Bolton and Laufa, 1982). Although it has not been scientifically proved, it is thought to relieve the stress and malnutrition caused by competition for food.

Trials conducted at Moitaka to determine whether growth of subadult *Crocodylus novaeguineae* was affected by the presence of *C. porosus* showed that segregation of species held no advantages as growth rates of each species were not altered. However, Burgin (1981), working on hatchlings, showed that dietary requirements between species differed, therefore indicating that it would be advantageous to segregate species at this level. Further research is needed to establish whether segregation would enhance the growth rates of each species from hatchling to culling size.

3. Stocking densities

Due to the variability of conditions existing from farm to farm and within farms, no firm guide to densities has been found (Bolton, 1981; Gaudie, pers. comm.). In those farms that have a varied feed supply, good size segregation, and adequate shade, density figures shown in Table 1 have proved successful.

4. Growth and Diet

Although growth is dependent on many factors, such as those mentioned above, diet can be regarded as one of the most important. During the history of the project feed trials were carried out at Moitaka Crocodile Farm to determine the optimum available diet, the criterion for success

Table 1. Table shows successful stocking densities

Belly width cm	Total Length cm	Area m ²
		per crocodile
10 - 20	43 - 94	0.66
21 - 25	95 - 111	1.00
26 - 36	112 - 166	1.13

being improved growth rates. Bolton (1981) concluded that despite the superiority of fish and fish mixed with poultry, poultry showed perfectly satisfactory growth rates. The food supplement Trivim was later added to the fish diet, but no significant improvements in growth were recorded. Obviously there is room for more experimentation with other food items before optimum diet can be realized. Such trials are currently being undertaken at Mainland Holdings at Lae.

Differential growth rates have been attributed to individual variation, sex, size, and species. Individual growth rates have been seen to be enormous, and these may override variability due to species and sex (Bolton, 1981; Gaudie, pers. comm.). In animals with comparable growth rates, males have been found to grow faster than females and *C. porosus* faster than *C. novaeguineae*. Quantification of the former in sub-adults has been found to be difficult due to problems in sexing individuals.

As with most other animals, captive crocodiles in Papua New Guinea show a decrease in growth rate with increasing size. Table 2 data shows average rate of growth for both species and sex.

Decrease in growth rate is important when considering the commercial turnoff point, i.e., when the highest rate of return is exceeded. Although these would vary from farm to farm due to growth rates and fixed costs such as labor, food, etc., information so far indicates that it would be in the range of 35-41 cm belly width. This could be altered depending on market requirements abroad.

5. Mortality

Mortality rates vary with standards of management and size distribution of stock found on individual farms. Table 3 shows the aggregation mortality rates for two government farms in the Sepik. At the time of writing no data for commercial farms is available but indications are that mortality is lower. This would be expected as the major of

crocodiles reaching commercial farms are settled stock, all the weak having been eliminated at government redistribution farms. As can be seen in Table 3, a significant proportion of fatalities occur in stock 10 cm belly width or under. Although difficult to prove, it is felt by project staff that this is due to stress. Bolton (1981) reports that stress in crocodiles leads to anorexia and then to eventual death. He recommended the use of parenteral glucose and/or isolation of affected animals in carefully managed sick pens, depending on the stage of sickness, i.e., in the early stages of health attribution the latter method may prove to be all that is required.

In order to alleviate stress, the government farm at Kikori (Gulf Province) uses an introductory pen system. Newly purchased crocodiles are placed in a 30 x 30 m heavily vegetated pen, where they are allowed to acclimate to captive conditions before being placed with other stock. To date, this has resulted in a significant reduction of the mortality rate. It has been recommended that other farms in PNG adopt a similar system.

Table 2. Average rearing periods from hatchling to 50 cm belly width (after Bolton, 1981)

Species	Males	Females
<u>C. porosus</u>	3 years 11 months	4 years 4 months
<u>C. novaeguineae</u>	5 years 10 months	6 years 4 months

Table 3. Mortality rates and size related distribution on two Government Farms in the Sepik (After Whitam, 1981).

Belly width Size (cm)	Number of Deaths	Mortality over 6 month period (%)
Under 10	180	20
10 - 11	59	10
12 - 14	7	4
15 - 16	3	2
Total	249	

6. Breeding

Due to the Government's restrictions on possessing crocodiles over 51 cm belly width, breeding research has been carried out only at Moitaka Government Farm. Crocodiles at Moitaka are housed in enclosures of varying sizes (all constructed from galvanized wire) ranging from 9 m x 15 m (containing one pair of crocodiles) to 56 m x 66 m (housing 20 crocodiles at a sex ratio of 4:1) (Callis, 1981). Ponds occupy approximately 35 percent of total area with an average depth of 1.5 m. None of the pools are lined and shade is provided by natural vegetation. Diet consists mainly of trash fish and is supplemented (subject to availability) by mixed offal and lamb flaps. Each crocodile receives an average of 2.5 kg of food per week (Callis, 1981).

To date results have been disappointing. Although breeding has occurred regularly for a number of years, success rates have been low. Last season 26 adult female C. porosus and 21 female C. novaeguineae produced only 409 and 38 hatchlings respectively (Hollands, pers. comm.). These figures of 9.7 and 1.2 hatchlings per adult per year clearly show that the present stock, under prevailing conditions, is not commercially viable. In addition it appears that 55 percent of C. porosus eggs were found to be infertile.

It has also been observed that in these small colonies territorial behavior prevented smaller females from entering ponds for mating (Callis, 1981). However the inclusion of one small pond per female has eased the problem. The poor reproduction rate demonstrated at Moitaka could be a result of stress imposed by captive conditions (Burgin, 1981), an unknown dietary deficiency (Bolton, 1981), or a combination of both.

7. Incubation of Eggs

The methods of incubating crocodilian eggs that have been used elsewhere include:

- Removal of eggs immediately following laying and subsequent incubation carried out in controlled environment chambers (Joanen and McNease, 1975);
- Removal of eggs from natural nests prior to the termination of development. These are then placed in incubators;
- Transference of eggs to artificial nests (Pooley, 1971).

The merits and disadvantages of each method were discussed by Bolton (1981). In the absence of environmentally controlled chambers, the method used at Moitaka has been a compromise between methods (b) and (c). Eggs are transferred from natural nests 75 days after laying; average natural incubation periods being C. porosus 95 days (Moitaka records) and C. novaeguineae 87 days (Hall, 1982). These eggs are then

placed in incubators complete with natural nesting materials. Recent research (Fergusson, 1981) demonstrated that natural nesting material is essential to successful hatching of young crocodilians.

8. Rearing of hatchlings.

Investigations into factors affecting hatchling growth were carried out by Burgin (1981) over the period 1978-1980 and Bolton (1981) to the present date. Criteria used to measure progress were survival and weight.

9. Conditions

Initial hatchling enclosures consisted of 1 m x 2 m pens. These were found to be unsatisfactory (Burgin, 1981) and were later modified to 2 m x 2 m pens. Each pen was constructed from thermolite blocks faced with mortar. Pools containing water were approximately 5 cm deep and occupied 36 percent of the total area. Pens were furnished with a small raised wooden board to provide cover. The whole area was shaded by chicken wire covered with hessian.

These enclosures were open to daily fluctuations in ambient temperature. Early in 1981, brooders were introduced. Results proved to be inconclusive, and Bolton (1981) recommended an improved design.

After three months, crocodiles which have shown good growth are moved to a 3 m x 3 m pen which has a circular pool 25 cm in depth, occupying 47 percent of the total area, an earth floor, and natural vegetation.

10. Investigations and Results

Burgin (1981) investigated the effects of diet, stocking density, and handling. She concluded that of the diets tested, chopped marine fish produced the best results for *C. novaeguineae* but the least successful for *C. porosus*, and that a mixture of fish and chicken proved successful for *C. novaeguineae*. Comparison of *C. novaeguineae* fed on marine fish for six months to those started on freshwater fingerlings for three months and thence marine fish for the remaining three months showed the latter diet to enhance survival but did not reveal significant differences in weight. The use of vitamins and insects as food supplements were also studied. The former revealed that no advantages (at the dosage administered) could be found, and that the use of insect traps proved detrimental to survival. High density (0.2 m² per animal) stocking and regular resorting into size categories also proved to be detrimental to hatchling production.

During this study unacceptably high mortalities were incurred (up to 90 percent in some trials). Burgin attributed this to low hygienic conditions, poor stock quantity, and density housing.

However, subsequent trials using only *C. porosus* under similar housing conditions and densities as Burgin, but only feeding coarsely

minced *Talapia* have been encouraging. The trials experienced less than 10 percent mortality and growth increments averaging 25.1 percent of total weight per month. 1982 results showed mortalities to be higher: 16 percent for *C. porosus* and 29 percent for *C. novaeguineae*. However average growth increments are 34.6 percent and 27 percent of total weight for *C. novaeguineae* and *C. porosus* respectively. Although rearing techniques appear satisfactory, it is felt that production could be improved by feeding small crustaceans such as prawns and small crabs. Evidence from the wild (Taylor, 1977; Ross, 1977) shows that small crustaceans make up a major proportion of the diet of young crocodiles.

It has also been observed in the Sepik (Bolton and Laufa, 1982) and in Gulf Province (pers. obs.) that villagers have successfully reared *C. novaeguineae* feeding only freshwater prawns (*Macrobrachium* spp.). Even under extremely poor housing conditions (normally an oil drum) and in high densities (up to 0.025 per m² per animal) with maximum disturbance, all animals appeared to be extremely healthy. Thus it would appear that hatchlings fed on this diet can overcome factors assumed in other captive conditions to cause stress with its subsequent lowering of growth rates and high mortalities. At present project staff are investigating a reliable cheap source of prawns to test this hypothesis.

Legislation

Until 1966 there were no laws in Papua New Guinea relating to the crocodile industry. In 1966 the Crocodile Trade Production Act came into force. This required all dealers to be licensed. It also protected all adult crocodiles over 51 cm belly width (approximately 2 m total length) but was only adopted in the Papuan region. Only in 1975 was it ratified by the entire country. In 1974 a new act was put before Parliament but was not enacted until late February 1980. This was amended and became split into the following categories.

- a) Crocodile Traders' License--this is restricted to skin traders only;
- b) Company Crocodile Buyers License--for persons employed by the company. This enables them to buy both live crocodiles and their skins. The licensee cannot buy crocodiles for anybody else but the company which employs him.
- c) Crocodile Export License--is granted to companies on condition that only export skins that have been bought through its company buyers' license and that all skins are tagged before leaving the country.

Under the new law, the upper size limit of 51 cm remained the same but a lower limit was introduced preventing any person from dealing in skins of less than 18 cm belly width. All crocodile farms with stocks of over 200 crocodiles must now be registered, and six monthly stock reports sent to the Conservator of Fauna. In addition, a scientific worker

wishing to collect, kill, or keep crocodiles may only do so after receiving a permit from the Conservator.

Summary and Future Management

To date progress with regard to husbandry techniques and the goal of replacing skin hunting with captive rearing has been slower than expected. The main reason for this is that most of the initial effort was put into village level farming. As shown in the text and elsewhere (Burgin, 1980), this has proved unsuccessful. However, despite this significant progress has been made, as indicated by this paper and others (Whitaker and Kemp, 1980; Hollands, 1982; Bolton and Laufa, 1983). A summary is shown below:

- a) Extension work by field officers has led to improved skinning and preservation techniques yielding higher average skin grades.
- b) Extension work both by government and commercial farms has established a live crocodile purchase network.
- c) Extension workers in some areas have effectively encouraged the protection of adult crocodiles and their nests.
- d) The project represents a form of crocodile management which provides a sustainable cash crop in areas where other forms do not exist.
- e) There now exists a crop of trained crocodile officers.
- f) Some progress towards successful breeding and rearing of hatchlings.
- g) The establishment of protected areas and restocking schemes.
- h) The establishment of a monitoring and research program.
- i) The establishment of a legislative framework on which the industry can be based.
- j) Direct marketing to Europe and Japan instead of through Singapore has increased revenue.

Following the Government's budget, released later in 1981, the Crocodile Project, with the exception of the Monitoring component, has been in effect decentralized, i.e., each province is now responsible for its crocodile resource. This means that the management is in danger of becoming uncoordinated and fragmented. In order to prevent this from happening, the establishment of a Crocodile Management Board has been proposed.

The purpose of this board would be to provide a forum where management decisions pertaining to the resource could be discussed and future policies formulated as well as raising money to fund the monitoring program. It is hoped that such a board would bring about unanimous agreement and provide a united front on such matters as monitoring legislation and marketing. A meeting of all parties concerned was held in May of this year with encouraging results, and a further meeting has been scheduled for November. The feasibility and financing of such a board is currently being investigated by project staff.

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PRODUCTS CITED

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SITUATION REPORT: INDIA
CENTRAL CROCODILE BREEDING AND MANAGEMENT PROJECT

Prepared by L.A.K. SINGH on behalf of the Government of India,
Central Crocodile Breeding and Management Training Institute,
Bahadurpura, Hyderabad -- 500 264, India

Beginning of the Project

The Central Crocodile Breeding and Management Project of the Government of India was started in 1975 with assistance from U.N.D.P./F.A.O. Several sub-projects were started at different state levels where crocodilians or their potential habitats occurred. These projects were managed by the different State Forest Departments directly or through their Wildlife wings.

The objectives of the Project have been to (1) protect remaining natural populations, (2) maximize natural recruitment through a "grow and release technique," (3) introduce crocodilians into areas where they once occurred and which still have suitable habitat, (4) promote captive breeding, (5) commence research on the different aspects of the biology and management of the Indian crocodilians, and (6) establish a multi-level program for training personnel.

Progress

1. Protection: This has been possible because of protection given to all Indian crocodilian species through (a) an act preventing export of crocodilian leathers, (b) the Wildlife (Protection) Act of India, 1972, (c) the creation of 11 special crocodile sanctuaries (Appendix I), and (d) public education.

2. Releases: The "grow and release technique" involved (a) collection of eggs from the wild, (b) artificial incubation of the eggs in a hatchery at $30 \pm 2^{\circ}\text{C}$ while maintaining a 7-10 percent moisture content by weight, (c) rearing hatchlings under simulated natural conditions to a length of about 1.2 m, (d) release of the hatchlings in sanctuaries, and (e) protection of the released crocodilians.

The total releases made through summer 1982 are: mugger, 490; gharial, 855; and saltwater crocodile, 278. The details of these releases are given in Appendix I. A list of the different rehabilitation projects is given in Appendix II.