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THE ROLE OF MANAGEMENT IN THE CONSERVATION OF ENDANGERED SPECIES  
WITH SPECIAL REFERENCE TO INDIAN CROCODILIANS.

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Following some general remarks on aspects of management critical to conservation of endangered species, the paper describes the role of these same aspects of management in the achievements of the all-India Project, Crocodile Breeding and Management.

INTRODUCTION

This paper, in as far as it relates to crocodilians, discusses one aspect - one extreme - of management, here described as 'active management', where there is deliberate, well-planned, interference in the life history of the species under management. The management used is of the most 'active' type, in that individuals of the species are reared in captivity, under as natural conditions as possible, in order to provide maximum boost to the size of the populations in the shortest possible time. This management regime is illustrated throughout with reference to the crocodilians, since this is the author's specialist field, but more importantly, because there has been a large-scale project on crocodilians in India extending over many years, which many of you will know about, and this Project provides a yard-stick against which the achievements of active management of this type can be measured.

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This is most important, as in suggesting active management as an invaluable tool in the case of extremely rare and greatly endangered species, it is vital that the likely results of this approach can be quantified.

## MANAGEMENT

### The Scope of Management

Management can be extremely 'light' - it could involve merely keeping visitors out of a part of a sanctuary at a particular time of year - when ground nesting birds are nesting for instance - or delaying the cutting of grass by several weeks to allow part of the life cycle of some small animal, ground-nesting bird, or insect, to be completed. On the other hand it could involve - as in the case of crocodilians in India - the 'production' of large numbers of release-sized animals to repopulate whole areas of the natural habitat. Management may involve captive breeding of an endangered species, and rearing of the resultant young in captivity for release back into the wild, management of the natural area etc

Since wild life needs space in which to live wild life management is about land and the use of this land. Often man need not be excluded from the land if his activities are compatible with the particular forms of wild life being managed.

Since even relatively undisturbed areas of the natural habitat are now becoming rare, in many/most parts of the World, management involves the preservation of certain tracts of land in as near to natural conditions as possible. Such tracts of land, which may constitute only a small fraction of the total land area being managed, are an integral part of

management programmes but such (drastic) action will not be needed in most instances. What will be necessary is to prevent poaching and to ensure that activities which are permitted are compatible with the type of wild life being managed. Elephants, for instance, will survive well in/natural forest tracts being worked on a well-planned, sustained yield utilisation basis by the Forestry Departments, provided these departments are able to ensure the long-term survival of their Reserved and Protected Forests. Elephants provide an excellent example of the need to manage large areas of land for certain species. They do not need exclusive access to the land but the land must be maintained under natural, mixed, forest/bamboo cover. Furthermore, many of the problems facing elephants in India today are problems that are equally acute for the Forest Service. It is the alienation of large tracts of land within the Reserved Forests which has provided a major problem for the future of India's elephant populations. Due to man invading the forests, and clearing and settling large areas of forest for agricultural settlement, he is increasingly coming into conflict with elephants.

It is not to downgrade the deleterious effects of large-scale 'economically-oriented' poaching, to state that land is the first and foremost need in wild life management. An endangered species may have become endangered while the habitat remained abundant, and in good /<sup>ecological</sup> shape, as a result of poaching, but increasingly today, pressure is on the land, and there is no possibility of using modern techniques to build up the populations of endangered species unless land is available for their use. The ultimate need will always be for habitat - land.

Hence the first role of management has to be to retain - or where this has already been lost - to build up - a 'land bank' for the concerned species.

#### Major Management Activities

We now come down from generalisations to the specific, and the above ideas are expanded and illustrated using, not theory, but the practical results of many years of hard work by dedicated Indians, with whom I have had the very great pleasure to work, in many parts of your enormous Country, from Gujarat to West Bengal, and from northern Uttar Pradesh to Tamil Nadu.

Although the large-scale Government of India/FAO/UNDP Project Crocodile Breeding and Management which I recommended be initiated in my 1974/Report to the Government of India, and for which I was Chief Technical Adviser for many years (1975-1981), covered all three species of Indian crocodilians - the gharial (Gavialis gangeticus), the saltwater or estuarine crocodile (Crocodylus porosus) and the mugger or marsh crocodile (C. palustris) we will here concentrate mainly on the gharial as its conservation is already well known, and the saltwater crocodile, as it illustrates the land management problem ideally, in a fascinating, but little-known, and very fragile, ecosystem.

We faced the extremely difficult problem initially that the animal which we were charged with conserving - the gharial - itself as elusive throughout most of the year as the tiger - was very little known. Even its netting season was incorrectly stated by Malcolm Smith (1931), an error never corrected in the literature until the present Project

started publishing its results. Accordingly we had to study its biology from scratch as we went along - we could not afford ourselves the luxury of doing this first before initiating the Project as the gharial would have been extinct before we had learned very much.

With many other species being managed, or proposed for management, the biology may be much better known so this aspect can be downgraded.

There are four (sequential) aspects in setting up a conservation project of this type, although in the present instance, due to the endangered status of the gharial as a species, and of the saltwater crocodile as a member of the Indian fauna (this latter species has a wide extra-Indian distribution also) these four separate, but inter-related, tasks had to commence simultaneously.

These steps are:

1. land management
2. protection
3. getting to know the animal - in the Konrad Lorenz sense that to adequately study the behaviour of a dog one must first become a dog - leading to research projects as/where necessary
4. active management of the endangered species

These four topics are discussed separately below, first in general terms, and then illustrated using examples from the crocodilian project. Although the examples are, therefore, all Indian, the same type of problems occur everywhere - it is the matter of degree that differs from country to country. Incidentally, in many countries known to the author the problems are very much greater than in India.

## 1. Land.

The first considerations are,

- a) if not already known, to locate key areas of land for the species concerned and,
- b) to decide what degree of management control must be exercised over these in order to provide adequate long-term protection to the species.

Phase a) may entail extensive surveys in the first instance ~~xxx~~ in order to delineate key areas of the natural habitat in which all the species' requirements are met at all seasons of the year. If this is not possible - in a migratory species for instance - land corridors may have to be incorporated in the land plan at this stage linking two or more areas of land in order to achieve this objective.

In phase b), it is important to fully appreciate that land, as the most basic commodity in the lives of most people, is intensely political. While the sincere conservationist will have to fight for the land that it required he/she should not ask for more control (or more land) than is absolutely necessary for the Project to achieve its objectives. We are hopefully passing out of the phase in which eager conservationists state that 'all' that needs to be done in order to save species X is to build a wall around land area Y, keep people out, and stop every kind of activity within. This approach - even if it were feasible - is likely to be counter-productive, and is at the opposite extreme from active management here proposed, which appreciates the 'political realities' of life, and tries to actively manage in the interests of the species in order to ameliorate other considerations

which cannot be changed.

Wherever possible multi-land use should be encouraged, but this should not be an excuse for land alienation and/or poaching (the subject of the next section). There is no question but that multi-land use, good as the idea is, requires the 'manager' to be constantly on his toes and 'manage' in order to detect and deflect intrusions of all kinds. It can be likened to a guerilla war.

In concluding this very brief discussion on land <sup>4</sup> would point out that it will not be possible to fulfill considerations a) and b) set out at the start of this section without good biological information on the species under management. This will involve good basic research, if the work has not been adequately carried out already, and I must state that such 'good basic research' is, unfortunately, not the norm in a great many conservation projects. It is essential to have one's facts right. Enthusiasm, important as it is, is not an adequate substitute for 'hard data' when it becomes a matter of bargaining over land. Nor should it be.

## 2. Protection.

It is a straightforward matter to formulate protection requirements or to write suitable protective legislation. The problems are practical, at the implementative stage. Many sanctuaries may have superb management plans but if the actual staff on the ground have never seen the management plan then it is of little use.

A preliminary observation, relating to India, based on my eight years practical experience in many areas of the Country, is that even

a low and extremely simple level of protection can have an amazing effect. This sometimes reflects virtual absence of any form of protection in the area previously, but quite clearly reflects the deeply ingrained attitude of the ordinary people of India - Indian villagers are basically respectful and law-abiding. The problems lie elsewhere.

There are several basic factors to get right at the start in formulating any protective programme. These include:

- 1) The status of the land. Penalties are automatically doubled for poaching offenses committed in sanctuaries or National Parks. Hence it may be useful, for this reason alone (but also for others set out below), to have key management areas gazetted as sanctuaries and where appropriate later upgraded to National Park status.
- 2) Appointment of protection staff. Staff must be appointed solely for protection duties. It is no use putting people already engaged on other work onto part-time protection work also. If the existing staff (let us assume the protection area is ~~ix~~ already a State Forest) are not sufficiently motivated then new recruits should be used. As far as India is concerned, there is frequently in my experience, an unfortunate lack of liaison with lower staff - those who actually have to do the work. Furthermore, staff should not be diverted from their duties to other activities.
- 3) Supporting the staff. I have found a major problem in protection shortcomings is that the staff are not sufficiently motivated, which invariably means that their superior officer(s) are not wholehearted in their

task. There is a great willingness to please superiors in India and if catching poachers is not likely to please their superiors the field staff will divert their energies elsewhere. So there must be no doubt about the commitment of the senior officers, including the O-I-C. This commitment must be demonstrated regularly if protection is to succeed. It should be self-obvious that all these staff (seniormost as well as field guards) must live in or on the edge of the area they are protecting. This point requires heavy emphasis as it is apparently not-obvious here in India, where officers-in-charge of National Parks, often live at a remote distance from their jurisdiction where contact with them is difficult at best, and extremely time-consuming.

The above three factors are prerequisites without which there is no point in drawing up a protection operating plan.

It is not possible to generalise here about how protection should be carried out. Even within India there are markedly different regional attitudes to such matters as, for instance, the arming of protection staff. While this is the norm in certain northern States it is virtually unknown in many other areas of the Country. My own feeling is that it is often unfair to expect unarmed and/ill-equipped guards, to overcome gangs of armed poachers. Of course, even today the British police are unarmed, but there are key differences. The British police do not operate in remote areas against people (in this case poachers) who are always armed. Wild life guards have by the very manner of their duties, to operate in remote areas where they can be shot and the murderer is unlikely ever to be apprehended. To expect unarmed men under such circumstances to be

thoroughly dedicated in their work may be expecting too much. This is a topic which I frequently pointed out during my many years in conservation work in Australia. I can think of many areas of the World where such a situation exists. In a sense the status (which includes arms and training in their proper use) of the wild life guards, reflects the importance the Country or State places on the proper protection of its wild life resources.

However, it can be stated as a general rule, that wild life guards must patrol constantly by day and night, on an irregular schedule. It will be ideal if they are trained to carry out basic research duties as has been the case in the crocodile project (see below) as this gives them a reason to be actively moving around the sanctuary/National Park in the course of collecting data. The senior staff should join patrols as frequently as possible.

Poachers know whether guards are active or not. Patrolling as an end in itself can become extremely boring, especially as the more successful the patrols, the fewer people will risk poaching, so encounters become greatly reduced. We have found in the crocodile project that the presence of an active research group, working on the animals in the wild, backed up by a skeleton protection staff, has worked wonders for protection.

Guards to protect everything. It must be made clear at the outset that the guards are not employed merely to protect tiger, or gharial, or rhinoceros. Their job is to prevent any unlawful activity within the boundaries of the protection area whether it be illegal cutting of

grass or felling of trees, as opposed to game poaching. The former activities, of course, may in the long term, be as deleterious to the survival of the species being protected as direct killing by poachers, which is why such activities are banned under such circumstances. They will not be obvious to the protection staff, however, and the reasons should be carefully explained to them.

### 3. Getting to know the animal.

This need not, and should not, be restricted to the research staff. The more familiar the protection staff are with the habits of the animal(s) on which protection is concentrated the better. Furthermore, in India, as in many parts of the World, the right sort of protection staff (see below) may know much more about the animals than the newly-appointed research staff - at a practical level at least. This is a tremendous advantage. Protection staff should always be local people. Quite apart from the advantage of their local wild life and geographical knowledge, they will have invaluable contacts among the local people. Government policy is usually the reverse - to take people away from their local areas, where it is thought they may use their contacts for improper purposes. Furthermore, transfers are frequent - often absurdly so - the stated reason being to prevent their building up local contacts which can be used improperly. To my mind this is a defeatist attitude. Furthermore, in wild life work frequent transfers of staff cannot be tolerated.

One does not require rigorous scientific training to be able to

collect research data under supervision. Illiterate or semi-literate field guards can collect extremely valuable data as will be shown below by selected examples from the crocodile project. The scientific skills lie in experimental design and in interpretation of the data, data collection in itself being largely a routine affair requiring honesty and reliability, <sup>traits</sup> which I have found to be readily available in the Indian countryside.

#### 4. Active management.

Before moving on to what, in the context of this paper, is active management, we should briefly list various degrees of active management, arranged loosely in ascending order of management involvement:

1. Fire prevention activities as carried out by the State Forest Departments are an interference with the natural habitat designed to reduce incidence of forest fires. Such activities benefit most of the wild life.
2. Seasonal burning of grass provides an extension of 1) above in that it may prevent more serious fires by <sup>deliberately starting</sup> man-made, controlled, cool grass fires. This also serves to maintain open grazing areas and perhaps to provide a crop of young grass shoots (e.g. rhino). Where these have been carried on since time immemorial they have become part of the ecology (one must remember that man has influenced the ecology since the early days of 'man the hunter-food gatherer'). Not to burn would be to have the forest encroach on such open areas, so essential to many grazing animals, and in time they would become completely forested.
3. Provision of better nesting areas provides another example. For

instance, in the case of sea turtles, which rest extremely densely on restricted areas of beach, it has been shown (Bustard, 1972) that the configuration of vegetation on the beach results in uneven nesting, some areas being several times over-utilised (in the sense that putting down a nest there results in a high probability of destroying an existing nest). In the simplest case removal of large tree trunks, especially those lying parallel to the beach, opens up areas previously barred to nesting activities (as sea turtles cannot surmount such obstacles), and greatly reduces 'funnelling' effects into areas in between. No one, I would think, would object to such activities in the interests of conserving an endangered sea turtle species. This is, however, active management, although of a comparatively low order.

4. Manipulation of the food supply can vary from a low to a medium-high level of active management, and is a widespread management tool. It may only take place in times of duress (such as drought), but by preventing large-scale deaths at such times its effect on the population being managed may be dramatic. Quite apart from supplementary feeding under conditions described in 2) above, and fire which can greatly affect food supply (such as in 1) and 2) above) a more common activity today is manipulation of the predator-prey relationship. It may be necessary to improve the predator's food supply before the numbers of the predator species can be built up. The main prey species may have been lost due to illegal hunting activities (as in the case of ungulates for instance) or from over- or uncontrolled fishing in the case of the gharial's food supply.

5. Translocation of endangered species may help to enhance the populations of many species, using carefully controlled introductions of animals from another area. Introductions may even be into areas where the species has become completely extinct. In the latter case, a strong incentive for carrying out what is a complicated and essentially long-term task, may be to better ensure the survival of an endangered species by distributing it more widely. Many endangered species have become restricted to a few or even a single area at least within the boundaries of one country. Here in India the Indian lion and the Great Indian Rhinoceros are important examples.

6. Captive breeding/rearing of endangered species provides a virtual gradation from 5) into this, the highest category of management, as translocated individuals, <sup>U</sup> <sub>L</sub> <sup>U</sup> <sub>L</sub> must, of course, be taken into captivity before translocation, and may have to be held for some time in the new area and then slowly allowed their freedom. Other activities, set out above, such as supplementary feeding, may be involved in this gradual release process.

Under the head 'captive breeding/rearing of endangered species' we include collection of wild-laid eggs for captive hatching and rearing of young for subsequent release back into the wild as has been so very extensively carried out by the crocodile project here in India, and which, since it is described below, will not be further mentioned here. As I have pointed out to our President, Dr Salim Ali, this is a technique applicable to many species of birds, especially those ~~xxxxxxx~~ <sup>where</sup> only one of two eggs laid, or otherwise less than the full egg complement

will be reared under normal conditions, the 'surplus' can be collected and placed in an incubator. The technique can also be used in the case of birds which will continue to lay/eggs are removed while the normal egg complement is being built up (Lack, 1954). Such species offer tremendous scope.

Although this is an outstanding technique, of wide applicability, it should, I believe, be operated according to a set of very definite rules where animals are to be released back into the wild. Even in the case of crocodilians, the idea is to rear them to release size as quickly as possible, under as natural conditions as possible, and using natural food throughout. We set out, therefore, not to produce pet animals, and animals conditioned to unnatural conditions in captivity, as these may not readily adapt to life back in nature following release. Proof of the efficacy of our methodology comes from the very pleasing sight of released crocodilians catching fish in the wild within minutes/hours of release and in the longer term in the very high survival rates achieved by released animals.

Although it is a very controversial subject I do not believe the technique is suitable for master predators which quickly ~~lose~~ lose their respect/fear of man and which when released may then attack humans. I consider tiger and other large cats to be a prime example of this problem. A problem which, I might add, we have never encountered with crocodilians.

Animals which are captive-bred - provided they are of a suitable species for release, can be released just as captive hatched/reared young. Zoological gardens have the opportunity to provide such material for

release from a wide range of species, and a first step in this direction is to become self-sufficient so that more need not be captured, often extremely wastefully (e.g. apes) from the wild.

Finally we come to captive breeding groups which may be retained in captivity indefinitely to ensure the gene-pool of ~~the~~ species which have a poor prognosis for continued survival in the wild, the hope being that at some stage some safe natural areas can be made available for releases. In all such cases stud books should be kept and sufficient out-breeding organised (by exchanges of stock) to ensure the continued genetic diversity of the stock.

#### MANAGEMENT IN THE CROCODILE PROJECT

Turning to the practical achievements of the Crocodile Project we will review the topics briefly set out above in the light of the Project's practical experience on the ground in many parts of India. Further details of the Project are given by Jayal (1980) and Bustard (1981).

##### 1. Land.

As stated above, in the case of the Crocodile Project, all four areas of work had to commence simultaneously. However, in the preliminary report to Government (Bustard, 1974) the emphasis was on status and the need for sanctuary areas offering good protection.

In the 1974 report, which formed the basis of the Project initiated the following year, three areas were recommended for creation as sanctuaries. These were Ranapratapsagar on the Chambal River in Rajasthan, Satkoshia Gorge on the Mahanadi River in Orissa - both for the gharial - and Bhitarkanika in Orissa for the saltwater crocodile. The last mentioned had already been highlighted and recommended as a sanctuary by our Curator,

Mr J.C. Daniel (Daniel and Hussain, 1973). In all these areas, together with many more - the Project was responsible for the creation of no less than eleven new sanctuaries - the Project assisted in the development of protection/management regimes, including the preparation of several management plans, quite apart from becoming involved in strengthening the management in a number of existing sanctuaries/National Parks. A list of the sanctuaries which were created as a result of the Project is given in Table 1.

This substantial achievement requires elaboration. At the start of the Project in April 1975 India was under-represented as far as sanctuaries were concerned, and, as is so often the case, those very areas where sanctuaries were most needed, were often where progress was slowest. The Project tried to provide momentum in key areas of crocodilian need. These areas, were often of national importance, quite apart from crocodilians and, their management has benefited all other species as well.

It may be profitable to consider this topic on a State-by-State basis:  
from April 1975

1. Orissa. Since this was the first State to join the Project, /I ~~initially~~ lived in Orissa on the banks of the Mahanadi river in the heart of the area which I had recommended for Satkoshia Gorge Sanctuary. The first sanctuary declared in Orissa was Bhitarkanika which covers an area of about 250sq.km. Its creation was a major achievement for the State Forest Department as it lies in ~~an~~ a very rich alluvial deltaic area of mangrove forests fronting onto the Bay of Bengal. The mangrove vegetation can be cleared, and the ground prepared for cultivation, (the technique has been practiced for centuries) and the land outside the sanctuary is already all under rice cultivation. A brief aerial inspection graphically

illustrates (a) the need for the sanctuary, and (b) its vulnerability. Anyone doubtful of the need for sanctuaries should see this from the air, as it illustrates a situation which will become increasingly the norm in the not too distant future. Such a sanctuary, of course, faces enormous management difficulties even in (just) maintaining its integrity (see below).

Satkoshia Gorge sanctuary takes in a 22km stretch of the Mahanadi river in an area where the river passes between high hills, and although not a gorge in the properly accepted sense, forms deep pools greatly favoured by gharial. The sanctuary boundaries were selected to take in much of the surrounding catchment and includes rich forest cover with (amongst others) good tiger and gaur populations in its 790 sq. km. There were delays in getting this sanctuary gazetted, meanwhile the Oriyan race of the gharial (the most Southerly surviving, and also the most isolated, so potentially the most distinctive) was brought to the verge of extinction. The final, extremely swift, gazettelement of this beautiful sanctuary was brought about by the personal interest of the present Prime Minister. We are ~~extremely~~ extremely fortunate in India to have this deep-rooted interest in wild life at the highest level. We are also fortunate that in the I.A.S. there are a number of dedicated individuals with keen interest in wild life matters. This combination should augur very well for wild life. Unfortunately it does not appear to have achieved its potential.

The third sanctuary sponsored by the Project in Orissa is Hadgarh,

also a most scenic area, and selected for a mugger rehabilitation programme. It comprises 191 sq.km. and the large lake is surrounded by densely wooded areas. Full details of the Orissa programme, including a rich presentation of background material, is provided in a Report which is a model of its kind, by Kanungo (1976).

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2. Andhra Pradesh. In U.P. we have been extremely fortunate to have Mr V.B. Singh as Chief Wild Life Warden from the inception of the Project (but not in 1974 when I was surveying). Mr Singh, whose achievement in the conservation of the gharial in north India is unique, has provided a detailed account of the status and rehabilitation of the gharial in U.P. (Singh, 1978). In U.P. in addition to the creation of Katarniaghat sanctuary of Girwa river, for what is the most dense remaining gharial population in the country, Mr Singh has worked endlessly to bring about the country's largest sanctuary. This has been gazetted for the gharial and takes in some 350 km. of the Chambal river in an approximately East-West direction. The Chambal sanctuary is a tri-State sanctuary in the States of U.P., M.P. and Rajasthan and 12,568 sq.km. in size.

In the creation of this enormous sanctuary I would also like to acknowledge the debt that we owe to the interest and perseverance of Mr Seth, Inspector General of Forests at the time that this sanctuary was at the proposal stage. Mr Seth well appreciated the need for large sanctuaries - I point I have constantly stressed - and that we should develop several National homes for the gharial. The Chambal National Gharial Sanctuary - to give it its proper name - is an area of outstanding potential, and when management finally reaches the desired level, can be

a truly national home for the gharial assisted by a number of well run State sanctuaries/National Parks. I will not feel that we have achieved our target, however, until the Chambal is raised to National Park status.

3. Andhra Pradesh. With the growth of the Project I had to move to a more central point with telephone facilities etc. I was relocated in Hyderabad. The Project has assisted in the creation of five sanctuaries in A.P. These are the Krishna Sanctuary (still given the unappealing and lengthy name Nagarjunasagar/Srisaillam sanctuary by the State Forest Department). This was the country's largest sanctuary at the time of its creation at 3,588 sq. km. Properly managed it can provide one of the National homes for the mugger as well as protecting some of the State's best tiger areas and a wide range of other wild life.

Few people know that gharial, until very recently, occurred in South India. Our own reference to this (Bustard and Choudhury, 1983) is the first in the literature. In A.P. we have selected an outstanding area of the Godaverri river for the State's re-introduction of the gharial. Reminiscent in many ways of Satkoshia Gorge in Orissa, this 591 sq.k. sanctuary can be an important asset to A.P.

The saltwater crocodile is extinct in South India, the last recorded individuals having been shot more than forty years ago. Bustard and Choudhury (1980a) recorded a recent capture in the Godaverri estuary which we think was a stray individual, probably from the Andamans. However, a suitable area of Godaverri delta has been created a sanctuary (Coringa sanctuary, 236 sq.km.) specifically for re-introduction of the species and the first few individuals have been released there.

The two remaining sanctuaries are both small areas, and despite what has been stated above, there is a place for special areas of small size provided that they are additional to, and do not replace, larger, more viable areas. Both of these small areas are for mugger, one is Lanju Modugu on the trans-Godaveri (20sq.km), an ideal and beautiful area of mugger habitat where several mugger nest each year (a very rare phenomenon in Andhra Pradesh nowadays), and the other is Manjira sanctuary on the river of the same name. This latter sanctuary is conveniently located for a visit from Hyderabad (about one hours' drive from the city) and offers good viewing of several very large mugger which are not frightened of people. In both of these latter areas there are no problems with local people (who seldom prove a problem) and at Manjira small boys wash their family's buffaloes or swim in the water in close vicinity to the large mugger. This provides an excellent illustration for city dwellers - who consider all crocodiles to be extremely dangerous man-eaters - of the way in which people and animals can co-exist where protection is nowadays given to the crocodiles.

Creation of sanctuaries requires very hard and unremitting work. Of the eleven sanctuaries described above, all of which were initiated by the Project, eight were created in the two States where I was resident over many years hence fulfilling a major aspect of the United Nations involvement which is meant to help to move things along. Unfortunately through the system under which the Project worked, I was the sole crocodile expert throughout, and obviously greatly over-extended in a country the size of India where twelve States were co-operating with the Project and many more wished to become involved. It was a case

of doing the best one could.

The United Nations policy of short-term appointments only, makes it impossible for most people to take up appointments, thus greatly hampering the calibre of person who can be recruited, other than on short-term consultancies. Except for specific, well circumscribed roles, short-term consultancies in my view, at least in the wild life field, are less likely to be of lasting benefit, than people who will come, stay and see a Project through.

In concluding this section I would say,

- a) that many ideal sanctuary areas remain to be gazetted, often due to lack of someone to 'push' for them, many examples being known to me, and
- b) what is needed above all is a National Review of the 'state of the art' as far as sanctuaries/National Parks are concerned in India. Sanctuaries tend to come up haphazardly and what we need ~~xxxxxx~~ is an indepth review, published in book form, of all existing wild life areas, their flora, fauna and protection status. The author(s) would need to personally visit each area to ensure consistency of editorial approach. This would then provide a blue-print for further gazettelements in areas - both geographical and flora/faunistically - un- or under-represented at the present time.

In concluding this section I would not like to suggest that the sanctuary programme has not faced any difficulties. It has. However, these have been containable. The worst has been serious encroachment of the Bhitarkanika sanctuary in Cuttack district of Orissa. The

continued integrity of this sanctuary in the face of people of Bangladeshi origin who wish to cut down the mangrove forests and cultivate the area will depend on continued strong support from the Government of India.

do not  
include

2. Protection.

Protective duties have been of maximum importance in the crocodile project. Animals may become endangered for a number of reasons, including loss of habitat. In the crocodile project the gharial had been driven to the brink of extinction before the project was initiated, yet much of its natural habitat remained in a more or less virgin state. Hunting for its skin (Bustard, 1974) had been responsible for the large-scale catastrophic drop in numbers. Only an effectively-enforced, cessation of all hunting activities, could save it. Furthermore, with numbers reduced to an estimated 60-70 adult or subadult gharial throughout its extensive Indian range, any further losses would quickly become irreversible, as it would no longer be possible for the few remaining, and mostly scattered individuals, to find mates. In Orissa for instance by 1975 the population was reduced to four adults, two of each sex, all living within the Satkoshia Gorge proposed sanctuary area. Natural breeding in the wild, however, stopped. The last successful hatch was reported to me by local staff to have taken place in 1974. I personally collected a nest of eggs in 1975 but the eggs were infertile. The same was the case in 1976, and thereafter no further nests were recorded. Without protection, and without the project to focus

attention on its critical status and concurrently to tackle the problem, the gharial would have slipped away like the cheetah.

Protection by itself might not have been enough, at least for many population remnants, which is why an active management programme was initiated (see 3) below).

The Orissa gharial project provides a good illustration of protection in practice. This is briefly described below.

Protection antedated the declaration of Satkoshia Gorge sanctuary by about a year. Protection staff were minimal at the outset comprising four river-borne staff and four land-based forest guards. The river staff were specially-recruited, local fisherman-caste, villagers with an intimate knowledge of the river, since they were normally on it each day in the course of their fishing activities. The river staff moved two to a boat. The boats were their own canoes, ideal for moving on the river in monsoon torrents or summer drought. Two were from Tikerpada village near the top of the 'gorge' and two from a village near the Southern river limits of the sanctuary. They patrolled daily. The time of greatest threat to the gharial is always during winter when they lie out to bask for much of the day. The threat is greatest following failure of the monsoon due to the abnormally reduced water levels which then result. This then had to be the season of maximum alertness.

None of the first three instances of poaching detected by these guards concerned gharial. I had made it very clear from the outset, that any illegal act within the proposed sanctuary boundaries was to be

stopped. I had sat with the guards on the banks of the Mahanadi and pointed out the high sandbanks which the gharial use for nesting and explained how their maintenance was helped by the massive trees of the riverine forest.

The first three poaching incidents involved one case of teak <sup>log</sup> poaching and two of illegal bamboo cutting and attempted removal. We also had <sup>a</sup> dramatic incidents involving attempted poaching of gharial, but first I would like to discuss other activities within the river portion of the sanctuary and how these were modified in the interests of the gharial without adversely affecting the legitimate interests of the local people.

Although it is correct to say that the catastrophic drop in gharial numbers was brought about by commercially-oriented hunting for their skins, the introduction of the use of nylon gill nets (set nets) further decimated those individuals which had survived the poachers. Crocodiles learn fast - there are even scientifically documented instances of single instance learning in crocodilians (Bustard, 1968) <sup>^</sup> and large individuals - the breeding stock - are very wary of man where they are actively hunted, and normally cannot be caught by conventional means. Chinks in their armour - which make them extremely vulnerable - are basking, in those species where seasonally in the winter this is essential on climatic grounds (as in gharial), and nest guarding, where this trait is well developed (e.g. the saltwater crocodile).

Nylon gill nets are set across rivers - sometimes right across

the river - and the normal behaviour of a captured crocodile is to twist round, which results in it becoming more and more entangled in the net. The nets are put out in the evening and taken in the next morning so are in place during the crocodiles time of major activity. Very large individuals seem to become wary of nets (presumably following a previous encounter and successful escape) but smaller individuals are caught, like fish, before they can learn to avoid them. Even in areas where the local people do not hunt crocodiles, individuals caught in nets will still be killed in order to save the extremely valuable net from damage. In the mid-seventies in Satkoshia Gorge a net was worth the equivalent of the average annual cash income of a fisherman, so that the investment, offered as a loan from the fishing contractor, is enormous.

Fishing contractors (the auctioning of lengths of rivers or lakes is widespread), and set nets, are political. Let it suffice to say that the policy of the crocodile project has been:

- 1) to ban the use of set nets for the above reasons, and
- 2) to get rid of the contractor system,
- 3) to advise the local villagers that the nets are not in their long-term best interests in river systems since they are over-efficient and catch all the fish. (As the larger fish become scarce they catch the recruiting individuals, on which replenishment of the breeding stock depends, by reducing the mesh spacing).
- 4) to allow fishing to continue using traditional methods - baited lines,

small throw nets, fishing scoops etc

5) to restrict fishing to those people living within the area and enjoying traditional rights

6) to help the local people to set up fishing co-operatives to enable them to obtain the best price for their fish

The people of Tikerpada within Satkoshia Gorge sanctuary will tell the enquiring visitor that the set ~~nets~~ destroyed their fishery resource and that following banning of the use of set nets the resource is recovering under local fishing, using traditional means, and without the very large number of outsider people which the Revenue staff had licensed.

One of the most significant things for the conservationist to realise is that conservation is always in the interests of the local people. When their area is ruined - the forest resource gone, the fish all caught - they cannot go away - it is their home. Hence a long-term policy of sustained yield utilisation, properly explained, provided it is implemented early enough in the destructive process, will always have their approval. The contractor system, on the other hand, be it for fish or timber, is quite the reverse. The contractor is given a short-term contract. He wants to extract the maximum pecuniary advantage from this contract in the shortest possible time. He has no vested interest in the long-term ecological health of the contract area. When it is finished he will go off and start again elsewhere.

We like to think that much can be learned from the 'set net' saga.

But it was not - and is not - easy, and there are many conflicting vested interests at stake. Conservation is an intensely political activity. I often tell my students that conservation is 90% politics and 10% conservation science. By politics I do not mean talking to politicians. Any sensible conservationist will retain the traditional civil servants apolitical stance as far as any particular party is concerned, but the questions of land use form the very basis of political doctrine in most countries.

our  
As ~~xxxxx~~ conservation staff in Satkoshia Gorge sanctuary grew, and we were able to patrol over a longer stretch of the river, we continued our policy of appointing local riverine staff for river patrols. We have deliberately, in some case, selected former poachers assistants. In the early seventies, in this area, one individual was reportedly responsible for the loss of most of the small number of remaining gharial. He arrived with two vehicles each winter from another State complete with a Forest Department permit to shoot sambhar. He contacted local villagers and offered them a reward if they would take him to a spot where a gharial basked. He would then try to shoot it. I have talked personally to several people who claim to have helped him. The reward they obtained for showing the gharial was Rs. 16-25. Since gharial were already scarce, there was little money to be made from this activity. Such people were very willing to work for the Forest Department as protection staff on a regular monthly salary, which I explained would continue as long as they were able to show the gharial, that they were appointed to protect, to me or sanctuary officers

on patrol.

The above may all sound very simple. Anyone who knows India will know it is not. This is not the way the Forest Departments recruit their staff. They go to the labour exchange, and since villagers from remote areas are not registered, get townspeople who know nothing about interior areas, hate them, and spend their time manipulating a transfer back to the town. I could fill a whole book about this in a single sanctuary in Orissa - Bhitarkanika. But we should think, and try to act, positively, while yet being aware of all the pitfalls.

I would like now to briefly mention two attempted poaching cases foiled by our protection staff. I have heard much criticism of the staff during my many years in India. I have nothing but admiration for many of them - particularly where they have been given proper guidance by their senior officers - as these two instances will demonstrate.

The first instance concerns a winter poaching attempt by three armed men on our largest gharial male, which at 21'6" is equal to the World record for the species (Pitman, 1924). This was foiled by two of our villagers, fisherman-caste, guards who spotted the people just as they were creeping up to take aim at the gharial, and unarmed, managed to persuade them not to shoot it. We were extremely fortunate both in the timing of their appearance, and the quality of our protection staff. The plan, of course, is to try to apprehend poachers before they reach the river area.

The second instance concerns a rich city-dweller who wanted to shoot

a trophy gharial, and who came, perfectly legally, and took up residence in one of our Forest Rest Houses within the Sanctuary. I had long advocated complete searches of the boots of all vehicles entering or passing through the sanctuary. The facility existed as we had forest gates manned on a twentyfour hour basis. It seemed ludicrous to me that a signature was required to pass through, but searches were not carried out. So our trophy hunters arrived armed. When his intention became known to the local project forester, he visited him and explained the position. The man remained extremely keen, and offered extensive bribes, eventually totalling Rs.25,000 so I am advised. The forester remained adamant, and the life of a large gharial was again saved. Without the Project the importance of gharial conservation would not have been known to more than a handful of dedicated forest officers, and the gharial would have gone the way of the cheetah.

I do not have time to go deeper into protection. The type of approach that I have in mind is perfectly obvious from the above examples.

3. ~~SETTING~~ Getting to know the animal - research projects as required.

It is important to get a 'feel' for the animal being studied. This is exactly what Konrad Lorenz meant in the example cited above. Extensive field work by the right sort of person will provide this. This 'feel', incidentally, is present in many country folk, and well developed in all the better poachers or hunters. Many senior Indian Forest Officers - S.P. Shahi is an outstanding example - will tell

you how they moved from shikar to conservation with the decrease of India's wild life. It will not be sufficient, however, to merely develop this trait. On some aspects, at least, rigorous research will be needed.

Research, particularly where supported by outside conservation society funds, ~~fund~~ should be relevant to the conservation programme. As a research scientist, I have seen the scientific community done great disservice - and also the supply of such grants jeopardised in the future - by individuals who have used conservation funds for work of doubtful if any relevance to the particular project. This does not mean that the research should be weak. It should be of the highest quality so that its results cannot be set aside.

At the start of the gharial project we had to decide on the size of the riverine portion of Satkoshia Gorge sanctuary. Nothing was known about gharial movements. Dr L.A.K. Singh, then one of my Ph.D. students, and I commenced a study in August 1975 which showed that gharial move considerable distances in the river and may do so quite quickly (Busford and Singh, 1983). Both the large male and large female moved maximum distances of 44km between August 1975 and January 1976 and a smaller male and female 28.8. and 22.8 km in the same time span. This showed the need for long river stretches within sanctuaries to afford adequate protection. Of great interest were distances of 12km over 2 hours and also in one day, and 3.6 km in 30 minutes, all three being up river. The contribution of the field protection staff in collecting the data for this paper was paramount. Without their help the paper could not have been written.

We also developed a method of estimating gharial size without seeing the individual from measurement of certain scutes at the base of the tail which leave a good impression on slightly moist sand (Bustard and Singh, 1977). This technique is excellent in that even an illiterate guard can collect the data in the field. We measure three scutes and average the measurement and the guard brings back three sticks or one larger stick notched with the scute lengths. Singh and Bustard (1977) also developed individual identification using a technique called 'tail printing' - using the natural colour bandings on the tail - which has very wide applicability.

In order to collect extensive data on gharial/biology in various and crocodilian geographic regions I undertook the supervision, through their Ph.D.'s, seven of ~~nix~~ Indian M.Sc's in Zoology acting in each case with an internal University guide also. This has proved an outstanding method of data collection as well as training future potential managers for India. One of these students has worked on the Pacific Ridley sea turtle in Orissa, sea turtles being my other specialist interest.

Since we were extensively involved in the handling and incubation of crocodilian eggs, on a very large-scale, much of our research was centred on eggs, and naturally, extensive data collected on such topics as clutch size, nesting behaviour, nesting season and related topics.

In the case of the saltwater crocodile, which is assumed to be a 'Vicious man-eater', Dr S.K. Kar (another former student) and I carried out research in the Bhitarkanika wild life sanctuary of Orissa extending over 10 years (Bustard and Kar, 1982) and showed that man-eating was a

very rare event. On the basis of this careful scientific study we were forced to conclude that saltwater crocodiles, like many other animals, avoid man. Before the control of fishing in the sanctuary, local people daily waded into the muddy creeks to fish. Crocodiles could have attacked them unseen yet these attacks hardly ever took place. We documented only four instances of human attack over a ten year period yet this sanctuary contains some of the largest surviving crocodiles of this species in the World - the very individuals which one would expect to be responsible for such attacks.

The gharial is considered harmless to man and Dr Singh and I, therefore, documented a surprising attack on a man on the Mahanadi (Bustard and Singh, 1981).

Following on from the studies on human attacks by the saltwater crocodile we published a study of attacks on domestic livestock (also extremely rare in a situation where countless opportunities occur daily) (Bustard and Kar, 1981a), and the obverse situation, of local people stealing the crocodile's kills (Bustard and Kar, 1981b). Such publications often have immediate management implications. For instance concerning the occasional losses of cattle to saltwater crocodiles we wrote,

'The attacks all occurred at (four) locations where the natural mangrove cover had been destroyed. Unless this is the case domestic livestock cannot come to the river bank. Cattle attacks increase the unpopularity of the saltwater crocodile and increase the forces working against its conservation. Ideally crocodiles and cattle should be

separated - there should be no grazing in sanctuaries. This idea, however, is difficult to achieve in much of the developing world inhabited by crocodiles. The solution lies in maintaining a strip of undisturbed mangrove forest, at least 50m wide, along all creeks adjacent to cultivated land. Since this fringing forest cover is important for the crocodiles themselves this should form a key aspect of management.'

In the paper dealing with crocodile kills taken as human food we concluded,

'The implication of kill stealing for the management of crocodile (and tiger) sanctuaries is clear. There is a need to separate crocodiles from local people. The sanctum sanctorum or core area of such sanctuaries must be free from human habitation or intrusions. In sanctuaries the animals must have 'right of way' at all times, otherwise the sanctuaries will ultimately prove of little value in the conservation of their endangered species.'

Bustard (1980) and Bustard and Choudhury(1981a) pointed out the crucial situation facing the saltwater crocodile in India and the steps that need to be followed if it is to survive. Bustard and Choudhury (1980a) in a paper on parental care in the saltwater crocodile pointed out the management implications of this trait. Due to incomplete nest guarding, vulnerability to human attack while at the nest, and the difficulty of guarding such a large brood of siblings, which also disperse too early for female protection to be effective, the authors feel that collection of eggs for hatchery incubation and captive rearing

of the resultant young provides a much greater survival rate than the mother is able to achieve.

Extensive work has been carried out on the post-release monitoring of released 1.2m long crocodilians of all three (Indian) species<sup>s</sup>. Since this work clearly could not commence until we had raised large numbers of crocodilians to this size and released them back into the wild few of these studies have as yet appeared. An outstanding account, showing very little movement and excellent survival - probably 100% after several years back in the wild - has recently appeared for the Indian mugger (Choudhury and Bustard, 1983). These mugger are the first captive-reared and released crocodilians to have bred following their return to the wild (Choudhury and Bustard, in press). Much of this basic data was collected by the protection staff and their contribution is clearly set out in the paper's tables.

Kar and Bustard (in press) document 80% survival of a small group of fifteen saltwater crocodiles rehabilitated into Bhitarkanika after two years back in the wild. Survival figures are always minimal ones, as failure to record an animal does not mean that it has died, it may reflect human error, or the crocodile in question may have moved outside the census area.

In order to carry out subsequent<sup>vent</sup> monitoring, all released crocodiles must be marked. They should be marked in a way which is cheap, easy to carry out in remote areas, and which, most importantly, can be seen without having to catch the crocodile. This last aspect is crucial as crocodiles learn very fast (Bustard, 1968), so censusing based

on physical handling will result in markedly decreased recapture success, and animals which are maintaining themselves well in the population, but evading recapture, will appear to have disappeared. There are two further considerations. A tag physically applied to the crocodile may become detached, and the marking method should be one requiring minimum literacy (if any). We published our methodology in the 'Indian Forester' (Bustard and Choudhury, 1981b). This includes scute-clipping of the single row of scutes on the tail. Regeneration does not take place. The clip can be seen easily when the animal is basking (the clipping includes a sex code), literacy is not required to record presence of the clip. Crocodiles often swim or float with the tip of the tail above water and an experienced observer can record the clip at such times. Both Dr Kat and I have had no difficulty in recording it using a spotlight at night in Bhitarkanika, when recruiting-sized individuals come into shallow water at the edge of mudbanks and elevate the tail clear of the muddy water. Using this methodology it is possible to individually mark crocodiles also, as detailed in the paper. For general use, however, we recommend only the use of a single recognition clip, the scute clipped changing each year, so that at a glance one can see if the animal is a released individual, and at the same time the year of release. Since we release approximately 2.5 females per male, deliberately we do not clip the more abundant females for sex, but clip males. So all the above information is incorporated in a single clipped scute for females and two in the case of males.

The above few examples should serve to indicate the type of research that is needed. We in the Project have published some one hundred research papers, many in the Society's Journal. Although we publish internationally, we have always made a point of publishing papers of major conservation importance here in India. Further details of these publications together with an annotated bibliography of Indian crocodilians was published by the Project (Bustard and Singh, 1982) and is available free on request. A further useful publication on crocodile conservation and research in India is that of Singh and Choudhury (1982).

#### 4. Active management.

In my 1974 report I recommended that an active management approach be undertaken of the gharial and other Indian crocodilians in order to boost numbers quickly. In crocodilians and other animals which produce large numbers of eggs, wastage is very large. Management, by vastly reducing this wastage at various levels of the life history has the capacity to rapidly raise population size with the result that it is possible to re-establish whole populations rapidly. This is not the place to go into an evaluation of the techniques involved (Bustard, 1975), nor the necessary safeguards (Bustard, in press), of which perhaps the most important is to maintain genetic diversity in the population. It would clearly be most unwise to repopulate an entire river system with the successive progeny of one pair of crocodilians on genetic grounds, although due to their fecundity, this was a practical proposition in terms of numbers of young required, over a ten year re-introduction timescale.

The main reason for my recommending an active management programme was that otherwise recovery, in the case of the gharial, would have been patchy at best, with possible recovery limited to one or two areas in the country at best, and with the remnant populations elsewhere failing to maintain themselves and being lost. This clearly would have been unsatisfactory. In the case of the saltwater crocodile, without the active management programme I felt - and still feel - this species would have been lost from the Indian fauna over a period of time.

It may be worthwhile to point out that mugger numbers were so low in many areas of the Country that only active management has maintained the geographical spread of the mugger, although the species itself was not endangered, only seriously depleted.

There were other good reasons to adopt this approach:

- FAO
- 1) the proposals which were contained in my 1974/Report to the Government of India included the creation of many new sanctuaries in the Country, many of substantial areas (see 1 above). It would have been extremely difficult to justify their creation for only a handful of animals.
  - 2) In a conservation programme of this size there is tremendous scope for conservation education. Although saving the animal must take precedence over everything else, conservation education would provide a most valuable spin-off. If people interested in learning about the Project cannot even see the animal that is being conserved when they travel to an interior sanctuary, it is difficult, if not impossible, to generate this.

- 3) The active management programme focussed attention on the sanctuaries themselves, as the captive rearing stations were located as far as possible within the sanctuaries themselves. The success of this approach was obvious - the rearing stations quickly became tourist attractions in their own right, in a number of States, notably in U.P., Orissa and West Bengal. Furthermore, by focussing attention on the rearing centres people were 'streamed' away from the river itself, where large-scale tourism, such as the rearing centres encountered, would have been a serious disturbance, to the wild gharial.
- 4) The captive rearing stations were a tangible demonstration of what was being done to conserve the species.
- 5) The population parameters of the crocodilian species lent themselves superbly to this approach.

The core of the active management programme focussed on the species itself - as opposed to the parallel, extremely active programme of sanctuary selection, gazettelement and protection - consisted of protection of eggs during their lengthy (approximately two and a half month) incubation period, together with protection of hatchlings until they were large enough to look after themselves.

The only way to effectively protect eggs on a large-scale, in widely separated nesting areas, spread over numerous remote areas in the Country, was to collect them, preferably as soon as laid, bring them to a series of central points, and incubate them in predator-proof hatcheries. That was carried out in association with the Project in the States of Orissa, Uttar Pradesh, Andhra Pradesh, Tamil Nadu, West

Bengal, Kerala, Rajasthan, and Gujarat shows the size and geographical spread of the undertaking.

Collection of wild-laid eggs for captive incubation saves the eggs from a wide range of natural predators including man. It is not always appreciated that in many areas of India, tribal man, may be the most serious - and effective - predator. For instance in Nepal, and adjacent Bihar when gharial were still present in the latter area, all eggs were collected. In extensive surveys of the Narayani river of Nepal in the mid-1970's I found no recruiting individuals implying that egg collection had been 100% over many years. In the Andamans in 1978 my student, Mr B.C. Choudhury, in a nest study on no less than 30 nests of the saltwater crocodile found that only one nest or 3.3% of those studied, hatched. Human predation accounted for 84.6% of nest losses (~~Bustard and~~ Choudhury and Bustard, 1980). Add to this level of predation, nests lost through flooding during incubation, and the arguments for nest collection become overwhelming.

Juvenile crocodiles are very small, averaging around 30cm (slightly more in the case of the gharial), soft and delicate, and form easy prey for a wide range of predators, including fish, aquatic birds, mammals and other reptiles. Hence the greatly enhanced numbers which can be hatched in captivity can be further multiplied by keeping the young in specially designed pools in captivity until they are through this critical phase. Taking into account varying conditions in different areas - as is essential in a National Project - it was decided that 1.0 -1.20m (3-4 feet) was an ideal release size. The plan calls for

rapid growth under semi-natural conditions, using natural food throughout in order to attain this size as quickly as possible. Under ideal husbandry conditions, ~~using nat~~ in climatically favoured areas experiencing reduced winter effects, it is possible to attain this size within 18-20 months of hatching and thus operate a two year cycle in the hatchling and yearling pools ( Bustard, 1975). This fits in well with release times which should be set to enable the released animals to become familiar with their new habitat before onset of the monsoon. The Project recommended release in February in the warmer Southern areas, with this delayed until March in the extreme North.

This activity, comprising collection of eggs and rearing of young for subsequent release into protected sanctuary areas in ideal natural habitat, has been called the 'rear and release' technique. It is, of course, essential that the 'protected sanctuary areas' are created simultaneously with the rearing programme, but the 'production' of very large numbers of an endangered species provides tremendous impetus for pushing ahead with the sanctuary creation/management goals. The efficacy of this approach can be seen in the results - sanctuaries declared (Table 1) and animals released up to 1982. These figures (Singh and Choudhury, 1982) are:

Gharial - 855 (approximately twelve times the estimated 60-70 adult/subadult individuals surviving in the entire country when the project was initiated

saltwater crocodile - 278 (approximately ten times, the probable wild population of adults and sub-adults in 1974), and

mugger - 490

In addition substantially larger numbers of each species than these, were currently being reared for future release.

CONCLUDING REMARKS

I would briefly sum up by saying that in the crocodilian project the role of management was paramount - without the active management programme there would be no gharial today, and the saltwater crocodile would be on the verge of extinction in India.

Management entails always putting the legitimate interests of the species first. One has got to argue very strenuously for one's beliefs in the World today. One can argue more effectively if it is obvious to all parties that you have no vested interest other than the best interests of the animal itself.

Addressing myself to the younger members of the audience I would say that conservation - or science itself for that matter - is not an easy career. One must be dedicated. Conservation is a world-wide war. Furthermore, it is a war that can never be won. One can win 'encounters, skirmishes or minor engagements' (which if you lose will have a catastrophic effect on your animal or ecosystem), but you can never win the ultimate battle, as even when your 'animal' (for want of a better word) is numerous, and in what you believe is a secure National Park, even in the most-developed countries, such places have not proven to be sacrosanct.

In concluding this paper I would like to point out that the approach set out in this paper is one that can be adopted, with only minor variations in the conservation of a wide range of endangered animals both here

in India and overseas.

#### ACKNOWLEDGEMENTS

The Crocodile Project is indebted to a very large number of people all of whom obviously cannot be mentioned here, but I am listing a few of those whose contributions were outstanding. They are mentioned in chronological order as they assisted the Project in time: Mr M.K. Ranjitsinh, then Deputy Secretary, GOI, who helped to bring the Project into existence, Mr K.L. Lahiri, then Inspector General of Forests who told me to travel throughout India to get a 'birds eye view' of the problem, the late Mr S.R. Choudhury who ensured Orissa was the first State to take up the Project and whom I was proud to have as a friend and counsellor, Mr S.P. Shahi, then Chief Conservator of Forests, Bihar, who assisted me greatly with his knowledge of the gharial both in discussion and in the field, Mr V.B. Singh, Chief Wild Life Warden, Uttar Pradesh whose contribution to the conservation of the gharial was outstanding, Mr N.D. Jayal, Joint Secretary, GOI, who guided the Project tirelessly throughout most of its life and was an inspiration to us all, Mr Seth, then Inspector General of Forests, Mr B.P. Srivastava, then Inspector General of Forests, whose active interest and support we had even when he was C.C.F., U.P., and Mr Samar Singh, Joint Secretary, GOI who guided the Project in its final period. Lastly I owe a special debt to the enthusiasm and hard work of my Ph.D. students, particularly Dr L.A.K. Singh on gharial, Dr S.K. Kar on saltwater crocodiles and Mr B.C. Choudhury on the mugger.

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