The Kouprey

An Action Plan for its Conservation

Edited by
John R. MacKinnon and Simon N. Stuart

Foreword by
Prof. Vo Quy

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Cover photo: Adult female kouprey in Kampuchea. (Photo by P. Pfeffer/WWF)

The Kouprey

An Action Plan for its Conservation

Prepared by the Species Survival Commission (SSC)
of the International Union for Conservation
of Nature and Natural Resources (IUCN),
and the World Wide Fund for Nature (WWF).

Based on the results of the International Workshop
on the Kouprey Conservation Programme,
held in Hanoi, S.R. Vietnam,
on January 15 and 16, 1988,
hosted by the Centre for Environmental Studies
at Hanoi University.

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A herd of kouprey. (Photo courtesy of the New York Zoological Society)

Foreword

Together with the Javan rhinoceros (*Rhinoceros sondaicus*) and the tamaraw (*Bubalus mindorensis*), the kouprey (*Bos sauveli*) is one of the most seriously threatened large mammals in the world. It is the IUCN/SSC Asian Wild Cattle Specialist Group's most serious challenge that two of these species fall within its purview. The kouprey has come to symbolize conservation within Indochina, largely due to the work of the late Harold J. Coolidge, and the plight of the species was specifically mentioned in conservation agreements signed by Vietnam, Laos, and Kampuchea in 1986. In recent years, it has again become possible to consider formulating and launching a coherent programme to conserve and manage the kouprey. It was for this reason that the University of Hanoi, S.R. Vietnam, held a workshop in January 1988 to bring together as many of the potential partners in the programme as possible. These included representatives of the four governments concerned, a wide variety of interested donors, and experts from the Asian Wild Cattle, Captive Breeding, and Veterinary Specialist Groups of the IUCN Species Survival Commission. This Action Plan is the direct result of the workshop.

Any reader of this document will soon appreciate that much work was completed during the workshop, and that a coherent programme has indeed emerged. However, even a cursory glance at the concluding section will make it clear that enormous problems still remain. A great deal of work, a deep commitment, and probably a fair dose of good fortune is needed if we are to save the kouprey, and to manage it for the benefit of the people of Vietnam, Laos, Kampuchea and Thailand. The IUCN/SSC Asian Wild Cattle Specialist Group therefore calls upon all those concerned to work closely together to maximize the chances of this programme being successful.

Prof. Vo Quy, Chairman
IUCN/SSC Asian Wild Cattle Specialist Group
Dean of Biology, University of Hanoi

Editors' Note and Acknowledgements

This Action Plan is the product of the International Workshop on the Kouprey Conservation Programme, held in the University of Hanoi, S.R. Vietnam, on January 15-16, 1988. Almost all of the document was drafted during the workshop by the various participants, and as editors, we have been responsible for compiling the various inputs into a coherent form.

We would like to express particular thanks to the following people and institutions, without whose efforts both the workshop and this resulting publication could not have taken place:

- The People's Committee of Hanoi for welcoming all the participants to the workshop.
- The University of Hanoi for hosting the meeting, and for making everyone so comfortable and welcome during the course of the workshop.
- The Governments of Vietnam, Laos, Kampuchea and Thailand for sending representatives to the workshop.
- The World Wide Fund for Nature—International for providing funds for the workshop expenses and the publication of this Action Plan.
- All those who contributed to the formulation of this Action Plan during the workshop :

  Vo Quy, Dao Van Tien, Le Vu Khoi, Le Dien Duc, Han Dinh Duc, Pham Binh Quyen, Le Thac Can, Le Trong Cuc, Dang Huy Huynh, Cao Van Sung, Pham Trong Anh, Nguyen Mau Tai, Nguyen Thanh Son, Pham Mong Giao, Tran Hong Viet, Do Tuoc, To Linh (Vietnam)

  Bouavay Phouminh, Sivannavong Savathvong (Laos)

  Chan Sarun, Chimm Somean, Lao Kim-song, Ma-Sethea (Kampuchea)

  Phairot Suvanakorn, Suvat Singhapant (Thailand)

  Simon Stuart (IUCN)

  John MacKinnon, Charles Santiapillai (WWF)

  Mohd Khan bin Momin Khan, Louis Ratnam, Ulysses Seal, Michael Woodford (IUCN Species Survival Commission network)

  Pisit na Patalung (Wildlife Fund Thailand)

  George Schaller (Wildlife Conservation International)

  Betsy Dresser, Bruce Read, Lee Simmons (zoo community)

- All those who worked hard on the successful organisation of the workshop:

  Vo Quy, Pascale Moehrle, Nicole Hennlich, Doreen Zivkovic, Tom Foose, Elizabeth Kemf, Vitus Fernando.

- Those who carefully reviewed and commented on this Action Plan:

  Rick Salter, Jeffrey Sayer, Jeffrey McNeely, Winifred Carter, Steve Edwards, David Stone, Elizabeth Kemf, Martin Holdgate, Ann Stuart, Francoise Burhenne-Guilmin, Michael Woodford, Tom Foose.

The collaboration and spirit of comradeship which marked the workshop was most remarkable. If this cooperation can now be maintained during the implementation of this Action Plan, then hopefully it will not be too late to save the kouprey for the people of Indochina.

John R. MacKinnon, WWF
Simon N. Stuart, IUCN

1. Introduction

The International Workshop on the Kouprey Conservation Programme was held in the University of Hanoi on January 15-16, 1988. The purpose of this workshop was to agree upon, among the responsible government agencies and interested donors, a workable and realistic Action Plan to save the kouprey (*Bos sauveli*) from extinction and restore it to productive levels. This document is the result, and consists of three main parts:

First, a section entitled "Portrait of an Endangered Species," in which our present knowledge of the kouprey is summarized.

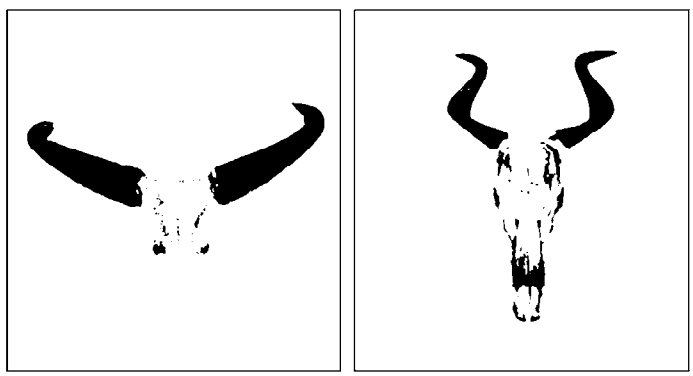
Second, "An Appraisal of Kouprey Conservation Options," which represents the substance of the debate which took place during the workshop. The resolution of this debate appears in sub-section 3.5. The statements included here were agreed upon by all participants to the workshop.

Third, "The Action Plan." This consists of an outline of the work needed to bring the agreement detailed in sub-section 3.5 into operational reality. Parts of this comprehensive programme are already earmarked for funding by the various donors present at the workshop (notably the international zoo community, the World Wide Fund for Nature, and Wildlife Conservation International). IUCN is seeking the required additional donor support for discrete aspects of the programme.

2. Portrait of an Endangered Species

2.1 The Grey Ox of Indochina

The kouprey, or grey ox (*Bos sauveli*) of Indochina, is one of the most recent large mammals to be described (Urbain 1937). The first specimen to be scientifically described was a young male calf sent to the Vincennes Zoo near Paris, having been collected in Kampuchea the previous year by Dr. R. Sauvel, after whom it was named. It was another three years before a full description of an adult bull was available (Coolidge 1940). Coolidge was impressed by many of the primitive features of the kouprey and created a new genus for it, *Novibos*, on the grounds of differences from more advanced wild cattle, the banteng (*Bos javanicus*) and gaur (*Bos gaurus*), which live in the same area of Indochina. The genus has tended to be ignored by subsequent taxonomists who continue to place the kouprey in the genus *Bos* (e.g. Ellerman and Morrison-Scott 1951; Simpson 1945).



Horns of the male kouprey (left) show characteristic fraying at the tips; horns of the female (right) spiral upwards. (Photo courtesy of the Smithsonian Institution)

The kouprey is lighter in build than other wild cattle. The male loses its grey flanks with age, becoming increasingly black. Adult males have a pronounced dewlap which may even drag along the ground. They have widespaced, tapering horns with characteristic fraying near the tips. The young are brown, but adult females are a characteristic grey colour, which gives the animal its local name (grey ox), and readily distinguishes them from the reddish-brown females of banteng and the dark, blackish-brown females of gaur. Both sexes of kouprey have a very long tail and notched nostrils. The horns of female kouprey are gracefully lyriform. In young animals, the horns are transversely ringed.

2.2 Distribution

The kouprey is confined to the Indochinese peninsula, being centred on the northern plains of Kampuchea, but occasionally ranging into the Dongrak mountains of eastern Thailand, and also ranging through the southernmost provinces of Laos and the western edge of Vietnam along the Kampuchean border. The description of two specimens shot in 1929 at Suoi Kiet (107°41'N, 110°58'E.) in southern Vietnam indicates that the species distribution might have been recently larger than today (Hoffmann 1986). The same paper presents some evidence that the species might even have ranged as far as Yunnan in southern China in ancient times. Wharton (1957) describes the habitat of kouprey as having been highly populated during the days of the Khmer Empire and suggests that the animal only moved into that area recently.

Fig. 2.1 indicates the distribution in the mid-1950s and recent (post 1980) records of the species. It will be noticed that recent records come from a widely scattered area, covering most, if not all, of the distribution known in the 1950s. Nearly all of the recent records come from reports by villagers, who have provided convincing descriptions of the kouprey, and have clearly distinguished it from the gaur, banteng, and wild water buffalo (*Bubalus bubalis*).

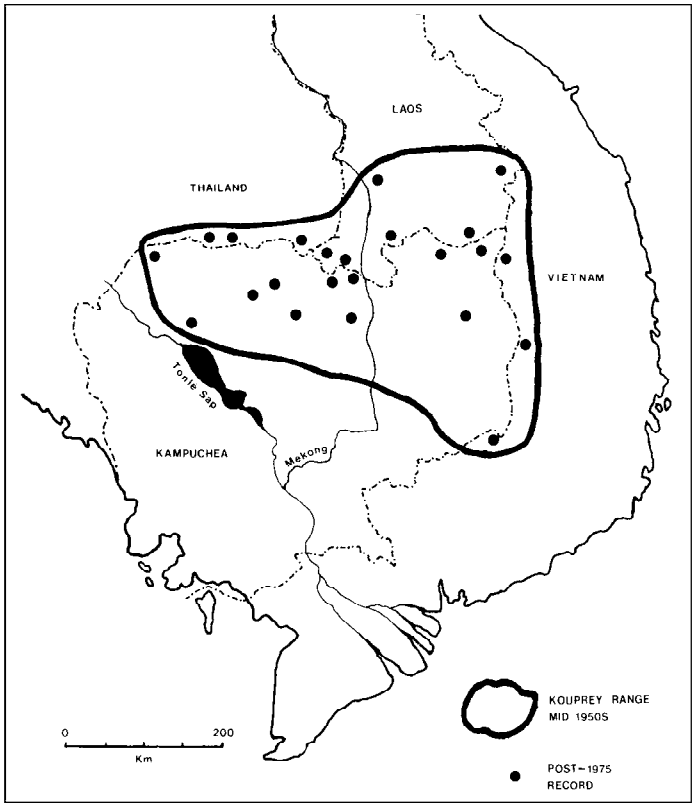


Fig. 2.1 Past and present distribution of the kouprey (*Bos sauveli*).

Table 2.1. Information on protected areas within the habitat and range of the kouprey.

Name	Gazetted[1]	Category[2]	Area (km²)
Kampuchea			
Angkor	T	2	107
Hondrai-Sou	F	4	1200
Lomphat	F	4	1975
Phnom Prich	T	4	1951
Preah Vihea	T	4	14670
Laos			
Attapeu	F	4	1000
Bolovens Plateau	F	4	300
Dong Kalo	F	4	400
Dong Kanh Thuong	F	4	180
Thong Hin Tang	F	4	1000
Xe Pian	F	4	1240
Thailand			
Huai Sala	F	4	400
Phanom Dongrak	T	4	316
Yot Dom	T	4	203
Vietnam			
Bugiamap	T	4	160
Yok Don-Easup	T	4	750
Mom Rai-Ngoc Vin-Sathay	T	4	450
Nam Cat Tien	T	2	350
Quang Xuyen	T	4	200

[1] T = legally gazetted protected area; F = proposed protected area under consideration. [2] 2 = national park; 4 = nature conservation reserve/managed nature reserve/wildlife sanctuary (see definitions in MacKinnon & MacKinnon (1986)).

2.3 Habitat

The kouprey is found almost entirely in open forests (dry dipterocarp forest), open parkland savannah on poorer soils, tree and orchard savannah, gallery forests and patches of dense monsoon forest. Wharton (1957) defined the habitat requirements as consisting of a combination of the following features:

- Natural open areas which afford good grazing and maximum visibility
- The presence of salt licks where kouprey can obtain vital minerals
- Enough waterholes so that water can be obtained at the height of the dry season
- Dense forest nearby where kouprey can retreat during the hotter times of the year
- Absence of nearby villages (secure refuge from hunters).

2.4 Diet

The diet of the kouprey has been only partially studied, but is known to consist of at least tall and short grasses, particularly the bamboo grasses (*Arundinaria* spp.), ploong grass (*Arundinella setosa*), and koom grass (*Chloris* sp.); sedges, some browse from the leaves of trees and bushes, and some mineral-rich soils eaten or licked at salt licks or termite mounds. Wharton (1957) provides lists of food species. Additional information is provided by Dang Huy Huynh & Pham Trong Anh (1988) and Tran Hong Viet et al. (1988).

2.5 Herd Composition

Kouprey travel in small herds composed of females and their young. The ratio of young to cows observed by Wharton (1957) was more than one to three. For part of the year, the mature and young bulls form "bachelor herds" but in the dry season they mix freely with the female herds. Wharton's 1957 study animals were classified as 39 bulls over 3 years of age, 48 bulls under three years, 145 females and 47 calves.

Kouprey groups divide and regroup constantly (Wharton 1957), and bed down in the early afternoon in tight, controlled circles, becoming active again in late afternoon. They may travel from five to fifteen kilometres in a night. Kouprey herds may mix with banteng, but they retain their own herd identity. They also mix with feral water buffalo.

Female kouprey with young. (Photo courtesy of the New York Zoological Society)

2.6 Breeding Season

Kouprey apparently mate in April and bear young from December to the end of February before the hottest part of the dry season (when widespread fires consume the desiccated grasses). Mothers leave the herd at the time of birth and regroup with the herd when the calf is about one month old.

2.7 General Behaviour

Kouprey are active, energetic animals. They travel long distances each night and appear restless when active, doubling backward and forward whilst feeding, in contrast to the more spaced and directed feeding movements of banteng. Kouprey use forest cover during the heat of the day, particularly in the dry season, but less so in the rainy or fly-ridden times of year. They can cross dense forest patches at least one kilometre wide.

Kouprey make regular use of saltlicks and waterholes. They drink at least as often as banteng, and use the same waterholes. Bull kouprey occasionally dig in the mud with their horns, which may be one reason for their characterisitic frayed tips.

2.8 Seasonal Movements

Kouprey are restless travellers, and there are some indications that herds tend to move up into higher, hilly terrain during the wettest times of the year. Seasonal movements are not well documented, but may prove important in determining protective management.

2.9 Response to Humans

Kouprey have been hunted for many decades. The traditional hunting in the region was done with large crossbows, firing poisoned bolts from elephant-back. Such hunting still occurs in the hillier parts of the kouprey range, but has been replaced in most areas by hunting with large-bore flintlocks and military rifles.

The kouprey is generally shy towards humans and is swift to turn tail and canter away. Nevertheless, Wharton's team was able to film kouprey with a hand-held 70 mm lens, and other accounts indicate that the kouprey is not unapproachable.

Hunters say that kouprey are easy to kill at saltlicks and waterholes. Another method is to chase them with dogs (Neese 1975). This induces some kouprey to turn and fight the dogs, and renders them easy for the following hunters to approach and shoot.

There is some indirect evidence that the kouprey might once have been domesticated in China. A large number of bronze figures from south Yunnan dating from the 1st century B.C. depict a slave society in which bull fights were staged. The bulls look remarkably like kouprey, and might have been a domesticated form of it. The Yi people retained a slave society until the 1940s, and they still domesticate cows, but they now keep a type quite different from the kouprey and the early bronze figures.

2.10 Pre-War Status

The kouprey has always been regarded as rare, even from its first description. Sauvel (1949) estimated that there were about 500-600 kouprey on the west side of the Mekong river, and about 200 east of Samrong. These figures were based on ten years of familiarity with the region, but did not include the animals along the Srepok river and elsewhere (Laos, Vietnam, Thailand, and other parts of Kampuchea).

Sauvel claimed that kouprey numbers had been reduced from hunting by Siamese soldiers and police during their brief occupation of northern Kampuchea (1941-46). However, Boonsong Lekagul (pers. comm.) claimed that, in fact, very few kouprey were killed at this time.

Wharton (1957) estimated about 400-500 kouprey west of the Mekong, about 50 from the Samrong region and about 200-300 along the Srepok River, thus giving a total of 650-850 for the whole of Kampuchea. He preferred to use a conservative estimate of 500 to be safe. In comparison, he estimated the banteng population at about 5000.

We can conclude that the kouprey probably has never numbered more than 2000 animals in recent times.

2.11 Current Status

Because of the difficulties of conducting surveys in the main strongholds of kouprey in Kampuchea, current estimates of numbers are very crude, consisting entirely of educated guesses. The kouprey has undoubtedly suffered badly in the wars as a result of habitat damage and severe hunting.

Estimates from Vietnam suggest that only about 27 kouprey occur there. Reports from Laos suggest a larger population, perhaps between 40 and 100. The most optimistic estimates from Kampuchea suggest less than 200 kouprey survive (Chan Sarun 1985). Small numbers may still move seasonally into the Dongrak Mountains of Thailand. Further information is presented in the various workshop papers (Dan Huy Huynh & Pham Trong Anh 1988; Le Vu Khoi 1988; Suvanakorn 1988; Tran Hong Viet et al. 1988).

For what the figures are worth, they suggest a surviving kouprey population of between 100 and 300 animals. In any case,

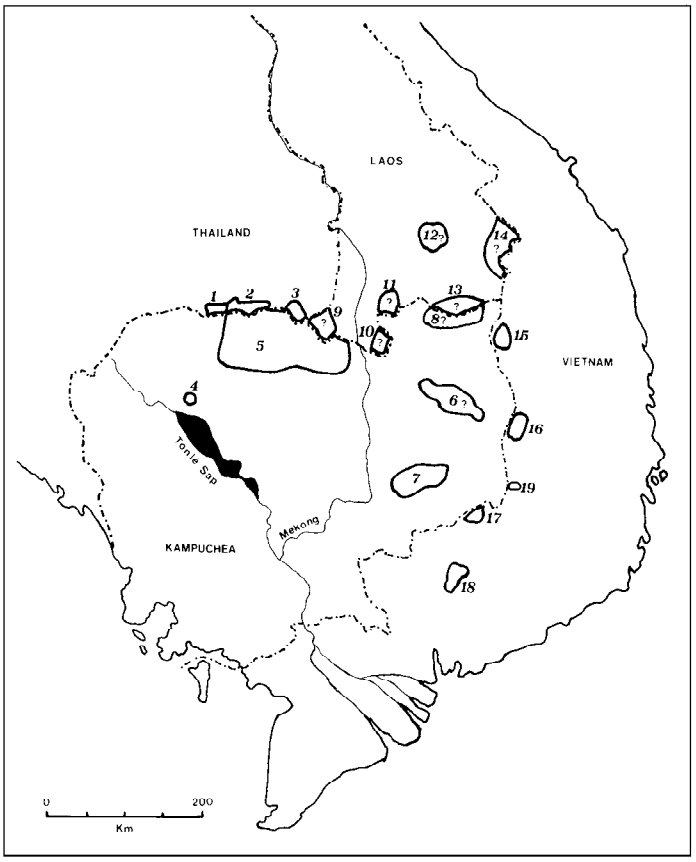


Fig. 2.2 Gazetted and proposed reserves within the range of the kouprey. ? = proposed reserve, not gazetted. 1. Huai Sala. 2. Phanom Dongrak. 3. Yot Dom. 4. Angkor. 5. Preah Vihea. 6. Lomphat. 7. Phnom Prich. 8. Hondrai-sou. 9. Dong Khan Thuong. 10. Dong Kalo. 11. Xe Pian. 12. Bolovens Plateau. 13. Attapeu. 14. Thong Hin Tang. 15. Mom Rai-Ngoc Vin-Sathay. 16. Yok Don-Easup. 17. Bugiamap. 18. Nam Cat Tien. 19. Quang Xuyen. Note: The display of proposed protected areas on this map does not imply endorsement or acceptance of such boundaries by the governments concerned.

it is clear that the kouprey is one of the rarest surviving large mammals in the world, and its IUCN status category is Endangered (IUCN 1988).

2.12 Conservation Measures Taken

The first conservation measures taken for the kouprey were ordered by Prince Sihanouk of Kampuchea in 1960, when he declared it the national animal of the country, gave it protected status, and declared three major reserves for its conservation. These reserves were maintained under the regime of Lon Nol (1970-1974), but became meaningless during the period of Khmer Rouge rule under Pol Pot (1974-1978).

Under the current government of Heng Samrin, these nature reserves have been resurrected on paper, but they still require reconfirmation, and may also require boundary modifications. As much of this territory is still a military security zone, such distinctions remain academic.

Following renewed reports of kouprey entering Thailand in the 1970s, three protected areas were created in Thailand along the Dongrak mountains. The kouprey has been given total protection in Thailand since 1961.

In Laos, the kouprey is now the only protected animal, awaiting the ratification of a new game protection law. There are as yet no protected areas in southern Laos, but three areas are currently proposed for protection.

In Vietnam, the kouprey was added to the protected species list in 1985, and two small reserves exist along the border area with Kampuchea, Mom Rai-Ngoc Vin-Sathay, and Yok Don-Easup. The presence of kouprey here has been confirmed. It is hoped that kouprey will also be found in the nearby reserves of Bugiamap, Quang Xuyen, and Nam Cat Tien.

2.13 Existing Protected Area System

Fig. 2.2 shows the boundaries and sizes of these various proposed and ratified protected areas. Table 2.1 summarizes the status and size of each area.

2.14 Security Across the Kouprey Range

It was impossible to mount any serious conservation work in the habitat of the kouprey during the long years of the second Indochinese War. Even the survey of Wharton in 1951 was undertaken at great risk, with a platoon of heavily armed guards to protect the team from attack by Viet Minh groups operating at that time in the area. During the Pol Pot regime in Kampuchea, that country was particularly dangerous, with very large numbers of people being killed. Since the fall of Pol Pot, northern Kampuchea has remained a skirmishing ground between remnant Khmer Rouge forces and the Vietnamese and Kampuchean armed forces.

Much of the recent information on kouprey in northern Kampuchea comes from Khmer Rouge groups returning to Thailand (Thouless 1987) rather than from Kampuchean government sources. Security is now quite good in Vietnam, in Kampuchea east of the Mekong, and in Laos. Little work can be done in Laos west of the Mekong and probably no work for the time being in Kampuchea west of the Mekong. Even areas that are safe from guerrilla activity are still littered with unexploded bombs and mines. Surveys along the Thai border had to be abandoned when one of the rangers stepped on a landmine.

2.15 Current Constraints

While the biggest constraint has undoubtedly been the security problem throughout most of the kouprey range (both during and following the long war years), there are many other problems.

Laos has had no previous experience of government organized wildlife conservation, so a new department has been formed, and training started from scratch. The Directorate of Wildlife is still very small, has insufficient trained personnel, and has no library materials or field equipment to mount surveys. However, this situation is now being addressed through the IUCN Forest Resources Conservation Project in Laos, which started in early 1988 and is being funded by the Swedish International Development Agency (SIDA).

In Kampuchea, almost the entire staff of the Forestry Bureau was killed during the Pol Pot period. All maps and documents relating to the existing protected areas were destroyed. The department has a critical lack of trained personnel and operational funds.

Vietnam has no shortage of competent personnel, but they have very little experience in the capture and management of large mammals. There are severe limitations on field equipment and operational budgets.

Thailand, which is best placed in terms of personnel, equipment and operational funds, may no longer have any kouprey to save!

2.16 New Initiatives

In a preliminary project (WWF 3696 in 1986), Vo Quy and John MacKinnon were able to visit all three Indochinese countries and obtain written agreements to cooperate between themselves and with IUCN and WWF in mounting a project to save the kouprey. Such agreement was possible within the framework of the existing Commission for Economic and Cultural Cooperation between the three Indochinese countries.

Under the terms of these agreements (Appendices 2 and 3), WWF and IUCN agreed to assist the three countries in starting a project to save the kouprey. The Vietnamese side undertook to train and assist the other two countries to participate in a joint project. All parties agreed to undertake more field surveys. These agreements were the basis for providing some basic training in wildlife management and animal capture techniques (conducted at the Wildlife Institute of India, Dehra Dun) for two Vietnamese scientists (three Laotian technicians had already received training there).

More survey work was undertaken in both Laos and Vietnam, including the first actual sighting of a kouprey by a scientist, Dr. Le Vu Khoi, in many years. More information was also collected in Kampuchea on the status of kouprey. An international meeting funded by WWF and hosted by the University of Hanoi was held in Hanoi in January, 1988 to bring the various parties together, review the new information, and draft a species survival plan to form the basis for further action. This publication is the result.

Such a plan is therefore timely both from a political and technical point of view. This is possibly the last time that such favourable factors will coincide, so such a unique opportunity for action should not be lost.

3. An Appraisal of Kouprey Conservation Options

3.1 What is Needed to Save the Kouprey in the Wild?

From all that has been started in the previous section, it is immediately clear that very little is known about the kouprey. Almost all the ecological, biological, and distributional information is of a very sketchy nature. Consequently, at this stage it is necessary to make a number of unproven assumptions about what is needed to conserve the animal. The only long-term solution to these deficiencies is a thorough field study of the species, and this must be considered a high priority. From the point of view of managing the species in perpetuity in the wild, information on the following is particularly necessary:

1. **Habitat requirements and annual movements.** Despite the brief information provided in sub-sections 2.3 and 2.8, it is still far from clear what range of habitats must be conserved for the species to survive.

2. **Distribution of areas of highest kouprey population density.** Although considerable information testifies to the survival of the kouprey through much of its former known range, almost nothing is known of where the largest populations occur. Consequently, it is very difficult at this stage to decide where conservation efforts should be concentrated.

3. **Threats.** Strangely enough, there is no hard information on any principal threats to the kouprey. One might speculate on various factors, such as hunting by local people or guerrilla armies, habitat clearance, or inbreeding in small, inviable populations. Information is so scanty that it cannot even be shown that the kouprey has declined at all, though there is nobody who believes that a major reduction has not taken place. Whatever the case, any future conservation programme is going to have to identify the threats and devise ways to counter them.

A dead kouprey. (Photo courtesy of the Museum of Comparative Zoology, Harvard University) Correction: Probably water buffalo.

A major field study on the kouprey, doubtless combined with field surveys, is therefore considered essential.

Despite the problem of lack of knowledge about the kouprey, a number of reasonably confident assertions can be made concerning its conservation needs in the wild:

1. The species will only survive if its needs, and those of the local people, are brought into harmony as part of the sustainable development of the region. In the long-term, it would be most desirable if the kouprey could be restored to population levels such that people could derive direct economic benefit from its existence, as they undoubtedly have in the past (see sub-section 2.9). A pre-condition for such use of the kouprey is that it should be sustainable.

2. The conservation needs of the kouprey have attracted such a high public concern, both regionally and internationally, that it ought to be possible to use this attention as a vehicle for more comprehensive conservation programmes. Such programmes would in any case be of the greatest benefit to the kouprey, since they are the most likely to take care of the complex social, economic, and political factors, which are the context in which the species must survive.

3. As with most species of large mammal, survival of the kouprey will probably be closely linked to the establishment of well-managed, protected areas that have the support of the local human populations. Such protected areas should ideally be located so as to provide protection to other threatened species, notably the Javan rhinoceros (*Rhinoceros sondaicus*), Eld's deer (*Cervus eldei*), the Asian elephant (*Elephas maximus*), and the tiger (*Panthera tigris*). The first two of these are of especially high international importance.

4. Public education campaigns on the uniqueness and importance of the kouprey will also be needed within the context of environmental education programmes in the four countries concerned.

3.2 *In Situ* or *Ex Situ* Conservation?

Saving the kouprey means saving the species in its natural habitat, with a full range of genetic variation allowing it to follow natural evolutionary processes. This objective has two components: saving the habitat of the kouprey, and saving the gene pool of the species.

Through the application of standard *in situ* conservation procedures (see previous section), it might be possible to save the species by protecting it and its habitat together. However, in view of the very low numbers of kouprey believed to remain, and the lack of long-term security over much of the species distribution, there is a strong possibity that the wild population cannot be afforded sufficient protection to allow its numbers to recover. The possibility of using *ex situ* conservation techniques therefore needs to be considered as well.

Ex situ conservation would involve catching a number of wild kouprey and establishing a captive breeding herd. Such action is recommended because circumstantial evidence suggests that the numbers in the wild are still sufficient to allow the removal of a few founder animals without greatly affecting survival chances of the wild population. The effects on the wild population will be reduced if the animals removed are weaned calves (which probably have a high natural mortality rate) or "doomed" animals, isolated from the main wild population centres and outside of planned protected areas.

There are also good publicity reasons for establishing a captive kouprey herd. Such a herd could stimulate public interest in the species and act as a fund-raising focus for *in situ* conservation efforts.

Another good reason to establish a captive kouprey herd is that the species could be a useful domestic animal of the future, and hybrids with domestic cattle might benefit from accelerated growth rates (due to hybrid vigour), better adaptation to local environments and food resources, and natural disease resistance. Hybrids between other wild cattle (e.g. gaur and banteng) with domestic cows have been found to be useful. It is probable that similar benefits could be derived from the kouprey. Farmers in both Laos and Kampuchea formerly put out their cows to be mated by kouprey bulls, claiming the young were stronger than pure stock. Wharton (1957) has even suggested that kouprey may have natural disease resistance against rinderpest, though this is not supported by conclusive evidence. Valuable research into possible benfits to be derived from the kouprey is only possible if a captive herd can be established.

Based on experience with gaur (*Bos gaurus*), another rare species of large bovid held cooperatively in 16 North American zoos, it is felt that the objectives of a captive management programme for the kouprey should be as follows:

- To ensure the survival of the species by acting as a genetic reservoir

- To generate sufficient offspring so that it is possible to supplement the wild population with animals which have been declared surplus to the genetic and demographic requirements of the captive population.

Using the gaur Species Survival Plan (SSP) as an example, a number of lessons may be of benefit.

It is possible, using the management, reproductive strategies, and technologies worked out by the gaur SSP cooperating institutions, to expand rapidly the captive population of a rare bovid such as the kouprey. This rapid expansion is possible due to the following attributes of a well-managed captive population:

a) Enhanced survival of adults due to better nutritional and medical management

b) Extended reproductive lifespans

c) Higher reproductive rates

d) Greatly enhanced survival rates of calves (in the wild, mortalities may exceed 65%)

e) New reproductive technology such as artificial insemination and embryo transfer.

This rapid population expansion is necessary to rescue the species, but is not without its dangers. Too great a concentration of animals in one facility may put a substantial portion of the

population at risk due to disease or natural disaster. This is a reason for moving some animals out of the country of origin. Another problem which must be avoided is mismanagement of the gene pool, either intentionally or accidentally. For this reason, the principles of small population biology should be rigorously applied in any efforts to establish a captive herd.

3.3 The Dangers of Small Populations

As populations of animal species reach low levels, the survival probability of the species drops very quickly. Two main factors are involved. First, the effects of chance mortality, unbalanced sex ratio, or the entire population being killed by a natural disaster or disease become very pronounced. Second, the population suffers from loss of genetic diversity through random losses of rare genes and increased levels of inbreeding.

Loss of genetic diversity in the population results in a reduced ability to respond to environmental variation and change. Loss of genes that may be needed to protect the population against unknown eventualities, such as disease, may also occur. Loss of genetic diversity and inbreeding also result in an increasing number of homozygous loci in the genetic make-up (genotype) of the individual animals, thus causing the deleterious effects of recessive genes to be shown in the phenotype (often resulting in loss of vigour and reduced fertility).

When populations are large (thousands), the rate of loss of rare genes (due to random gene loss) can be exceeded by the rate of acquiring new genes through mutation.

Limited migration between local populations, whether due to territoriality, kinship-based herd structure, geographic or biotic barriers to dispersal, or low vagility, can partially isolate local populations genetically. Such isolation can lead to localized inbreeding and loss of genetic diversity relative to the more global population, but also allows genetic differentiation to develop among sub-populations. Such differentiation can be adaptive, with sub-populations evolving traits well suited to local conditions. Because local populations are usually small, they face the demographic and genetic risks of any small population, and, if largely isolated from potential sources of immigrants, are likely to have high rates of extinction. Global extinction will occur if recolonization of vacated habitat does not keep place with local extinction.

These forces are utilized in animal husbandry, which often aims to manage semi-isolated genetic stocks. Breeders balance the need for constancy of desired genetic traits (a form of local "adaptation") against the maintenance of high vigor through outcrossing. However, most domestic animal breeds occur in large total populations (tens or hundreds of thousands) with little risk of demographic fluctuations, and it is generally easy to maintain adequate genetic variation.

In the captive breeding of rare animals such as the kouprey, numbers are initially very low (tens or hundreds), and the maintenance of high diversity can be very difficult. Of particular danger are genetic bottlenecks, very low numbers of breeding animals for one to many generations, as occurs at the outset of captive breeding programmes. Even after a population builds to moderate numbers, the remaining genetic diversity will be derived from the very narrow range of founder animals that persisted through the bottleneck. The duration of such bottlenecks is critical, as the decay of genetic variation each generation is cumulative and essentially irreversible (unless or until new, unrelated stock can be obtained).

The male kouprey has a pronounced dewlap. (Photo courtesy of the New York Zoological Society)

In managing very small populations, it is important to maximize the number of founder animals contributing to the managed population, to equalize family sizes of founders, and to minimize inbreeding by trying to ensure that the genetically effective breeding size (N_e) approaches the total population size (N) as closely as possible. One important aspect of this involves trying to include each captive male evenly in the breeding programme, which may be very different from what happens in nature or with domestic stock where the most desirable (strongest, largest, fastest-maturing) is allowed disproportionate breeding.

Another important aspect is to physically split the population so that it is not so vulnerable to a total extirpation caused by epidemic disease or other forms of disaster. While such splitting of the population might seem to contradict the need to minimize inbreeding, this is not a great problem in managed populations where outbreeding between split sub-populations can easily be maintained by the occasional transfer of animals or genetic materials.

3.4 Possible Methods for Accelerated Captive Breeding

If it is possible to establish a captive kouprey population, every attempt should first be made to breed the animals "naturally." Calves resulting from such matings could then be incorporated into an accelerated breeding programme (if natural reproduction occurs within several months after capture). In other related species, heifers can be involved in an artificial breeding programme at about one and a half years of age. This ensures that the adults at capture will be kept as the genetic (pool) nucleus while artificial reproduction technology is applied to the offspring. Semen may be collected and stored from all founder bulls to ensure their representation.

In the event that natural reproduction does not occur as soon as desired, plans should be developed to implement an accelerated

breeding programme through the application of artificial reproduction technology. Techniques that have been developed for, and are successful with, domestic cattle should be emphasized. Those techniques that have been applied in captivity to the wild bovids most closely related to the kouprey (i.e. gaur and banteng) should be given priority. The following is a list of reproduction technologies to be considered as possible methods for use in the artificial propagation of kouprey in an effort to increase their numbers in captivity more quickly.

1. **Embryo Transfer.** Embryo transfer is a method of high priority, since an embryo carries the fullest genetic complement of two founder animals (parents), and the embryo (fertilized egg) is more likely to survive than the individual reproductive cells (eggs and sperm). The embryo is also more easily collected than eggs, and can be obtained without surgery. Even though sperm is usually easily acquired, eggs require surgical recovery, and successful fertilization in culture (*in vitro*) is quite low (2%) with domestic cattle. Therefore, nonsurgical embryo collection should be attempted, followed by immediate transfer into the uteri of hormonally synchronized domestic cows (*Bos taurus*) to maximize success.

   It is suggested that these procedures be performed by experienced professionals who are fully trained in embryo recovery, handling, and transfer. Precise conditions are required to maintain embryos in culture and should be strictly adhered to, or the efforts will fail. It is therefore suggested that experienced embryologists trained in the countries of kouprey origin receive further training in North America or Europe, where the techniques of wild cattle embryo transfer are best developed. Alternatively, foreign experts could perform the embryo transfer procedures *in situ* and train local personnel until sufficient numbers of kouprey (20-25) are produced by this technology. It is anticipated that approximately 30% of freshly transferred kouprey embryos will result in calves, but only if the most highly qualified experts are employed.

2. **Embryo Cryopreservation (Freezing).** Since bovid ovaries can sometimes be induced to produce many eggs (40 at one time) and thus embryos, freezing is often desired and necessary to preserve genetic material. It is suspected that embryos can be "banked" in small plastic 0.25 cc straws for as long as hundreds of years, but to date the technology is only about 8 years old. Therefore, kouprey embryos, if not immediately transferred to domestic cows, should be frozen and banked until additional recipient cows are identified, or until they can be transported elsewhere for the establishment of another captive herd.

   Again, only trained embryologists should be responsible for freezing and thawing embryos, since precise conditions are crucial to survival. Also, since the viability of frozen-thawed domestic cattle embryos is only 60%, it is anticipated that, until more is known about kouprey embryos in culture, survival rates will be reduced to approximately 20%. Therefore, it is suggested that when kouprey embryos are frozen for transport outside the country of origin, that 25% of the banked embryos, for a minimum number of 100 embryos, be transported abroad, and the remainder of the frozen embryos be kept within the country of origin to supplement the founder population when facilities and personnel allow for an increase in herd size.

   Frozen embryos also provide insurance against the reduction of kouprey herd size due to unexpected diseases. If the embryos are banked, they can be thawed when necessary and act as back-ups to the genetic pool of living founders, either within the country of origin or elsewhere.

3. **Semen Collection.** Semen should be collected whenever bulls are restrained for other purposes, or else a programme should be implemented to collect semen on a scheduled basis through chemical immobilization of the bulls and semen collected by electro-ejaculation. This could occur weekly or monthly. If a restraint chute is designed and in place, semen could be collected once or twice a week and used for artificial insemination or banked after freezing. It is anticipated that ten 0.5 cc straws could be collected during each attempt.

4. **Semen Cryopreservation (Freezing).** Semen would most likely be frozen and banked for later use or transport to other locations. It could be most importantly used as a genetic resource and for the introduction of new genetic material to captive kouprey herds located outside the country of origin. Eventually, kouprey semen could be thawed for experimental hybridization with domestic cattle. This, however, should not be a high priority until a "pure" herd of kouprey has been well established.

5. **Artificial Insemination.** Artificial insemination of kouprey cows could be accomplished with chemical immobilization or preferably with cows who have adapted to restraint in chutes. Ideally, a cow should be inseminated twice during one standing estrus period, but a single insemination, if properly timed, can result in pregnancy. Artificial insemination should only be required when new genetic material is requested away from the herd where the semen was collected. It is suggested that 80% of the semen be provided to captive breeding herds outside the country of origin until the herds are large enough to satisfy minimum viable population requirements. After this time, 25% of the semen could be provided for artificial insemination outside the country of origin for experimental use in hybridization with domestic cattle. Seventy-five percent would thus be retained within the country of origin.

6. **Micromanipulation (Embryo Splitting).** Embryos can be split into halves through the application of microsurgery. Offspring from domestic cattle, sheep, pigs, and horses have been produced by this method, and it is suggested that after breeding groups are successful, attempts be made with kouprey embryos to increase offspring production through the application of this technology when larger numbers of embryos are available. However, highly specialized expertise is required to split embryos, and only personnel well trained in this technology should attempt the procedures. Embryos should be split before they are frozen and should immediately be transferred instead of frozen. Training in em-

bryo micromanipulation could be provided in the laboratories of embryologists in zoos or commercial embryo transfer operations in North America or Europe; alternatively, a team of previously trained embryologists could provide expertise and training *in situ*.

7. **Alternative Methods.** Other methods of reproduction technology such as *in vitro* fertilization or oocyte (egg) freezing should not be considered for use in the kouprey propagation programme until better success is achieved in domestic cattle.

   A specific time frame for an accelerated breeding programme and the application of artificial reproduction technology should be determined once a captive herd(s) of kouprey is/are established and natural reproduction has been attempted. A suggested time frame is:

Technology	**Time Frame** (years post capture)
Semen Collection	First Year
Semen Cryopreservation	First Year
Artificial Insemination	Second Year
Embryo Transfer	Second/Third Year
Embryo Cryopreservation	Second/Third Year
Micromanipulation	Fourth Year

3.5 Conclusions of the International Kouprey Workshop

The following is the agreement issued at the close of the International Workshop on the Kouprey Conservation Programme:

"An international workshop was hosted at the Hanoi University, and sponsored by WWF and IUCN, to discuss and formulate an overall action plan to save the kouprey (*Bos sauveli*). Representatives from all four countries in which kouprey have been found, Kampuchea, Laos, Thailand, and Vietnam, were present, together with international experts representing four of IUCN's SSC Specialist Groups, WWF, Wildlife Conservation International and the international zoo community.

Agreements on the following points were reached, and decisions made for future action.

1. The delegates agreed that the conservation of the kouprey (*Bos sauveli*) is one of the region's highest conservation priorities and a matter of the gravest urgency.

2. All parties agreed that each nation where the kouprey now exists is sovereign and holds absolute rights over the species in that country.

3. All parties agreed that the primary responsibility for saving this species rests with the people and authorities in each country where the kouprey exists.

4. All parties agreed that external agencies or individuals who agree to participate in the programme either by contributing funds or expertise do so recognising the implications of points 2 and 3 above.

5. Convincing evidence has been presented that small numbers of kouprey still survive throughout almost the entire former known range of the kouprey. They are still found in Vietnam, Laos, and Kampuchea. Kouprey may still sometimes move seasonally into the Dongrak Mountains of Thailand.

6. Kouprey are mostly distributed in the border areas between Kampuchea, Laos, and Vietnam. There are indications that kouprey freely cross these international frontiers. This means that the populations are a shared resource and that *in situ* conservation efforts will only be successful if the respective countries coordinate their efforts to protect the species.

   For this reason, Vietnam, Laos, and Kampuchea have signed agreements for such cooperation within the context of the special cooperation of cultural and economic development of the three Indochinese countries.

7. The following goals have been agreed for the programme of cooperation. The first goal is to save the kouprey in the wild. The second goal is to determine whether the kouprey can be used to benefit the cattle livestock industry. Following from these long-term goals are a number of short-term objectives.

   a) First, to secure and protect suitable areas of kouprey habitat as reserves in each country

   b) Second, to build up a strong, effective local team in each of the countries concerned, for managing the kouprey

   c) Third, to establish a captive population of kouprey as a means of ensuring the protection of the gene pool, a means of accelerating the recovery of wild populations (through a programme of reintroduction), and as a means of undertaking trials in kouprey domestication and hybridization.

8. On the basis of these goals and objectives, Vietnam, Laos, and Kampuchea each agree to (a) offer the highest possible category of legal protection to the kouprey, (b) establish a system of kouprey reserves, and (c) coordinate their selection of reserves as far as possible to establish trans-frontier reserves.

9. Vietnam has agreed to offer training and assistance to Laos and Kampuchea as may be needed.

10. The Thai delegation has agreed to manage a series of kouprey reserves adjacent to the Kampuchean border, and will inform the programme coordinators, through non-governmental channels, of any movements of kouprey across this border.

11. Vietnam, Laos, and Kampuchea have agreed to seek and accept assistance from the international zoo community in the establishment of a captive kouprey population. Such assistance is to be in the form of training local technicians in

the latest techniques for keeping and handling captive wild cattle, and the provision of equipment and assistance (if applicable) in new techniques of accelerating captive breeding rates. The three countries agree in return to allow the export of sufficient genetic stock to permit the establishment of a secure, global, captive population of kouprey. The export of 25% of sperm and 25% of embryos collected from founders or their offspring for hybrid cattle studies will also be allowed. Such exports will be controlled by the following conditions:

a) First generation kouprey resulting from embryo transplants would remain the property of the country of origin but would be regarded as being on long-term breeding loan to allow the establishment of a secure global captive population.

b) Second generation offspring or hybrids will remain the property of the country in which the births occur, but with the understanding that zoos holding kouprey will continue to make pure kouprey available without cost if these are needed for the reintroduction programme into wild habitat.

12. Vietnam, Laos, and Kampuchea will seek and accept assistance from IUCN, The Kouprey Conservation Trust (a consortium of zoos interested in kouprey), and WWF in training of animal capture teams, and will take every precaution to avoid any unecessary risks to the life of kouprey. Only skilled and competent technicians should be allowed to engage in such operations. The countries agreed to undertake capture operations only in compliance with guidelines outlined in the Kouprey Action Plan jointly developed by the participating parties.

13. Each country agreed to continue field surveys to gather the best possible data on the current distribution and status of kouprey in their respective territories and make the findings of such surveys freely available to the other participating parties.

14. Each country agreed to promote suitable public awareness materials to the local public, and particularly to villagers living within the range of the kouprey.

15. It was agreed to form two international committees—one based in Indochina to coordinate local regional activities, one based in Gland, Switzerland between IUCN and The Kouprey Conservation Trust to act as a focal point for the coordination of international aspects.

16. The four kouprey countries declared their acceptance of their respective responsibilities to take actions necessary to save the kouprey.

17. WWF and IUCN pledged their continuing willingness to provide assistance and advice, and to seek the necessary financial support for this important programme."

4. The Action Plan

4.1 Programme Goals

The programme is to be directed towards the two goals agreed at the workshop:

1. To save the kouprey in the wild.

2. To determine whether the kouprey can be used to the benefit of the cattle livestock industry.

4.2 Programme Design

1. **Objectives and activities.** In view of these goals, the programme has two distinct parts which need not necessarily coincide in space and time, namely (1) protection of the habitat of the kouprey, and (2) protection of the gene pool of the kouprey.

Protection of the habitat is a vital ingredient in achieving the primary aim of the programme, but might also achieve or partially achieve the protection of the kouprey gene pool. However, the gene pool can also be saved in other ways, such as captive breeding. These animals could then be returned to the wild at a later date, as has been done with other species on the brink of extinction, such as the Hawaiian goose (*Branta sandvicensis*) and Arabian oryx (*Oryx leucoryx*).

It has been decided to try both methods and take animals into captivity as insurance against the possible extinction of the wild population, as a tool for helping to accelerate the recovery of numbers in the wild population, and also as the only way to reach the secondary goal of the project; namely, attempting to use kouprey as a means of improving domestic cattle stocks.

The following objectives are therefore identified:

a) To establish a system of well-designed, adequately protected nature reserves to preserve viable wild populations of kouprey in their natural environment.

b) To build up a strong, effective local team in each of the countries concerned for managing the kouprey.

c) To establish a captive breeding population of kouprey with enough genetic variation for long-term viability, to serve as a source of animals or genetic material for release into the wild, either for the establishment of new populations or reinforcement of existing populations.

These objectives can be broken down into a number of specific activities:

(1) Undertake a detailed study on the kouprey, with particular reference to its conservation needs.

(2) Survey, select, and gazette suitable nature reserves.

(3) Prepare management plans to guide the development and future management of kouprey reserves.

(4) Provide essential training and equipment needed for the proper management and protection of kouprey reserves, and for the management of the species itself.

(5) Capture scattered animals outside the planned protected areas if they are considered to have little chance of survival, and translocate them into the planned reserves.

(6) Establish a captive breeding population of kouprey capable of retaining 90% of the genetic diversity available from the wild population for 200 years.

(7) Obtain sperm of wild kouprey as a genetic reserve and for use in hybridization trials with domestic cattle.

2. **Success indicators.** The success of the project can be judged by the gazettment of suitable reserves, evidence that these reserves contain a nucleus wild population at the end of the programme, the successful recruitment and training of guards and delivery of equipment, and the survival in captivity of a world kouprey herd containing the gene pool of at least twenty founder animals.

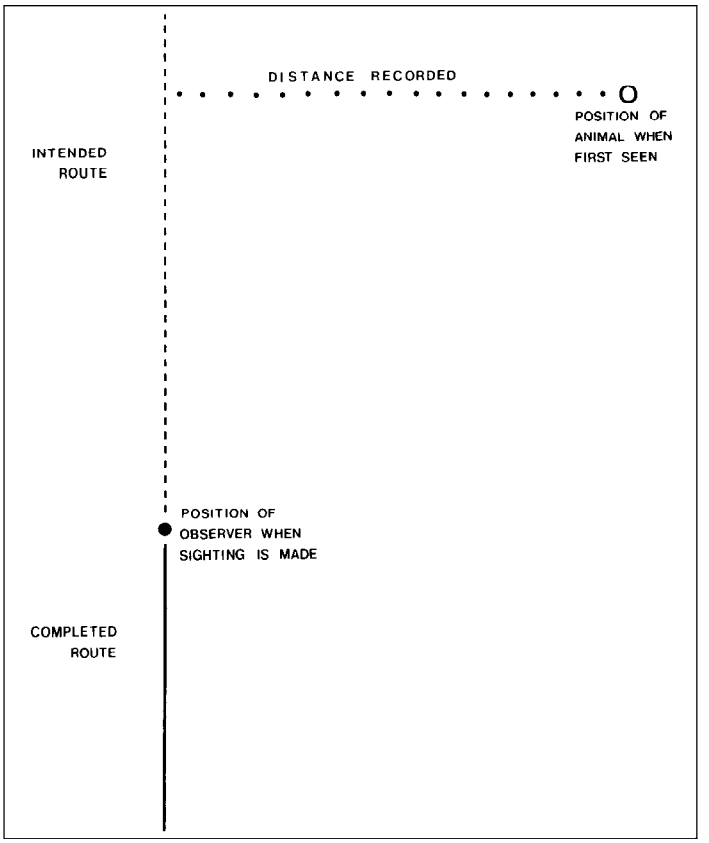


Fig. 4.1 Diagram to explain methodology of a transect survey.

4.3 A Study on the Kouprey's Conservation Requirements

The need for this study as the basic underpinning of all *in situ* conservation efforts is outlined in sub-section 3.1. This study should concentrate on the habitat requirements and seasonal movements of the species, and should seek to identify the largest remaining populations, especially those that could most easily be protected. The threats to the species should also be evaluated, and the measures needed to alleviate them should be outlined, within the prevailing social, economic and political context.

4.4 The Selection and Establishment of Protected Areas

The selection of reserves, assessment of kouprey numbers, and assessment of habitat suitability will require considerable field surveys during the course of the programme. The following methods are suggested:

1. Initial surveys should concentrate on those areas where there are known to be kouprey populations.

2. The most favourable survey time is the dry season, generally from December to April, when in certain habitats long grass is burned and deciduous trees have lost their leaves.

3. In surveying a new area, the first step is to obtain information from local people about the presence, location, and movement of kouprey, and also the location of any salt-licks, wallows, and waterholes; the second step is to estimate the number of kouprey through fieldwork.

4. Kouprey numbers can be estimated by stratified sampling; that is, areas with known kouprey are surveyed intensively, and areas in which presence is unconfirmed are surveyed less intensively.

5. Surveys in an area can be conducted by two means: first, by cross-country transect along compass lines; and second, from observations at meadows, waterholes, and saltlicks where animals may visit in morning or evening.

6. Survey teams used in transects should be small (at most 3-4 persons), they must move quietly, and each team should have at least one pair of binoculars, one camera, one compass, and a map on which sightings of wildlife and transect routes can be marked.

7. Transects can be made on foot, by elephant, and in some places by motor vehicle. The following information should be indicated on a form used for each transect: time at beginning and end of the transect, approximate distance travelled, direction of travel, ruggedness of terrain, weather, date, vegetation type, height of grass cover, and other relevant information (e.g. human activity in the area). To obtain the relative abundance of species, every encounter with a large mammal should be recorded; species, number in herd, age and sex, activity, and distance from observer (as estimated at right angles from the observers travel route (see Fig. 4.1). Skulls and lower jaws from dead animals found should be collected if possible.

8. Transects should be long (several km at least) and can either radiate from a centrally located camp, or proceed cross-country for several days. However, large blocks of terrain should be covered thoroughly to avoid missing local concentrations of kouprey.

9. Aerial surveys over open vegetation types are useful in that large areas can be covered quickly, and at least the minimum size of populations can be determined. A small, single engine plane is usually used in aerial surveys. Standardized methods of surveying (flight pattern, height above ground, flight speed, width of strip counted, duration of flight) have been well developed, and should be employed. The early morning, when animals may be in the open and visibility is usually good, is probably the best survey time. For certain local surveys, a helicopter might be useful. The use of a one-man, small, super-light plane (which is cheap to buy and easy to transport on a truck, but is limited to about 1 hour of flying time) might be suitable for surveying small areas intensively.

4.5 Gazettement of Reserves

Where existing reserves need ratification or boundary changes, and where proposed reserves have been surveyed and found suitable as protected areas, clear statements should be prepared in the form of feasibility reports. These documents should outline the need for a reserve, describe and map the boundary of the reserve, justify such reserve establishment, and indicate expected costs and benefits from such action.

The respective departments should lobby such documents through the necessary legislative procedures in their countries to achieve gazettement of the reserve system as soon as possible.

4.6 Training Requirements for Protected Area Management

With little background in wildlife and protected area management in the region, and with serious shortages of trained personnel in Laos and Kampuchea, there is a large need for increased staff training.

Three items of training are envisaged as part of the reserve development associated with this programme.

1. One training course to be run by foreign experts on management planning, to be attended by staff from Vietnam, Laos, and Kampuchea.

2. One annual training course to be run locally by experts from within the region for game rangers of the reserves.

3. Diploma of wildlife management fellowships (1 year each) at Wildlife Institute of India, for six reserve wardens.

4.7 Production of Management Plans

Management plans are urgently needed to guide the development and management of these important reserves. Such plans should comply with standard guidelines developed for protected areas in the tropics (MacKinnon et al. 1986). Each management plan should have a general descriptive part, a discussion and evaluation part, and a detailed prescription for management. The following section outline is recommended for each management plan:

1. Description of reserve
   a) Biogeographical setting of reserve (global sense)
   b) Local setting of reserve (in relation to towns, roads etc.)
   c) Physical description of reserve (brief description of landform, topography, geology, soil)
   d) Climatic conditions (summarized)
   e) Natural vegetation (brief description of main types)
   f) Floral characteristics (mention important plant species)
   g) Faunal characteristics (mention important animal species)
   h) Distribution of important species in reserve
   i) History of the area (previous agriculture, logging, grazing or burning)
   j) Current land-use (particularly if human residents are involved)
   k) Current management (details of staff etc.)
   l) Reseach to date (summary of any conducted)
   m) Visitor use (summary or statistics of levels of use)
   n) Current management constraints (identify main problems)
2. Evaluation, discussion, and conclusions

a) Evaluation of species conservation importance

b) Evaluation of hydrological importance

c) Evaluation of research value

d) Evaluation of tourist potential

e) Description of other needs placed on reserve (roads, water, fuelwood, regional income, etc.)

f) Assessment of compatibility of these different interests

g) Conclusions for management and development of reserve

3. Management prescription

a) Clear statement of objectives and goals (with an indication of relative importance and success indicators)

b) Programme of natural resources management (including review of reserve boundaries and particular management operations—breeding and release of rare animals, provisioning, habitat modifications, etc. that may be planned)

c) Programme of human use (including zoning of reserve with relevant regulations, development of buffer zones, needs of local people, resettlement of villagers from reserve (if needed), visitor use and controls, etc.)

d) Programme of research and monitoring (including special research needs to answer management questions, further inventory and monitoring of key or indicator species, and a measure of management effectiveness)

e) Programme of administration (including schedules of staff recruitment, training schedule, terms of reference, guidelines on law enforcement and care of equipment and buildings, channels of reporting, and relationships with external agencies)

f) Schedule of physical development (including specifications or plans for buildings, roads, and other structures)

g) Budgets (including item costs, yearly routine budget maintenance, day to day running costs, staff, etc.) by category and yearly development budget by category.

Descriptions should be brief. Where further details are presented (e.g. lists of species, weather details, etc.), these should be entered as appendices. Information should be in the form of maps or diagrams wherever possible for clarity.

Each management plan should be preceded by a short executive summary outlining the main points. This summary should present the salient features (i.e. size, location, and values) of the reserve, outline the proposed development and management, present the investment costs in terms of money and manpower, give justification for this management, and outline the expected benefits that will result.

Management plans have already been prepared for several other reserves in the region and can be used as models. WWF could provide assistance in the preparation of management plans and the training of management planners and managers.

4.8 Fire Management

Serious consideration will need to be given to the question of fire management. Wharton (1957, 1966) believed that kouprey, like other wild cattle, have moved into their current area of distribution as a result of human occupation practices, particularly grass-burning. Most of the current kouprey habitat is regularly fired by man. Although we do not know if such burning is optimal, or even necessary, for maintaining suitable kouprey habitat, we can at least conclude that it is compatible with the maintainance of habitat suitability. Fire may be needed to control bush encroachment, ticks and other pests, and to stimulate grass production.

It would be foolish to adopt a "no burning" management policy on the grounds of "naturalness". The region is already greatly affected by man. A more sensible initial management policy would be to try to maintain the status quo that existed in pre-war times. The same frequency of burning that occurred in former times should be maintained in reserves whilst some trial plots could be given variant treatments (e.g. early burning, less regular burning, no burning, etc.) to study the patterns of vegetation change and utilization by wild cattle species under such management.

The ultimate aim of such research should be to identify and apply the optimal fire policy for the survival of kouprey.

4.9 Implementation of a Captive Propagation Programme

1. **General Principles.** The establishment of a captive breeding programme for kouprey would be governed by the following principles:

a) At least twenty "founders"—wild caught animals that produce surviving offspring—should be secured for the captive population. The founders should include 7-10 breeder males and 10-13 breeder females.

b) This founder stock should be selected from different wild herds or groups to assure broad respresentation of the existing genetic diversity in the wild.

c) The genetic relationship of the kouprey to other species of wild and domestic cattle should be established by chromosomal and biochemical analysis of blood samples and tissues collected from captured animals as soon as possible.

d) The captive population should be expanded to 200 breeding adults from the founder stock as rapidly as possible. Thus, a captive carrying capacity of 400 animals will need to be secured.

c) The captive population should be distributed as widely as possible in Indochinese countries and other regions as soon as possible to reduce the risk of catastrophe.

f) All participants in the captive propagation programme must agree to participate in a species survival plan programme under the oversight of the IUCN/SSC Captive Breeding Specialist Group. Holders must keep designated records, participate in an international studbook, register all animals in ISIS, and agree to transfer animals or genetic material as required to meet the needs of the captive propagation programme.

g) A management plan should be drawn up for the captive propagation programme to ensure that breeding follows a sound genetic plan to maximize the effective population size and retain genetic diversity of the founder stock.

h) Such genetic planning should avoid potentially disastrous genetic bottlenecks which occur when a male is only bred with one female or one male is bred with many females while other males do not contribute.

i) The genetic representation of each founder should be kept approximately equal in the population through subsequent generations.

j) The management plan will require annual revision and review in response to changing conditions and availability of animals. This should be done on a collaborative basis with a species coordinator and a propagation committee with representatives from each of the kouprey holders.

k) The captive breeding population established to assist the conservation of the kouprey will be managed as a global population.

l) All participants in the captive propagation programme will agree to make animals available for approved release programmes at no cost for the animals. Such animals must be surplus to the needs for a stable and secure captive population as determined in the species survival plan.

2. **Selection of animals for capture.** In view of the urgency in establishing a secure captive population, and the low risk to wild populations caused by the removal of young animals (most of whom would die in the first year in the wild), the following principles should apply to the selection of animals for capture, until adequate captive stocks (minimum of 20 surviving founder animals) have been acquired.

a) Inside existing and proposed nature reserves or areas of habitat contiguous to such reserves, all weaned young and yearlings should be taken.

b) In areas well away from the proposed protected areas or isolated animals that are regarded as "doomed" (isolated units of the population at numbers too small to be viable), capture of both young and adult animals should be attempted, taking young first, as they are easier to transport and acclimatize more easily to captivity.

3. **Selection of sites for the holding of the captive population.** It is regarded as essential that the captive population should be divided between several locations so as to avoid the chances of accidental or disease-wrought disaster wiping out the entire stock. It is therefore decided that separate captive breeeding herds eventually be established in each of the three countries. The first station to be constructed will be in Vietnam at Nokau Daklac Pranh, some 40 km from the Yok Don-Easup Reserve.

Suitable sites will also eventually be selected in Laos and Kampuchea. Sites should be selected for proximity to suitable kouprey habitat, ease of access by road, and remoteness from human habitation or other cattlestock as a precaution against infections. As an interim measure, the veterinary cattle improvement station outside Vientiane could be used to hold kouprey.

4.10 Veterinary Precautions During Kouprey Capture and Translocation

1. The capture of doomed, isolated kouprey in areas outside the protected areas, whether for release in those areas or for translocation to the chosen site of the captive herd, will require careful planning.

2. If losses are to be minimized, capture teams will need to be trained in all the various relevant capture techniques available for large bovids.

3. Training in safe drug handling will also be needed.

4. Training may also be needed in the construction of crates (for transportation) and holding enclosures.

5. The establishment of safe protocols for transportation will be required.

6. Although every attempt should be made to capture kouprey in the 3-15 month age-class, preparations should be made for the emergency handling and maintenance of unweaned calves and mature adults.

7. Some training in radio-tracking (radio darts) and radio communication will be necessary.

8. Capture teams must be made familiar with first-aid procedures (both for humans and animals), and where possible a veterinarian should accompany each capture team. This is regarded as essential if drugs are to be used.

9. A selection of basic drugs and medicines for humans and kouprey must be carried in the field and applied as necessary.

10. Base camps should be established at or near roadheads, and should be in radio contact with capture teams operating in the area.

4.11 Veterinary Implications Post-capture

1. Newly captured kouprey may require tranquilization to minimize stress and accelerate taming.

2. Vaccination against haemorrhagic septicaemia (formolised broth vaccine) must be carried out as soon as possible after capture. Vaccination with oil-adjuvant H.S. vaccine should follow after 4 weeks.

3. Vaccination against anthrax and blackleg may be delayed until the kouprey have been trained to enter a crush.

4. Vaccination against other diseases (foot-and-mouth disease, rinderpest, etc.) should be carried out when the kouprey have settled down in captivity and only after taking into account the local cattle disease situation.

5. Contact with domestic cattle and water buffalo should be avoided.

6. Where domestic livestock are present near captive kouprey, these must be vaccinated against endemic diseases so as to form an immune barrier against infection.

7. Suitable anthelminthics should be administered when indicated. External parasites will also be routinely controlled.

8. A veterinary dispensary complete with basic drugs and instruments will be built and equipped at the captive breeding site.

9. Training (in service) in wild animal medicine and husbandry techniques will be provided for a resident national veterinarian.

10. Clinical post-mortem and pathological specimen collection equipment will be provided and training afforded in its use.

11. Suitable sources of vaccines will be identified.

12. Working relationships with central or regional veterinary laboratories will be established.

13. Captive kouprey will be tested for tuberculosis and brucellosis. Positive reactors will be isolated in separate herds.

14. Captive kouprey will be regularly monitored for gastro-intestinal and haemo-parasites.

15. Adequate veterinary records will be kept for each animal.

16. Carcass remains will be kept for appropriate distribution and future study.

4.12 Housing and Handling of Captive Kouprey

Wild cattle species have been successfully managed in captivity for many years. The management techniques used in housing, feeding, and breeding them have become routine in zoological institutions. As animals are captured to be relocated, basic procedures will need to be followed. First, and most important, is a method of marking each animal for identification. This can be accomplished by assigning each animal a number and tattooing that number in each ear and placing an ear tag in both ears to allow long range identification.

After the animals have been captured and marked, they will need to be placed in suitable housing. If adult animals are to be held in captivity, the facilities must allow conditioning of the animals to a captive situation. Young animals can use the same barn system as adults. Adult animals should be held in a barn that has solid walls and a ceiling. The barn should have an access door which allows an animal to be loaded directly into a stall from a crate. All the stalls should have connecting shift doors or runways. Once an animal has been acclimatized to shifting within the barn, then it can be trained to shift through a runway to an enclosed corral. The walls of this corral should be 2.5 meters high and solid to provide a total visual barrier. This barrier is to prevent the animals from trying to jump out of the corral. If needed, the corral should have the option of having a partial roof that can be removed once the animal has been conditioned to the corral and to returning to the barn. It is emphasized that cattle are traditional animals that rely on routines. When acclimatizing an animal to a contained environment, the manager should try to use this behaviour to his benefit. The manager creates a new routine for the animal and rewards performance with access to food and water.

For feeding, a hay manger is needed that does not protrude into the stall, but which allows the animal easy access to the hay. This will prevent injury of an excited animal if it runs into the stall walls. To prevent infestation with parasites through the ingestion of food, the animals should not be allowed to eat food off the floor. The type of hay fed depends on what is locally available and what is adequate and palatable for the animals to eat. A grain concentrate is recommended as a supplement to assure a balanced diet and to keep the animals in good condition. The manager must pay close attention to the nutritional status of the animal. The most stressful time is the transition from a natural diet to an artificial diet, and if the same plants that the animal consumes in the wild can be used in the captive diet, it makes the manager's job much easier.

To establish a manual restraint routine for the animal or herd, the corral should be connected to the barn by a runway with a squeeze chute and head catch in it. This means the animal will

pass through the squeeze chute on a daily basis while moving to the corral. The runway and chute should be covered to discourage the animal from jumping or running too fast. There should also be gates that can be closed to prevent the animals from backing up. By installing a manual restraint system in the daily routine, the manager will have the capability to give vaccinations, draw blood, examine the animal, collect semen, and characterize the female reproductive pattern for artificial insemination or embryo transfer.

The initial work with the animals will be important in determining how they respond to their new routines. Once the individual animals have been conditioned, they should be moved into a herd situation where they can have the company of fellow kouprey. This introduction should be made gradually, and the animals should be let out of the corral into a larger holding yard where there is enough space and visual barriers to allow the herd free movement. The herd should only be fed in the stalls so that they are taught to return to the barn on a daily basis. This completes the basic management routine and ensures the control of the herd.

The end goal for the establishment of a captive herd of kouprey is to place a number of founder animals into a secure environment and to allow access to the animals in the least stressful manner. This will provide a means to collect basic biological data and will give an understanding of the animal that is needed to help in the long-term survival of this species.

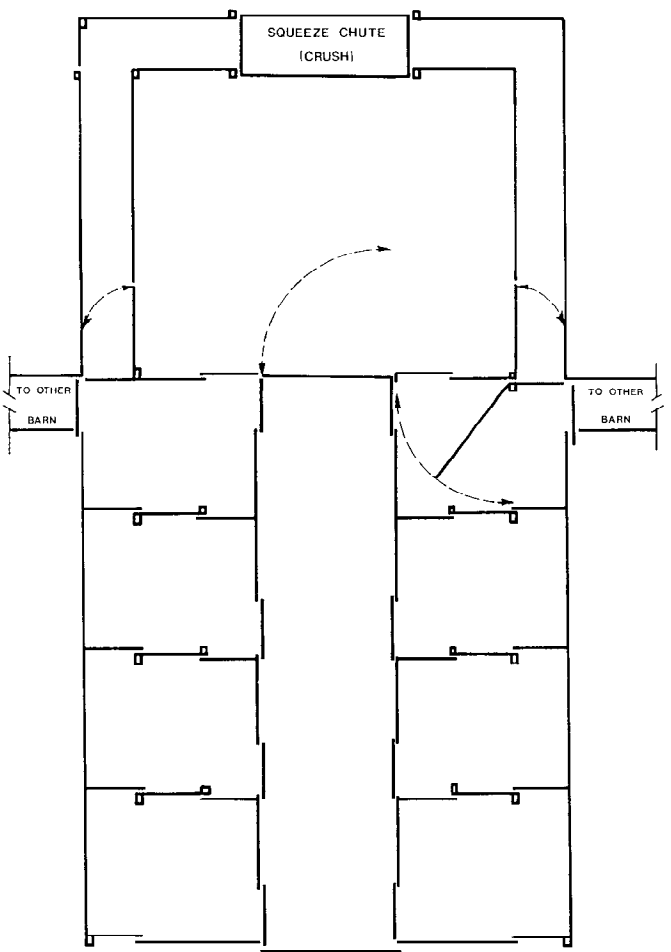


Fig. 4.2 A suggested design of holding stalls for kouprey.

4.13 Design of Holding Compounds

Detailed specifications for the design and construction of holding compounds will depend on the lie of the land and the availability of suitable construction materials, but the following guidelines should be followed.

1. Holding stalls for freshly caught animals

   - The area should have almost no light (but should have a provision for shutters that can be opened and closed).
   - There must be plenty of ventilation.
   - Each animal should have a two-compartment system of about 2.5 by 3 metres.
   - All doors should be of a sliding type unless otherwise specified.
   - The area should be attached to a runway system.

2. Stockades

   - The size of stockades can be variable, but they should be as large as practical.
   - The height of the main stockade should be at least 2.3 m with slanted lighter poles going up to 4 m (the latter as an anti-predator defence).
   - The stockade should be constructed of vertical poles that are rot and termite resistant, buried 0.5 m in the ground in a trench which is then filled with concrete. The main supports should also be vertical, buried in concrete filled holes at least 1.5 m deep (depending on soil type). Construction would involve erecting the main supports before fixing strong horizontal beams bolted onto the outside of the main supports at 2.3 m height. The verticals can then be fixed in place leaving gaps of 15 cm between vertical poles. The trench can then be filled with concrete and the tops secured to the horizontal beam with wire or nails. Each horizontal pole should be at least 10 cm wide (depending on the strength of wood used).
   - All doors should be of a sliding type.
   - The stockade should be attached to the holding stalls.
   - More than one stockade can be attached to one holding stall.
   - Erection of a 3-strand electric fence may be necessary as an external perimeter if large carnivores make persistent attempts to enter the compound.
   - Considerable variation is possible for the design of holding stalls.

The design presented in Figure 4.2 has proved efficient for holding other wild cattle species and includes design of a runway through a squeeze chute (crush) which is needed for close handling or veterinary treatment of animals.

4.14 Training Requirements for Wildlife Management

Three types of basic training are needed so that the first wild kouprey can be caught and kept safely in the first captive station planned in Vietnam: first, further training in the capture and transport of wild bovids; second, in the captive care and maintenance of wild bovids including taking routine samples of blood, tissue, and semen; and third, highly technical training in the embryological techniques that will eventually be needed to implement an accelerated breeding programme.

Three Laotian and two Vietnamese technicians have already received basic training in capture and immobilization techniques at the Wildlife Institute of India at Dehra Dun, which has included successful immobilization of deer and gaur. More wildlife managers will receive similar training in the course of the reserve development programme.

Further training will be given by an overseas expert working together with the Laotian and Vietnamese technicians in the first efforts to catch kouprey. A trial run in which banteng and gaur are captured may be used.

It is planned to send two technicians to North America to work for one month in a zoo actually handling gaur and banteng to learn the procedures and routines needed to keep these animals in good health, and to take samples from them. The same two technicians will then spend a further period of time working in an embryology lab, where they can acquire the basic skills in embryological manipulation and the latest techniques available for accelerated propagation. Further on-site training will be supervised by an overseas expert before any embryonic manipulation is attempted with captive kouprey.

4.15 Education Requirements

At a different level, public awareness campaigns on the uniqueness and importance of the kouprey should be undertaken in each country, within the context of general environmental education programmes. Local villages, especially those most likely to come into contact with the kouprey, should be the chief target audience of such campaigns. In this context, WWF is already producing pamphlets on the kouprey in Vietnamese, Lao, and Kampuchean.

4.16 Need for Overseas Experts

While one of the objectives is to build up a strong, effective local team in each of the three Indochinese countries, there is some need for involvement of overseas experts, at least in the early phases of the programme. Since some of the techniques to be used are potentially dangerous both to humans and kouprey, they should only be carried out by an experienced expert.

It is advisable that an overseas expert supervise the initial capture and transport operations. It is expected that an overseas expert can check the designs and supervise the construction of the first holding station for captive kouprey.

4.17 Equipment Needs

Locally available materials (wood, cement, etc.) will be used in the construction of buildings and holding pens, etc. and for transport (e.g. elephants). There is, however, a need for a considerable amount of specialized equipment that is not available locally and will need to be provided by the international parties involved in the agreement.

Such equipment should include a minimum of:

- Three trucks capable of transporting a crated adult bull kouprey
- Two squeeze chutes
- Two mechanical winches
- Various capture equipment (dart guns, nets, drugs, etc.)
- Photographic equipment
- Adequate veterinary equipment and supplies (including microscopes, freezers, humidifier, microtome, veterinary thermometers, electroejaculators, centrifuge, drugs, syringe poles, etc.).
- Micro-computer system for documentation and analysis
- Relevant library materials.

4.18 Coordination of the Programme

1. **National Coordination.** The four countries concerned, Vietnam, Laos, Kampuchea, and Thailand, will each form national committees to coordinate the programme activities within their territories. These committees will be responsible for all aspects of the programme implementation within their own countries, including the organization of public awareness campaigns to promote the plight and importance of the kouprey.

2. **Regional Coordination.** Under the terms of the conservation agreements between Vietnam, Laos, and Kampuchea, an Indochinese Committee will be established to coordinate all aspects of the programme that require such regional cooperation. These aspects include:

- Establishment of, and coordination of activities in, trans-frontier kouprey reserves

- Special authorization for survey and capture teams to cross international borders at locations away from official border posts

- Management of captive animals in Indochina, and apportionment of individual animals between breeding stations in Vietnam, Laos, and possibly eventually Kampuchea, in a way most consistent with the principles of small population biology, and hence most beneficial for the conservation of the species

- Arranging for the export of calves, embryos, or other forms of genetic material, as agreed, to institutions outside of the region, as agreed under the programme

- Organizing training within the region for the teams of all three countries

- Arranging clearance for overseas experts accepted to work in the region under cooperative agreement with the International Donor Committee (see below)

- Selection of suitable candidates from the three countries for specialized training overseas, and maintaining regular contact and dialogue with the secretariat of the International Donor Committee on all aspects of progress with the programme.

3. **Coordination of donors.** In order to ensure that the financial contributions to the programme are coordinated, an International Donor Committee will be established to consist of representatives of:

   - WWF

   - IUCN

   - The Kouprey Conservation Trust

   The secretariat for this committee will be provided by the IUCN Species Survival Commission Executive Office. This secretariat will ensure easy communication and coordination between the donors, the governments of the countries concerned, and appropriate IUCN interests.

4. **International Coordination.** To ensure smooth and efficient coordination of the programme, close liaison between the Indochinese Committee and the International Donor Committee will be essential. The secretariats of the two committees will be responsible for ensuring that this is the case.

4.19 Budgetary Needs

The programme will be conducted as a number of discrete and separately funded projects (e.g. captive breeding, protected area management plans).

One problem with estimating a budget at this stage is that there are so many "unknown quantities" associated with the overall programme. It is not clear how easy the kouprey populations will be to locate, or how easy the animals will be to catch. The logistical problems of establishing protected areas will undoubtedly be complex. As a result, only a rough estimate of the true costs can be made. The first three years of the programme are estimated to cost U.S. $600,000.

This is provisionally budgeted for three years as follows:

Activity	U.S.$
Kouprey field study	60,000
Surveys (including equipment)	100,000
Reserve establishment and management plan preparation	120,000
Animal capture and translocation	100,000
Holding site construction	20,000
Holding site management and veterinary care	60,000
Training requirements	70,000
Education campaign	30,000
Programme administration and coordination	40,000
Total	**600,000**

This sum will come from a number of sources. A consortium of North American and European zoos (comprising the Kouprey Conservation Trust) will cover the expenses connected with capture and captive breeding, as well as some survey and training costs. Initial work in Laos can be included as part of the SIDA-funded IUCN project in that country. WWF is contributing to some equipment costs and to the education and training programme. The People's Trust for Endangered Species hopes to cover some of the veterinary expenses. Other aspects of the programme can be covered through the various national budgets. However, much more needs to be raised, especially to cover the kouprey field study, reserve selection and establishment, and management plan preparation. IUCN will be seeking the required addition donor support for these discrete aspects of the programme.

References

Bohlken, H. 1961. Der Kouprey, *Bos (Bibos) sauveli* Urbain 1937. *Zeitschrift für Säugetierkunde* 26: 193-254.

Chan Sarun 1985. Intervention de la delegation du Kampuchea. In Thorsell, J.W. (Editor). *Conserving Asia's Natural Heritage*. Gland, International Union for Conservation of Nature and Natural Resources.

Coolidge, H.J. 1940. The Indo-Chinese Forest Ox or Kouprey. *Memoir of the Museum of Comparative Zoology*, Harvard 54: 421-531.

Dang Huy Huynh; Pham Trong Anh 1988. Kouprey (*Bos sauveli*, Urbain 1937): Investigations on Vietnamese, Kampuchean and Laotian territories. Mimeo. Paper presented at the International Workshop on the Kouprey Conservation Programme, Hanoi, 1988.

Dumas, C. 1943. *La faune sauvage du Cambodge*. Cambodia, Editions Aymonier.

Edmond-Blanc, F. 1947. A contribution to the knowledge of the Cambodian Wild Ox or Kouproh. *Journal of Mammalogy* 28:245-248.

Ellerman, J.R.; Morrison-Scott, T.C.S. 1951. *Checklist of Palaearctic and Indian mammals*. London, British Museum (Natural History).

Hoffmann, R.S. 1986. A new locality record for the Kouprey in Vietnam, and an archaeological record from China. *Mammalia* 50: 391-395.

IUCN 1976. *Red Data Book*, Volume 1 - *Mammalia*. Morges, International Union for Conservation of Nature and Natural Resources.

———. 1983. Wild cattle, bison and buffaloes: their status and potential value. Unpublished IUCN report.

———. 1988. *1988 IUCN Red List of Threatened Animals*. Gland, International Union for Conservation of Nature and Natural Resources.

Kemf, E. 1988. Fighting for the forest ox. *New Scientist* 118: 51-53.

Lekagul, B. 1950. Notes on the Kouprey, or Indo-Chinese Forest Ox. *Journal de l'Association Veterinaire de Thailande* 2(2).

Lekagul, B. 1952. On the trail of the Kouprey or the Indochinese Forest Ox. *Journal of the Bombay Natural History Society* 50: 623-628.

Lekagul, B.; McNeely, J.A. 1977. *Mammals of Thailand*. Bangkok Association for the Conservation of Wildlife.

Le Vu Khoi 1988. Kouprey (*Bos sauveli*, Urbain 1937), the current state of knowledge. Mimeo. Paper presented at the International Workshop on the Kouprey Conservation Programme, Hanoi, 1988.

MacKinnon, J. 1986. Report of WWF Project 3696: Kouprey Status Survey. Mimeo. Report to World Wildlife Fund.

MacKinnon, J.; MacKinnon, K. 1986. *Review of the protected areas system in the Indomalayan realm*. Gland, International Union for Conservation of Nature and Natural Resources and United Nations Environment Programme.

MacKinnon, J.; MacKinnon, K.; Child, G.; Thorsell, J. 1986. *Managing protected areas in the tropics*. Gland, International Union for Conservation of Nature and Natural Resources.

McNeely, J.A. 1975. *Wildlife and national parks in the Lower Mekong Basin*. Bangkok, Committee for the Coordination of Investigations in the Lower Mekong River.

Neese, H.C. 1975. The Kouprey—Report on a survey in southern Laos. Mimeo. Report to New York Zoological Society.

———. 1976. Kouprey clues and rhino news. *Wildlife* 18(9): 40-41.

Pfeffer, P. 1968. *Asia, a natural history*. New York, Random House.

———. 1969. Considerations sur l'ecologie des forets claires du Cambodge oriental. *La Terre et la Vie* 1: 3-24.

Pfeffer, P.; Ou Kim-San 1967. Le Kouprey *Bos (Bibos) sauveli* Urbain, 1937; discussion systematique et statut actuel. Hypothese sur l'origine du Zebu *Bos indicus*). *Mammalia* 31: 521-536.

Sauvel, R. 1942. Le Kouprey ou boeuf gris cambodgien. *La Terre et la Vie* 3: 88-109.

———. 1949. Distribution geographique du Kouprey (*Bibos sauveli*) Urbain. *Mammalia* 13: 144-148.

Simpson, G.G. 1945. The principles of classification, and a classification of mammals. *Bulletin of the American Museum of Natural History* 85: 1-350.

Suvanakorn, P. 1988. Kouprey in Thailand. Mimeo. Paper presented that the International Workshop on the Kouprey Conservation Programme, Hanoi, 1988.

Thouless, C. 1987. Kampuchean wildlife—survival against the odds. *Oryx* 21: 223-228.

Tran Hong Viet; Do Tuoc; Pham Mong Giao 1988. Kouprey habitat in Vietnam. Mimeo. Paper presented at the International Workshop on the Kouprey Conservation Programme.

Urbain, A. 1937. Le kou-prey ou boeuf gris cambodgien. *Bulletin de la Societe Zoologique de la France* 62: 305-307.

Wharton, C.H. 1957. An ecological study of the Kouprey *Novibos sauveli* (Urbain). *Monograph of the Institute of Science and Technology*, Manilla, No. 5.

Wharton, C.H. 1966. Man, fire, and wild cattle in north Cambodia. *Proceedings of the Annual Tall Timbers Fire Ecology Conference* 6: 23-65.

Wharton, C.H. 1968. Man, fire and wild cattle in southeast Asia. *Proceedings of the Annual Tall Timbers Fire Ecology Conference* 8: 107-167.

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