Development of a Management Plan for Grey Goral: Lessons from Blackbuck and Cheer Pheasant Reintroduction Attempts

Maqsood Anwar
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DEVELOPMENT OF A MANAGEMENT PLAN FOR GREY GORAL:
LESSONS FROM BLACKBUCK AND CHEER PHEASANT
REINTRODUCTION ATTEMPTS
by
Maqsood Anwar

A dissertation submitted in partial fulfillment
of the requirement for the degree
of
DOCTOR OF PHILOSOPHY
in
Wildlife Science

UTAH STATE UNIVERSITY
Logan, Utah
1989
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Maqsood Anwar
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ABSTRACT

Development of a Management Plan for Grey Goral:
Lessons from Blackbuck and Cheer Pheasant Reintroduction Attempts

by

Maqsood Anwar, Doctor of Philosophy
Utah State University, 1989

Major Professor: Dr. Joseph A. Chapman
Department: Fisheries and Wildlife

A study of grey goral (Nemorhaedus goral) in the Margalla Hills National Park, Pakistan, was conducted to develop a management plan for this animal. Goral are listed as endangered in Pakistan and elsewhere. They are confined to the steep slopes and difficult terrain that cover 28 percent of the total park area. Another 21 percent of the park area has similar habitat, but currently no goral occur there. Forty to 60 animals are estimated to be living in the park. Groups of two to three animals are common. During observation, goral spent most of their time in feeding, moving, and surveillance. Juveniles spent less time in surveillance and more in resting and ruminating than the adults. Group size was inversely correlated with the time
spent in surveillance. Goral foraged early in the morning and late in the evening and were rarely seen during the day. They changed their foraging activities from browsing during the winter to almost entirely grazing during the summer. The rutting period extended from October to December and the lambing period from March to May. Goral populations in the park were estimated to be increasing at a rate of 7 percent annually. They always escaped to a nearby ridge when danger was perceived. Adults and juveniles had dominant and subordinate interactions.

In goral habitat, about 60 percent of the vegetation consists of plant species commonly eaten by the animals. These species include Themeda anathera, Chrysopogon aucheri, Carissa opaca, Acacia modesta, Mimosa rubicaulis, and Ipomoea hispida. Human and livestock populations differ significantly inside and outside goral habitat in the park. Lack of suitable habitat, predation, poaching, and human and livestock pressures affect the goral population and its range in the park.

Reintroduction plans for blackbuck (Antilope cervicapra) and cheer pheasant (Catreus vallichii) were analyzed to determine the commonalities: source of animals, poaching, predation, and insufficient staff and funds. A goral management plan based on my field studies and the analysis of the other reintroduction plans are discussed. A general wildlife management strategy for Pakistan is
discussed. The government should have a well-defined policy about wildlife and park management. Habitat remains the critical factor. Strong legislation, well-educated and well-equipped staff, and proper funding are required for this purpose. In addition, education and economic development of the public, especially those living in and around parks, are essential.
INTRODUCTION

Pakistan forms a bridge between the Middle East and the Orient, stretching from longitude 60 to 75 and from latitude 24, on the arid coastal cliffs of the Arabian Sea, to 37 in the north where the frontier reaches to the permanent snow fields of the Pamir Wakhan (Figure 1). Located in the transition zone between two of the world's six zoogeographical regions, the Palaearctic and the Oriental, Pakistan has a variety of habitat types with a rich and varied wildlife fauna.

In the mid-1800s, elephant (Elephas maximus), lion (Panthera leo), and tiger (Panthera tigris) were common in the area. Herds of gazelle (Gazella gazella and Gazella subgutturosa), blackbuck (Antelope cervicapra), urial (Ovis orientalis), ibex (Capra ibex), and markhor (Capra falconeri) were found in forest and desert habitats. Altogether, at least 20 species of large ungulates and more than 900 species of birds (twice the number found in Europe) have been reported for this period (Sheikh 1986). By all measures, Pakistan has had a rich and diverse fauna. However, since the late 1800s, most wildlife populations have declined dramatically. Large mammal species have been extirpated. Currently, 31 species of mammals (12 of 16
Figure 1. Map of Pakistan showing national parks and major cities.
large ungulates), 20 species of birds, and 5 species of reptiles are listed as endangered (Khattak 1986).

The reasons for this trend in population decline are primarily human related and include encroachment by human populations, degradation of habitat, uncontrolled hunting, and removal for export (Roberts 1977).

The evidence of the earliest existence of mankind in this region dates from B.C. 3000. For many centuries, people lived in this region in a state of relative ecological equilibrium, perhaps because of historically lower population levels. During the past four or five decades of the twentieth century, Pakistan has experienced profound and accelerating ecological changes due to greatly increased human pressure (Roberts 1977).

Technological advances have also contributed to a decline in wildlife populations. In particular, major irrigation systems have been built to tap the water of the Indus River and its tributaries. Two of the world's largest earthen water-storage reservoirs were constructed in the 1960s and have had far-reaching effects on the northern areas of the country. Due to the increase in irrigated cultivation and control of monsoon river flooding, many of the extensive tracts of tropical thorn scrub, riverine swamps, and forest areas have already disappeared.

Populations of the larger species of oriental faunal origin have declined as a result of altered habitat and
increased human pressure for several reasons. First, in the recent past increased human pressure and livestock grazing have resulted in a sharp decline in soil fertility and an increase in soil erosion, which have in turn affected a broad array of animal and plant species (Ali 1985). Thus, in the mountainous regions, competition between wild and domestic ungulates for available forage has increased. Second, people living in these areas are skilled sportsmen with a tradition of hunting that has accelerated the extirpation of many birds and mammals (Roberts 1977). Third, the human population is increasing at a rate of about 2.9 percent per year, one of the highest growth rates in the developing world (Anonymous 1987). Demand for fuelwood resources has already led to the total denudation of many hillsides formerly covered with scattered scrub forest.

In the late 1960s, the government of Pakistan realized the seriousness of the situation, and a Wildlife Enquiry Committee was established. Its responsibility was to prepare a comprehensive report on the status of wildlife in the country. Since then, the federal and provincial governments have taken important steps to conserve wildlife. These include the creation of special wildlife conservation areas, development of comprehensive legislation for the protection of wildlife, formation of a National Council for Conservation of Wildlife (NCCW) at the federal level, and establishment of management boards at the provincial level.
The federal Zoological Survey Department is also working to determine the status of Pakistan's wildlife. International agencies, such as the World Wildlife Fund (WWF) and the World Pheasant Association (WPA), are helping in the conservation effort.

Although plans have been developed and some projects are underway, much more effort is needed. Special areas established for wildlife protection still need development and management plans. Basic scientific information about most of the existing wildlife species is lacking. Grey goral (*Nemorhaedus goral*) is one of the species needing immediate attention.

Goral are goat-like antelopes belonging to the family bovidae, subfamily caprinae, and tribe rupicaprinae. Adult body weight ranges from 22 to 42 kg, height at shoulders 50 to 78 cm, and body length 82 to 130 cm (Lekagul and McNeely 1977, Roberts 1977, Nowak and Paradiso 1983, Mcdonald 1984). Goral are found across the Himalayas to Assam; south to Burma; and north to Siberia, Korea, Thailand, and China. In Pakistan, they inhabit outer Himalayan foothills of scattered chir pine (*Pinus roxburghii*) and thorn scrub forest. Populations of this small ungulate continue to decrease in most of its habitat. The goral is currently listed as endangered by the United States Department of the Interior (Anonymous 1989).
Goal and objectives

The goal of this study is to develop a management strategy for grey goral in the Margalla Hills National Park (MHNP) adjacent to Islamabad, Pakistan. Previous recovery attempts for blackbuck and cheer pheasant (*Catreus vallichii*) will provide background information for the goral recovery plan. Both were extirpated from Pakistan and are currently being reintroduced into their native habitat. The specific objectives of this study are to:

1) delineate aspects of grey goral life history and ecology in the Margalla Hills National Park;

2) analyze the existing reintroduction plans for blackbuck and cheer pheasant for commonalities that can be used to develop a recovery plan for grey goral;

3) use the analysis outlined in objective 2 and data about the ecology and behavior of goral from objective 1 to define the basic parameters for a grey goral recovery plan; and

4) develop a goral recovery plan including biological, social, or political factors that can be used to guide future recovery attempts for other wildlife species.
Study area

The goral life-history study was conducted in the MHNP near the federal capital, Islamabad, in the north-central region of Pakistan (Figure 2). The area was selected because human disturbance is less than in other areas of goral and because goral habitat are better protected from poaching because of the national park status of the site. The area is easily accessible for protection activities.

The park is located north of Islamabad and is a part of the Murree Hills, an extension of the Himalayan foothills. It covers an area of about 14,786 ha. The topography is rugged, and the elevation ranges from 450 to 1580 m. The general aspect is southerly, and the terrain is interspersed with both large and small valleys. Climatically, the area has five distinct seasons: winter (December-February), spring (March-April), summer (May-June), monsoon (July-September), and autumn (November). The average minimum and maximum temperatures are 19.5 and 33.3 °C, respectively (Hussain 1986). The average annual rainfall is about 94 cm.

The flora of the park is dry tropical deciduous forest on lower slopes and the sub-tropical pine forest at higher elevations. The vegetation has been classed into five major plant communities on the basis of physiognomy, floristic composition, and dominance of vegetation (Amin et al. 1982).
Figure 2. Map of the study area in the Margalla Hills National Park, Islamabad, Pakistan.
These communities are as follows. *Olea ferruginea*–*Acacia modesta* occurs on the southern ranges of the Margalla Hills at lower elevations. The vegetation is dense in the valleys but more open on the slopes. *Acacia modesta*–*Carissa opaca* covers almost half of the area of the park. It provides a thick vegetation cover in the inner valleys and on northern slopes and is an ideal habitat for many secretive wildlife species. *Olea ferruginea*–*Carissa opaca* occurs towards the southern and eastern reaches of the park. The vegetation is dense in deep valleys and open on the slopes. *Myrsine africana*–*Dodonaea viscosa* is found up to 900 m elevations, where the climate is relatively cooler. The vegetation is open on the slopes and dense in the valleys and ravines. Finally, *Pinus roxburghii*–*Quercus incana* occurs at elevations above 975 m, where patches of pine and understory cover is dominated by grasses. Goral seem to be restricted to this habitat type.

Prior to 1960, the Margalla Hills area was under the control of the Forest Department and was managed mostly for firewood extraction as well as hay and livestock grazing. Hunting and poaching were common in the area, and excessive use by humans and livestock adversely affected the flora and fauna (Hussain 1986).

In 1960, with the development of Islamabad, management was shifted to the Capital Development Authority (CDA) of Islamabad. In 1979, Margalla Hills was declared a national
park to ensure the conservation of its wildlife species. The CDA banned wood cutting, hunting, livestock grazing, and all other activities that impact the flora and fauna of the park. Despite the fact that the park has existed for 10 years, people nevertheless still live within its boundaries in small villages. They cut firewood and hay, and their livestock graze in the park area. These activities are a source of continuous disturbance for the wildlife of the park.

In 1979, the CDA began to develop various visitor facilities including an access road, scenic viewpoints, hiking trails, and a small zoo. The MHNP is adjacent to Islamabad and attracts many visitors throughout the year.
METHODS

**Observations on goral**

To meet objective 1, goral were observed in the MHNP. Because there have been no studies on goral in this park, I first needed to locate not only occupied but also potential habitat within the park. Only one road connects the different areas of the park, and most goral habitat is distant from this road. A hike of three to four km is often necessary to reach goral sites. A site often consists of more than one ridge and several locations.

The CDA has built three rest houses inside the park. One of these is within one hour walking distance from some of the goral sites. I was allowed to stay in this rest house for observations at nearby sites. At other sites I camped or stayed in houses near the sites. However, most observations were made on the goral sites near the rest house.

Potential goral sites were visited during the day to look for any signs of the animal. Fecal dropping was the main sign used to determine the presence of goral. Feces of goral can be differentiated from those of other small ungulates in the park such as barking deer and domestic goat
and sheep. Goral feces are smaller, darker, and oval compared to the feces of other species, which are bigger, lighter, and round. If animal sign was found at a site, that site was observed for three to five days before moving to the next site.

Observations were made early in the morning and late in the afternoon until dark. Once located, goral were observed from a nearby ridge (100 to 500 m away) with a high-powered spotting scope and binoculars so that they would not be disturbed. A camera with a 400-mm zoom lens was used to photograph the animals. Observations were started whenever an animal was spotted and continued until it disappeared. In cases where more than one animal was spotted at a time, they were observed simultaneously. The time of first sighting, date, elevation, aspect, number of animals in a group, and sex and age class (if possible) were noted.

Distribution

Distribution was determined by thoroughly sampling all potential goral sites in the MHNP. The presence of goral at any site was marked on a map. The park has been mapped into several compartments of almost equal size. The area of goral habitat was calculated by adding the areas of all compartments where goral were actually seen or where their signs were found. Potential goral habitat was calculated by
adding the areas of all compartments having similar habitat but with no current observations or signs.

Population

Goral population levels were estimated from the number of goral locations at various sites in the park and the number of animals at each location. Some other aspects of goral demography, including age, sex, group composition, and daily activities, were also observed.

Goral age was determined from the presence or absence of horns and the size of the animals. Full-size horns in goral are attained at the age of two to three years, when the animals reach sexual maturity (Lekagul and McNeely 1977, Roberts 1977). All animals were classed as adults or juveniles. The sex of goral is difficult to determine by observation of their secondary sex characters. Both sexes have the same body color and size. The horns of females are more slender than those of males but are difficult to differentiate from a long distance. The sexes of some adult goral were assumed on the basis of their behavior and interactions with other animals. Group composition was noted during each observation.

During observations, activities were classed as moving, surveillance, feeding, resting, rumination, and social interaction. The distribution of time allocated to different activities was calculated by adding the number of
times the animals were involved in various activities. The effect of group size on the nature of activity (such as surveillance) was determined by noting the number of animals involved in that activity. The relationship between age and type of activity was determined from the number of animals of various age groups involved in different kinds of activities.

Feeding

The feeding habits of goral were observed during the study. The time and nature of feeding (i.e., grazing or browsing) as well as the plant species commonly eaten by goral were noted. The seasonal shifts in feeding were determined from the plant species frequently eaten by goral during different seasons of the year. The availability of various plant species was determined by conducting a vegetation survey at the goral occurrence sites. Goral were also observed for rumination.

Behavior

Behavior was documented by observing goral groups and noting interactions between animals. For this purpose, the distance to the nearest neighbor, its age and sex, and the nature of the interaction were noted. Two basic behaviors were observed. Social behavior included submissive posture, adult-juvenile interactions, and mother-young bond. Non-
social behavior included autogrooming, feeding, escape, and resting posture.

Vegetation survey

In order to determine the food and cover available to the goral, a vegetation survey of its habitat was conducted. A line intercept method developed by Canfield (1941) was used for this purpose. Fifty transects of 30.48 m (100 ft) each were laid in goral habitat at varying elevations, slopes, and aspects. Samples were randomly distributed at different sites. Each plant species was measured for its cover along the tape, and the number of plants were noted.

Disturbance by people and livestock

In order to determine the extent of human disturbance to goral, a survey of the human and livestock population was conducted in the park. Each village in and around the park was surveyed for the number of families living there, number of persons in each family, and the number and kind of livestock owned by them. The park was divided into three types of areas: areas where goral were observed, areas where goral signs were found, and areas where no goral or their signs were observed. The human and livestock populations in these areas were compared. The effects of people and livestock on the distribution of goral in the park were calculated by paired t-tests.
Existing management plans

To meet objective 2, information was collected on the biological, political, and social factors that influenced the reintroduction of blackbuck and cheer pheasant. This information was useful for the development of a goral management plan. Biological factors included information on the biology/ecology of the animal and the status of its habitat. Social factors included people's awareness of the present status of animals; importance of their conservation; and consequences of hunting, poaching, and habitat disturbance. Political factors included the availability of funds and well-educated, well-equipped staff to implement the plan and protection of the animal.

Current information about the reintroduction plan for cheer pheasant was obtained from the CDA officials. In addition, research reports on the project were reviewed (Ridley and Islam 1982, Hussain 1986). Data collected included initiation of the project, source of eggs, number of eggs hatched, chicks released, and post-release survival. Lal Suhanra National Park (LSNP), the reintroduction site of blackbuck, was visited to collect information on the reintroduction plan and to evaluate the status of blackbuck. Data collected included initiation of the reintroduction project, number of animals initially reintroduced, breeding
success, and difficulties faced (Shah 1986, Sheikh 1982, Ahmad unpublished manuscript). Information about the present status of blackbuck was collected from the park officials.

Data interpretation

To meet objective 3, data on the biological, political, and social factors from objective 2 were analyzed to determine the factors affecting the success or failure of these plans. The common factors affecting these plans were considered in defining the basic parameters of a goral recovery plan. The basic parameters were based on the data collected in the field about grey goral life history and ecology.

To meet objective 4, the biological, social, and political elements common to any management plan and their influence on the success of a particular management strategy were determined on the basis of the interpretation of data collected in objectives one through three. These factors were generalized so that they could be used in managing any rare or endangered wildlife species in any region of Pakistan.

Statistical analysis

Paired t-tests were applied to determine the effects of human population and livestock on the distribution of
goral in the park. The effect of group size on goral activity was tested by chi-square analyses. Differences were compared at the 90 percent significance level. All tests were considered non-significant if the P-value was greater than $P > 0.1$. 
RESULTS AND DISCUSSION

Grey goral

Goral were observed from October, 1987 through June, 1988 for 38 h and 16 min over a period of 103 days. The study area was visited 135 times, with 77 visits made in the mornings and 58 in the evenings. Goral were observed on 36 visits. Of these, 32 observations were made in the morning and four in the evening.

Distribution and population

In the MHNP, goral were primarily confined to the central part of the park (Fig. 3) where they were found between 800 and 1200 m elevation. They have been reported between 820 and 4000 m elevation in other parts of the Himalayas (Schaller 1977, Lekagul and McNeely 1977). In the MHNP, their habitat is characterized by sharp ridges running from north to south with very steep slopes and deep ravines. A similar habitat type has also been reported by Schaller (1977), Nowak and Paradiso (1983), Mcdonald (1984), and Mead (1989). Very few people or domestic animals were seen in this area in relation to other areas of the park. Goral were usually observed either standing on the ridges or
Figure 3. Distribution map for grey goral in the Margalla Hills National Park, Islamabad, Pakistan.
foraging on nearby vegetation. They were never observed far from the ridges. Their droppings were also found on or near the ridges, under dense cover.

Currently goral habitat is about 4,150 ha (28 percent of the total park area). Potential goral habitat comprised about 3,000 ha (21 percent of total park area) and is currently unoccupied by goral. Thus, 49 percent of the park could potentially support goral (Fig.3).

A non-variance-supported population estimate was calculated from the number of locations and the number of goral at each location within seven observation sites. At 10 locations, 26 different animals were counted. Goral rarely move from one site to another. One goral that I could recognize remained at the same site throughout the study. Therefore, there was a slight chance of counting an animal twice. At least three animals were counted at half of the locations and individuals and pairs were observed at the other locations.

Fresh goral droppings were found at 11 other locations but no goral were observed. Adult males were usually solitary but formed pairs during the rutting season (Roberts 1977, Schaller 1977). Mother-young pairs were common during other seasons. Thus, I assumed a minimum of two goral at each of these 11 locations for a total of 22 animals. The total goral population in the MHNP as estimated from scats and observations, was between 40 and 60 animals (Table 1).
Table 1. Goral population estimates in the Margalla Hills National Park during 1987-88.

<table>
<thead>
<tr>
<th>Area</th>
<th>Number of locations</th>
<th>Number of Animals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goral observed</td>
<td>10</td>
<td>26</td>
</tr>
<tr>
<td>Signs observed</td>
<td>11</td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
<td>48</td>
</tr>
</tbody>
</table>

Age and sex

Although goral could be classified into adults and juveniles, it was difficult to differentiate between yearlings and sub-adults. However, young fawns were identified by their smaller size. I observed goral 76 times (72 percent were adults and 28 percent were juveniles). Juveniles were with adult animals on 17 occasions and were alone three times.

The sex of adult goral was determined by their behavior and interactions with other individuals. I was able to recognize an adult female goral at one location because one of her horns was tilted backward. She had a small fawn at her side during the third week of March. Previously, she had always been accompanied by a juvenile but was never observed interacting. However, adults and juveniles in dominant-subordinate interactions were observed on other
occasions. On this basis, I assumed that in the pairs consisting of an adult and a juvenile, the adult that did not interact was a female and the one that interacted with a juvenile was a male.

I also assumed that in a pair of adults, one was a male and the other a female. If all adults in adult-juvenile pairs were females, the sex ratio is 40 males to 60 females. The actual sex ratio is probably near 50:50.

Productivity

In 1971, 15 to 20 goral were estimated to live in this park. In 1988, the population had increased to 40-60 animals, giving an annual increase of seven percent. If one young per breeding pair per year is usual (Schaller 1977, Roberts 1977, Mead 1989), the increase seems very low. Predation might be a major factor in limiting goral populations. Although no predation was observed, feral dogs were seen chasing goral. Feral dogs, jackal (Canis aureus), and jungle cat (Felis chaus) could prey on goral fawns.

Group composition

Goral less than 20 m apart were considered to belong to one group. Goral were observed 18 times as individuals, 18 times as pairs, six times in a group of three, and only once in a group of four (Table 2). They have also been reported in groups of four to 12 (Lekagul and McNeely 1977) and four to eight (Stebbins 1912 as cited in Schaller 1977). In the
MHNP, the occurrence of goral in small groups was probably
due to their small population size.

Table 2. Group size of goral in the Margalla Hills
National Park during 1987-88.

<table>
<thead>
<tr>
<th>Group size</th>
<th>Number of groups observed</th>
<th>Total animals observed</th>
<th>Percent of observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>18</td>
<td>18</td>
<td>41.9</td>
</tr>
<tr>
<td>2</td>
<td>18</td>
<td>36</td>
<td>41.9</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>18</td>
<td>13.9</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>4</td>
<td>2.3</td>
</tr>
</tbody>
</table>

Among individual animals observed, 88.9 percent were
adults and 11.1 percent were juveniles. Among pairs, the
majority (61.1%) consisted of an adult and a juvenile while
others (38.9%) consisted of two adult animals. Pairs
consisted of either an adult female with a young goral or an
adult male and adult female. Groups of three animals
usually consisted of two adults and one juvenile. Four
animals--two adults, a yearling and a fawn of about four
weeks--were observed together only on one occasion. The
juvenile was still with its mother but remained at a
distance from the other three animals.
Daily activities

Goral were active as early as 5:00 a.m., well before sunrise, and as late as 6:25 p.m., well after sunset. They fed early in the morning and could be observed for two to three hours after sunrise. They rested most of the day and again fed in late evening. Most evening feeding was done after sunset when there was no disturbance. Similar observations have also been made by Lekagul and McNeely (1977), Nowak and Paradiso (1983), and Mcdonald (1984).

The onset of goral activity in the morning is shown in Figure 4. The dots show the times when activity began. Because the animals could only be seen when active, the first observation was considered to be the start of their activity. The curve indicates that goral became active a little later during the colder months than during the hotter months, suggesting that the onset of goral activity in the morning may be related to temperature and sunrise. Goral were usually observed on the east-facing slopes in the morning and especially during the winter.

Activity/time distribution

Goral activities included moving, surveillance, feeding, resting, ruminating and social interactions. Each animal did more than one activity during a single observation. The frequency of these activities is shown in Table 3.
Figure 4. Onset of goral daily activity in relation to mean monthly temperatures.
Table 3. Distribution of goral activity based on observations in the Margalla Hills National Park during 1987-88.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Number of observations</th>
<th>Percent of observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moving</td>
<td>71</td>
<td>32.0</td>
</tr>
<tr>
<td>Surveillance</td>
<td>65</td>
<td>29.3</td>
</tr>
<tr>
<td>Feeding</td>
<td>57</td>
<td>25.7</td>
</tr>
<tr>
<td>Resting</td>
<td>12</td>
<td>5.4</td>
</tr>
<tr>
<td>Ruminating</td>
<td>11</td>
<td>4.9</td>
</tr>
<tr>
<td>Interacting</td>
<td>6</td>
<td>2.7</td>
</tr>
</tbody>
</table>

Goral spent most of their time moving (32.0 percent). The other major activities were surveillance and feeding in which they spent 29.3 and 25.7 percent of their time, respectively. Other activities infrequently observed during the morning and late evening were resting (5.4 percent), ruminating (4.9 percent), and interacting (2.7 percent). Diurnal and crepuscular observations were taken between 5:00 a.m. and 6:30 p.m.

**Activity/effect of age**

Differences in activity patterns of adults and juveniles is presented in Table 4. The underlined values...
are significantly different. Adults and juveniles differed significantly in their overall activities (Chi Sq. 17.244). Adult animals spent significantly more time in surveillance (74.5 percent) in relation to juveniles (19.1 percent). Juveniles apparently spent more time in feeding, resting, and ruminating than adults but the difference was not significant. Both age groups spent about the same amount of time in moving and in social interaction.

Table 4. Effect of age on goral activity in the Margalla Hills National Park during 1987-88.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Juveniles</th>
<th>Adults</th>
<th>Chi Sq. Values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
</tr>
<tr>
<td>Moving</td>
<td>20</td>
<td>95.2</td>
<td>52</td>
</tr>
<tr>
<td>Surveillance</td>
<td>4</td>
<td>19.1</td>
<td>41</td>
</tr>
<tr>
<td>Feeding</td>
<td>16</td>
<td>76.2</td>
<td>33</td>
</tr>
<tr>
<td>Resting</td>
<td>7</td>
<td>33.3</td>
<td>5</td>
</tr>
<tr>
<td>Ruminating</td>
<td>5</td>
<td>23.8</td>
<td>5</td>
</tr>
<tr>
<td>Interacting</td>
<td>3</td>
<td>14.2</td>
<td>4</td>
</tr>
</tbody>
</table>
Activity/effect of group size on surveillance

Group size was not significantly correlated with surveillance ($t=-2.32$), probably because of small size, (Table 5, Figure 5).

Table 5. Effect of group size on the surveillance activity of goral in the Margalla Hills National Park during 1987-88.

<table>
<thead>
<tr>
<th>Group size</th>
<th>Number goral observed</th>
<th>Number goral surveilling</th>
<th>Percent goral surveilling</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>18</td>
<td>12</td>
<td>66.7</td>
</tr>
<tr>
<td>2</td>
<td>36</td>
<td>13</td>
<td>36.1</td>
</tr>
<tr>
<td>3</td>
<td>18</td>
<td>8</td>
<td>44.4</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>1</td>
<td>25.0</td>
</tr>
</tbody>
</table>

Single goral spent 66.7 percent of their time in surveillance versus 36.1 percent in pairs, 44.4 percent in groups of three, and 25 percent in groups of four. Thus animals in larger groups fed more efficiently than those in smaller groups. This is an important aspect of goral behavior that can be used in their management. For example, the transplantation of goral would probably be more
Figure 5. Effect of group size on the daily surveillance activity of goral.
effective in smaller groups than with single animals. The advantages of grouping have been reported for other species (Kenward 1974, Powell 1974, Caraco et al. 1980, Sullivan 1984).

Feeding habits

The feeding behavior of goral was based on observations made throughout the year. Feeding usually occurred at sunrise and just before sunset (75.0 percent). Among the animals observed foraging, 21.1 percent grazed, 33.3 percent browsed, and 45.6 percent both browsed and grazed. Goral were commonly observed feeding on such plant species as Themeda anathera, Chrysopogon aucheri, Carissa opaca, Acacia modesta, Mimosa rubicaulis, and Ipomoea hispida. The percent cover and composition of plant species preferred by goral are given in Table 6. In the USSR, Schaulskaya (1980) found that 286 plant species were consumed by goral; however, their preference varies with the season (Valova 1979).

Seasonal changes in feeding patterns were calculated (Figure 6, Table 7). During the autumn, 77.9 percent of the animals browsed, 15.4 percent grazed, and 7.7 percent both browsed and grazed. In the winter, browsing was reduced to 46.7 percent and browsing/grazing rose to 40 percent. The level of grazing was about the same during the winter and autumn. During the spring, when green grass and leaves were
Figure 6. Seasonal changes in the diet of goral in the Margalla Hills National Park.
available, browsing/grazing increased to 73 percent, grazing increased to 19.3 percent, and browsing fell to 7.7 percent. A similar feeding pattern has been reported in the USSR and India where goral prefer forbs and grasses but shift to browsing during the winter and early spring (Bromlei 1956, Dang 1968).

Table 6. Percent cover and composition of plant species preferred as forage by goral in the Margalla Hills National Park during 1987-88.

<table>
<thead>
<tr>
<th>Name</th>
<th>Percent Cover</th>
<th>Percent Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Themeda anathera</em></td>
<td>21.3</td>
<td>35.9</td>
</tr>
<tr>
<td><em>Chrysopogon aucheri</em></td>
<td>10.3</td>
<td>18.5</td>
</tr>
<tr>
<td><em>Digitaria decumbens</em></td>
<td>6.0</td>
<td>10.9</td>
</tr>
<tr>
<td><em>Carissa opaca</em></td>
<td>8.0</td>
<td>3.9</td>
</tr>
<tr>
<td><em>Acacia modesta</em></td>
<td>5.8</td>
<td>1.2</td>
</tr>
<tr>
<td><em>Gymnosporea royleana</em></td>
<td>3.5</td>
<td>1.4</td>
</tr>
<tr>
<td><em>Mimosa rubicaulis</em></td>
<td>1.7</td>
<td>0.9</td>
</tr>
<tr>
<td><em>Acacia senegal</em></td>
<td>1.3</td>
<td>0.9</td>
</tr>
<tr>
<td><em>Ipomoea hispida</em></td>
<td>0.6</td>
<td>0.2</td>
</tr>
</tbody>
</table>
Table 7. Seasonal shifts in the diet of goral in the Margalla Hills National Park During 1987-88.

<table>
<thead>
<tr>
<th>Season</th>
<th>Forage type</th>
<th>Number of goral observed</th>
<th>Percent observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autumn</td>
<td>Browse</td>
<td>10</td>
<td>76.9</td>
</tr>
<tr>
<td></td>
<td>Graze</td>
<td>2</td>
<td>15.4</td>
</tr>
<tr>
<td></td>
<td>B/G</td>
<td>1</td>
<td>7.7</td>
</tr>
<tr>
<td>Winter</td>
<td>Browse</td>
<td>7</td>
<td>46.7</td>
</tr>
<tr>
<td></td>
<td>Graze</td>
<td>2</td>
<td>13.3</td>
</tr>
<tr>
<td></td>
<td>B/G</td>
<td>6</td>
<td>40.0</td>
</tr>
<tr>
<td>Spring</td>
<td>Browse</td>
<td>2</td>
<td>7.7</td>
</tr>
<tr>
<td></td>
<td>Graze</td>
<td>5</td>
<td>19.3</td>
</tr>
<tr>
<td></td>
<td>B/G</td>
<td>19</td>
<td>73.0</td>
</tr>
</tbody>
</table>

B/G: Browsing/Grazing

Rumination

A juvenile goral was observed ruminating for about 20 min. It was mid-morning and the animal was lying alone on the top of a ridge in a natural depression which was two to three meters long and a half meter deep. The goral was surveilling at the same time and it looked four times to its right side and three times to left side during rumination.
The average swallowing time was 31 sec, ranging from 15 to 40 sec. After foraging in the morning, goral rest and ruminate until they begin feeding the evening.

Breeding

Although the rutting behavior of goral was not observed, the timing of the rutting season was calculated. The rutting season has been reported to be from October to December with a peak in November (Lekagul and McNeely 1977, Myslenkov and Valoshina 1978, Nowak and Paradiso 1983). The gestation period is six (Lekagul and McNeely 1977, Nowak and Paradiso 1983) to eight months (Prater 1965, Mcdonald 1984). A young goral about one to two weeks old was seen on 23 March 1988. Its age was estimated from its size. Thus, the lambing period in the MHNP appears to begin in early March, coinciding with temperatures and mild new grass and leaves. Based on the lambing season and gestation period, the rutting season of goral in the MHNP must be October to November.

Behavior

Non-social behavior

**Autogrooming.**—Many bovids exhibit various autogrooming behaviors such as licking, nibbling, biting, and scratching (Leuthold 1977). Most smaller animals (e.g. gazelles) of slender build show more developed self-grooming, and their
grooming behavior seldom includes external objects (Leuthold
1977). Goral were observed scratching their legs and rump
with their lower incisors. The head and neck were scratched
with the hind feet. Allogrooming was not observed in goral.

Feeding.--Goral are mixed-feeders (Hofmann 1988).
Because they are small ruminants, they need more energy per
unit body weight than larger ruminants (Jarman 1974). Their
feeding habits correspond to the small African ruminants
which select succulent, concentrated herbage (Hofmann and
Stewart 1972). During observations, they mostly took small
and new leaves of shrubs and grasses as well as the flowers
and fruits of some trees.

Goral reached the higher plant parts by standing on
their hind legs and placing their fore legs on boulders.
This behavior has also been described for a number of other
species such as gerenuk Lithocranius walleri (Leuthold
1971), springbok Antidorcas marsupialis (Bigalke 1970), and
even elephants (Sikes 1971). During feeding goral did not
cover long distances. They carefully moved from boulder to
boulder, remaining under the vegetation.

Escape.--Although no predators were observed, goral
responded to the presence of men. They always tried to
approach ridges and steep slopes whenever they sensed
danger. When at the base of a ridge, they climbed with
great speed, and when at the top, they simply moved over to
the other side. Similar escape behavior has also been
described by Schaller (1977) for bharal *Pseudois nayar*, markhor, and Nilgiri tahr *Hemitragus hylocrius*.

**Resting posture.**--Goral were usually observed in the morning standing or feeding on the top of a ridge. A few individuals were also observed lying on the ridges and ruminating during the day. They usually layed down with their right front leg stretched forward.

**Alert posture.**--Goral stopped feeding, ruminating, and other activities when danger was perceived. They turned and stretched their head and neck in the direction of the potential danger. This is true for almost all ungulates (Leuthold 1977). Goral cocked their ears and stood motionless until the situation changed. They kept standing in the same position even after they saw the source of danger and did not move until approached.

**Social behavior**

**Submissive posture.**--The submissive behavior of a juvenile goral was observed. It lowered and stretched its head and neck along the ground when an adult goral approached. The anterior part of the body was lowered to some extent. This position was maintained until the adult moved away. This behavior is common to most ungulate species (Leuthold 1977).

**Adult–juvenile interactions.**--An adult goral chased a juvenile goral for about 100 m. The juvenile stopped and
lowered its head, neck, and front part of its body. The adult stretched higher and stood by positioning its head over the head of the juvenile. The adult also tapped its front right foot on the ground a few times. It then moved away and again followed the juvenile in the same manner.

**Mother-young bond.**—Young goral have a close association with their mothers. About 61 percent of the pairs consisted of an adult and a juvenile. The adults in these pairs were assumed to be females. Because the hiding phase of the Caprinae young lasts only four days (Schaller 1977), very young fawns were seen with their mothers. Juveniles accompanied their mothers until the next offspring were born, and remained in the vicinity of their mothers even after the newborn was present. Adult males also remained close to mothers and kids at this time.

**Vegetation survey**

A vegetation survey of goral habitat was carried out to determine available food and cover. Fifty samples 30.48 m (100 ft) each were taken in an area of 3000 ha. The samples were taken between 840 and 1060 m elevation at different aspects. The percent cover and composition of plant species were calculated (Table 8). The principal species were treated individually while the less abundant species were
Table 8. Cover and composition of major plant species in goral habitat in the Margalla Hills National Park during 1987-88.

<table>
<thead>
<tr>
<th>Name of species</th>
<th>Mean cover(SE) (meters)</th>
<th>percent cover</th>
<th>percent composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Themeda anathera (G)</td>
<td>6.28 (.73)</td>
<td>21.30</td>
<td>35.36</td>
</tr>
<tr>
<td>Chrysopogon aucheri (G)</td>
<td>3.04 (.30)</td>
<td>10.32</td>
<td>18.49</td>
</tr>
<tr>
<td>Carissa opaca (S)</td>
<td>2.37 (.25)</td>
<td>8.04</td>
<td>3.87</td>
</tr>
<tr>
<td>Digitaria decumbens (G)</td>
<td>1.77 (.34)</td>
<td>6.01</td>
<td>10.91</td>
</tr>
<tr>
<td>Acacia modesta (T)</td>
<td>1.69 (.81)</td>
<td>5.75</td>
<td>1.18</td>
</tr>
<tr>
<td>Heteropogon contortus (G)</td>
<td>1.61 (.25)</td>
<td>5.46</td>
<td>8.88</td>
</tr>
<tr>
<td>Bauhinia variegata (T)</td>
<td>1.41 (.21)</td>
<td>4.79</td>
<td>1.33</td>
</tr>
<tr>
<td>Eulaliopsis binata (G)</td>
<td>1.33 (.21)</td>
<td>3.85</td>
<td>7.03</td>
</tr>
<tr>
<td>Pinus roxburghii (T)</td>
<td>1.23 (.28)</td>
<td>4.16</td>
<td>0.39</td>
</tr>
<tr>
<td>Dodonaea viscosa (S)</td>
<td>1.23 (.24)</td>
<td>4.17</td>
<td>2.22</td>
</tr>
<tr>
<td>Gymnosporela royleana (S)</td>
<td>1.03 (.19)</td>
<td>3.49</td>
<td>1.39</td>
</tr>
<tr>
<td>Mallotus philippensis (T)</td>
<td>0.92 (.20)</td>
<td>3.13</td>
<td>0.52</td>
</tr>
<tr>
<td>Ehretia aspara (S)</td>
<td>0.62 (.16)</td>
<td>2.08</td>
<td>0.62</td>
</tr>
<tr>
<td>Buxus sempervirens (S)</td>
<td>0.58 (.11)</td>
<td>1.96</td>
<td>0.36</td>
</tr>
<tr>
<td>Mimosa rubicaulis (S)</td>
<td>0.49 (.10)</td>
<td>1.69</td>
<td>0.86</td>
</tr>
<tr>
<td>Flacourtia romanto (S)</td>
<td>0.41 (.13)</td>
<td>1.39</td>
<td>0.31</td>
</tr>
<tr>
<td>Grewia oppositifolia (S)</td>
<td>0.41 (.17)</td>
<td>1.41</td>
<td>0.32</td>
</tr>
<tr>
<td>Acacia senegal (T)</td>
<td>0.38 (.08)</td>
<td>1.29</td>
<td>0.91</td>
</tr>
<tr>
<td>Woodfordia floribunda (S)</td>
<td>0.33 (.09)</td>
<td>1.13</td>
<td>0.34</td>
</tr>
<tr>
<td>Myrsine africana (S)</td>
<td>0.31 (.18)</td>
<td>1.04</td>
<td>0.70</td>
</tr>
<tr>
<td>Grewia populifolia (S)</td>
<td>0.24 (.07)</td>
<td>0.80</td>
<td>0.27</td>
</tr>
<tr>
<td>Rhus cotinus (S)</td>
<td>0.19 (.07)</td>
<td>0.65</td>
<td>0.24</td>
</tr>
<tr>
<td>Adhatoda vasica (S)</td>
<td>0.18 (.07)</td>
<td>0.58</td>
<td>0.28</td>
</tr>
<tr>
<td>Ipomoea hispida (S)</td>
<td>0.18 (.09)</td>
<td>0.62</td>
<td>0.15</td>
</tr>
<tr>
<td>Minor trees</td>
<td>0.48 (.12)</td>
<td>1.64</td>
<td>0.57</td>
</tr>
<tr>
<td>Minor shrubs</td>
<td>0.89 (.09)</td>
<td>3.09</td>
<td>1.65</td>
</tr>
<tr>
<td>Minor grasses</td>
<td>0.06 (.002)</td>
<td>0.20</td>
<td>0.32</td>
</tr>
</tbody>
</table>

G-grass, S-shrub, T-tree.

grouped. Total cover, comprised 47.1 percent was grasses, 33.4 percent shrubs, and 19.5 percent trees. The frequency occurrence of grasses, shrubs, and trees was 81.5, 14.5, and 4.0 percent, respectively. Standard errors for all species were calculated.
Clumps of chir pine were found on higher elevations with grasses and small shrubs as understory cover. The ravines had a dense cover of shrubs with trees between small ridges. Patches of grasses with scattered shrubs and trees were present on gentle slopes. These areas were frequently used by goral for feeding. The cover and composition of some plant species varied on northern and southern slopes but the total ground cover was almost the same on both aspects.

Based on my observations of goral and on vegetation sampling, the ridge aspect did not seem to affect the distribution of goral in the park. Grasses such as Themeda anathera, Chrysopogon aucheri, and Digitaria decumbens were the most abundant and were equally available on the northern and southern slopes for goral forage. This was also true for Carissa opaca and Dodonaea viscosa, which were major shrubs in the area and provided cover for the goral.

Disturbance by people and livestock

A survey of human and livestock populations was conducted in 33 villages. Twenty-two villages were located inside park boundaries; the remainder were outside but nearby and dependent on the park resources. The total human population in these villages was 17,128 individuals. They owned 7,169 livestock including buffalo, cows, goats,
sheep, camels, and donkeys. The number of livestock species in and outside goral habitat are compared in Table 9.

Table 9. Number and species composition of livestock inside and outside goral habitat in the Margalla Hills National Park during 1987-88.

<table>
<thead>
<tr>
<th>Livestock</th>
<th>Goral habitat</th>
<th>Other areas</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
</tr>
<tr>
<td>Buffalo</td>
<td>553</td>
<td>34.3</td>
<td>1217</td>
</tr>
<tr>
<td>Cattle</td>
<td>356</td>
<td>22.1</td>
<td>1874</td>
</tr>
<tr>
<td>Goats</td>
<td>638</td>
<td>39.6</td>
<td>2343</td>
</tr>
<tr>
<td>Others</td>
<td>64</td>
<td>4.0</td>
<td>124</td>
</tr>
<tr>
<td>Total</td>
<td>1611</td>
<td>22.5</td>
<td>5558</td>
</tr>
</tbody>
</table>

Others: Sheep, Camels, and Donkeys.

Goats (41.6 percent) dominated the livestock population. Cows comprised 31.1 percent and buffalo 24.7 percent of the total livestock population. Cows and buffalo are essentially grazers and goats are essentially browsers. Both browsers and grazers may compete with the goral for forage. Although more goats were present,
competition may be more severe with cattle because of their large size with greater forage demand.

The villages were divided into four categories. These included AI--acquired by the CDA and inside the park, AO--acquired by the CDA and outside the park, UI--unacquired and inside the park, and UO--unacquired and outside the park. The human population and the number of livestock in these four categories of villages are shown in Figure 7.

The effect of people and livestock on the distribution of goral in the park was tested by paired \( t \)-test (Table 10). All underlined values were significant at \( P<0.1 \). The park was divided into three types of areas: (1) where goral were observed; (2) where goral signs were found; and (3) where no goral or their signs were observed.

The human population of areas where goral were observed was significantly lower than in the other two areas. The combined human population of the goral habitat area was also significantly lower than the population of other areas. The number of livestock in areas of goral occurrence was significantly lower than in areas of goral absence. Combined livestock numbers were also lower in areas of goral habitat than in areas with no goral. Thus, goral were confined to areas where there was less human disturbance and less competition with livestock for forage.
Figure 7. Human and livestock populations inside and outside of goral habitat in the Margalla Hills National Park.
Table 10. Statistical analysis of the effect of people and livestock on the distribution of goral in the Margalla Hills National Park during 1987-88. Underlined values are significant at \( P<0.1 \).

<table>
<thead>
<tr>
<th>Area</th>
<th>People Mean (SE)</th>
<th>t</th>
<th>Livestock Mean (SE)</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>95.2 (36.9)</td>
<td>-1.583</td>
<td>120.0 (62.4)</td>
<td>-0.495</td>
</tr>
<tr>
<td>2</td>
<td>480.0 (224.2)</td>
<td>1.745</td>
<td>168.2 (71.7)</td>
<td>-1.384</td>
</tr>
<tr>
<td>3</td>
<td>626.0 (142.6)</td>
<td>1.436</td>
<td>252.6 (43.0)</td>
<td>-1.531</td>
</tr>
</tbody>
</table>

Area codes are: 1-goral observed, 2-goral signs observed, 3-no goral or signs observed.
Blackbuck

Biology

Blackbuck are a medium-sized, slender antelope and the sole representative of the genus *Antilope* in the sub-family Antilopinae. The males have a striking pattern of black and white, and long spiral horns. Height of adult animals at the shoulder ranges from 60 to 83.8 cm, body length 117 to 150 cm, and body weight 25 to 45 kg. The horns in adult males may be 71.5 cm in length with 3 or 4 complete spirals. Females have no horns (Schaller 1967, Roberts 1977, Nowak and Paradiso 1983, Mcdonald 1984).

Distribution and status

Blackbuck are native to the Indian subcontinent. Formerly, they occurred from the Punjab (Pakistan) through Uttar Pradesh (India) and Nepal (Lydekker 1907). Blackbuck inhabit open semi-desert areas covered with thorn and dry deciduous forest and are never found in mountainous terrain (Schaller 1967). In Pakistan, blackbuck were reported in the 1950s to have occurred in the northern part of the Cholistan Desert near Bahawalpur. No blackbuck have been seen inside the Pakistan border since 1967, except the animals that have been reintroduced in the LSNP. A flourishing blackbuck population also exists in Texas (USA) where they were introduced in the 1940's (Roberts 1977).
Blackbuck populations have been reduced greatly in Pakistan and other areas due to excessive hunting, loss of habitat from agricultural development, and competition with domestic goats and sheep for forage (Schaller 1967, Mcdonald 1984). The Wildlife Preservation Society of India estimated that the blackbuck population in India fell from 80,000 in 1947 to 8,000 by 1964 (Seshadri 1969). Blackbuck were exterminated by farmers over much of their range because of damage to agricultural crops (Schaller 1967).

**Food habits and feeding behavior**

Blackbuck are almost exclusively grazers (Schaller 1967). They feed mainly on short grasses but may take leaves of shrubs and trees (Mirza and Waiz 1973, Roberts 1977, Chattopadhyay and Bhattacharya 1986). Roberts (1977) observed them browsing on the leaves of *Acacia jacquemontii* in Cholistan. In Lal Suhanra game sanctuary, their major diet consisted of such grasses as *Aristida depressa*, *Cenchrus pennisetiformis*, and *Cymbopogon martinii* (Mirza and Waiz 1973). In India, blackbuck are still considered a serious agricultural pest (Sharma 1980).

Chattopadhyay and Bhattacharya (1986) studied the seasonal feeding habits of blackbuck. During the dry season, when vegetation is scarce, they feed mainly on wheat bran (put out for livestock on crop lands) and tree leaves. During the wet season, grasses contribute to the main
portion of their diet, although wheat bran and tree leaves may be equally available.

Blackbuck herds forage either as widely scattered groups or as compact units. When foraging, each animal moves slowly at the rate of 122 to 183 m per hour, and often remains in an area as small as 30 m in diameter for several hours (Schaller 1967). During feeding, they usually look around after short intervals for no apparent reason. This behavior appears to be an adaption by which blackbuck spot potential dangers by sight rather than smell and may relate to their preference for open areas.

Schaller (1967) reported that blackbuck never drank water even during the hottest months of the year. It is likely that these animals can persist days or even weeks without drinking.

**Daily activities**

Blackbuck are diurnal in feeding activity. Most feed in the early morning and late evening and rest during midday (Schaller 1967, Roberts 1977, Lehmkuhl 1980). The daily routine of feeding and resting changes with the season. Schaller (1967) observed that during cool weather, blackbuck were active at 6:00 a.m. They intermittently grazed and rested for brief periods, usually between 10:00 a.m. and 2:00 p.m. In hot weather, animals were active at 5:00 a.m. and grazed until 7:30 p.m. They rested in the shade until
late afternoon. Lehmkuhl (1980) observed that when farmers and cattle become active during the day, blackbuck moved to croplands where cover was better. They sometimes stayed in the scrub forest during the day and returned to cultivated fields in the late evening.

Response to predators

Blackbuck rely more on sight than sound to detect potential danger, and warn other members of the herd. The most frequent visual signal in response to danger is an erect stance with the neck held vertically. They may stamp their forelegs and raise their short, narrow tails. If approached by a predator, blackbuck first crowd together and then flee, often with a stotting gait. Flight distance varies from 50 to 70 m depending on the nature of the danger. They appear to have a good sense of smell (Schaller 1967). Their main predators include panthers (Panthera pardus), wolves (Canis lupus), jackals (Canis aureus), and caracal (Felis caracal) which are found in Pakistan (Roberts 1977).

Social behavior

Blackbuck are social animals living in herds of from a few individuals to several hundred. In the late 19th century, herds of 8,000 to 10,000 individuals were observed in Punjab (India) where the greater monsoons produced a savannah-type vegetation most suited to this animal (Roberts
More recent observations are of herds of 5 to 50 animals, although in some areas, several groups may amalgamate during December and January (Schaller 1967). Nair (1976) reported that the average number of individuals per herd was 23, with a herd varying from 2 to 129.

From February to November, blackbuck populations divide into small breeding herds consisting of one or more bucks and several does and fawns (Schaller 1967). These groups limit their activity to restricted areas or territories. Adult males that neither establish territories nor acquire does form buck herds or remain on the periphery of breeding herd territory. The breeding herds form mixed-sex groups of varying size in December and January. Breeding herds are again formed in February. According to Prasad (1983), forage, social aspect, and disturbance by farmers may influence herd structure.

**Territoriality**

**Establishment.**—Adult males establish territories during the breeding season (Schaller 1967, Nair 1976, Lekagul and McNeely 1977, Rangitsinh 1982) varying in size from 8.09 to 100 ha (Schaller 1967, Rao and Prasad 1982, Nowak and Paradiso 1983). Bucks mark territories with visual and olfactory signs which serve to delineate the boundaries. The most conspicuous mark is the buck himself standing in a prominent place with his striking black and
white color and long horns. Bucks also tend to deposit feces at specific locations. Blackbuck have prominent preorbital glands which are used to mark grass and bushes with scent. The accumulation of visual and olfactory signals in a limited place characterizes blackbuck territories (Schaller 1967).

**Defence.**--Blackbuck defend their territories from younger males and other adults during the rut (Rangitsinh 1982, Nowak and Paradiso 1983). They maintain a linear dominance hierarchy, with dominant bucks having the largest bodies and longest horns. Subordinate bucks have smaller bodies and horns (Schaller 1967). The dominant bucks raise their muzzles high, pull their ears back, and raise their tails, which curl upward, making the white patch on the rump conspicuous. They approach their opponents in this posture. A direct threat consists of lowering the head until the chin touches the ground and pointing the tip of the horns at the opponent. A blackbuck may chase the opponent from 15 to 25 m in this position (Schaller 1967). One territorial male was observed chasing a younger male for one km (Lehmkuhl 1980). The horns are potentially dangerous weapons but serious fighting is rare (Nowak and Paradiso 1983).

**Breeding**

Adult male blackbuck are sexually active throughout the year. Although blackbuck show no breeding peaks in
captivity (Crandall 1964), they show two distinct rutting peaks in April and from mid-August to mid-October in the wild (Lydekker 1907, Prater 1948, Schaller 1967, Lehmkuhl 1980). Lehmkuhl (1980) argued that the April rutting season has advantages. Females breeding in this season have abundant new vegetation during gestation. Fawns are born in October and mature during the mild winter season when nutritious forage is more abundant for lactating females.

**Display postures.**—The display postures used by the buck in dominance and courtship are very similar. After sniffing the anal area or fresh urine of a doe, the buck usually approaches her with short, quick steps. The lips are curled, preorbital gland averted, and muzzle raised in a typical head-up display. If the doe runs, the buck follows her or stands parallel to her for brief periods in a head-up display. The buck shows his intention to mount by placing his chin on her back (Schaller 1967). One buck mounted nine does in succession. Sometimes animals copulate while walking or trotting.

**Gestation.**—The gestation period is six months (Roberts 1977, Mungall 1978, Nowak and Paradiso 1983) and usually a single young is born. According to Schaller (1967), females may not breed until two and half to three years old. The adult sex ratio varies from 45 to 71 bucks per 100 does. This unequal sex ratio was also present in yearlings (Schaller 1967).
Female behavior.--The females withdraw from the breeding herd a few days before parturition and give birth in a secluded place either within or outside the male territory. Young fawns spend most of the day lying quietly hidden in a patch of grass. They are visited at intervals by the doe. The doe seems to have little influence on where or when fawns lies down. Nose-touching and subsequent rump-licking is frequent during initial contact (Schaller 1967) probably serving as a means of recognition and bonding. Young fawns suckle several times during the day.

Management

During 1966 and 1967, two wildlife expeditions led by Guy Mountfort, a British ornithologist and naturalist (Bokhari 1970), were sponsored by the Government of Pakistan with the cooperation of the WWF. These expeditions assessed the status of wildlife in the country and recommended ways to preserve it. As a result, several wildlife reserves, sanctuaries and national parks were established, including Lal Suhanra near Bahawalpur. This area included former, arid blackbuck habitat. Human pressure was low with only one person per square kilometer. Animals were available for reintroduction, and with available funds through international agencies, the WWF-Pakistan decided to reintroduce blackbuck into Lal Suhanra. Public support was
present from those who wanted to see their favorite game animal returned to these areas.

The first reintroduction of blackbuck was started in 1970 in the LSNP with 10 animals (three males and seven females) donated by Texas (USA) ranchers in response to an appeal by the WWF-Pakistan. The park has an area of 51,610 ha (Fig. 8). The animals initially were kept in an 0.8 ha enclosure, but they were moved later to a 518 ha enclosure.

Blackbuck were kept in enclosures for various reasons. As studies have indicated (Roberts 1977), extirpation resulted from excessive hunting, competition with domestic goat and sheep for forage, and extermination by farmers because of damage to their agricultural crops. These mortality factors, in addition to predation, were largely controlled by keeping blackbuck in the enclosures. Wolves, jackals, and caracal are the major blackbuck predators in this area (Roberts 1977). Because blackbuck were brought from other areas for reintroduction, they may not have developed defensive strategies against these predators. Predation was therefore controlled to a large extent to ensure survival.

The initial population of 10 increased to only 19 by 1979 (M.H.Shah, personal communication). This slow increase was due to several factors, possibly including interference with breeding. Studies have shown that blackbuck establish territories during the breeding season, the minimum size
reported to be 8 ha. In an enclosure of 0.8 ha, the animals may not have been able to establish territories and therefore breed successfully. Predation contributed to the slow increase in the blackbuck population. Several animals also died from snake bites (Aleem 1978). Several fawns died due to exsanguination by mosquitoes (M.H.Shah, personal communication).

To increase breeding success, five females and one male from the Copenhagen Zoo were added to the enclosure in 1980. Several other steps also were taken to improve the condition of the park, including the relocation of 4,000 illegal human occupants, and improvement of habitat by reforestation in the areas where vegetation had vanished due to drought. Because animals were not fully protected from predation even inside the enclosures, a predator control program was also started (M.H.Shah, personal communication). In 1982, two more groups of blackbuck, each of five females and one male, were acquired from the Western Plains Zoo, Australia, and the Copenhagen Zoo, Denmark, by the WWF-Pakistan and released in a separate enclosure to establish a new breeding nucleus. Their diets were supplemented with grains.

These improvements resulted in the blackbuck population increasing to 48 animals in 1982 (Sheikh 1982). Although the blackbuck population had increased to 120 animals by 1988, they are still held in enclosures. If we consider the problems and difficulties to be faced, and the resources
required for reintroduction programs, the blackbuck program can be considered a partial success. As their numbers grow, it will be possible to release groups of sufficient size to establish populations under natural conditions. Perhaps the next step is to move the existing herd to larger enclosures and expose them to more natural conditions in order to prepare them for a more natural existence when they are released. A strong protection program coupled with a public education program are needed after release to ensure survival. Further studies on the status of habitat, competition from other wildlife species and livestock for forage and space, and possible predation and human pressure are needed. These data will help decide when and where to release the animals under natural conditions.
Cheer pheasant

Biology

Cheer pheasants are medium-sized montane pheasants with only slight sexual dimorphism. Their heads are characterized by a long, narrow occipital crest and a naked orbital patch. The males are blackish-brown on the top of the head, buffy-white and pale rusty dorsally and buffy-white ventrally with a blackish center on the abdomen. The females are similar in general appearance, but smaller in size (Delacour 1977, Ali and Ripley 1978, Johnsgard 1986). Adult males have a wing length of 235 to 270 mm, a tail length 450 to 580 mm, and a body weight of 1475 to 1700 gm. Adult females have a wing length of 225 to 245 mm, a tail length 320 to 470 mm, and a body weight of 1250 to 1360 gm (Ali and Ripley 1978).

Distribution and status

Cheer pheasant inhabit the Himalayas between 1,400 and 3,500 m elevation. They occur from Hazara (Pakistan) through Kashmir, Punjab, Himachal Pradesh, and Utter Pradesh (India) to central Nepal (Ali and Ripley 1978, King 1981,
Johnsgard 1986). They prefer steep rugged hillsides covered with long grass and scattered trees. In Pakistan, their original habitat consisted of long grasses, thick bushes, precipitous slopes, and tiered cliffs (Mirza 1980). In Nepal, they have been observed from 2,200 to 2,440 m elevation in open scrub forest and grassy cliffs. In India, they occur from 1,800 to 3,000 m elevation, and prefer subtropical pine forest habitat with subalpine meadows (Gaston et al. 1981).

Ali and Ripley (1978) reported that cheer pheasant were resident species that exhibited no seasonal movements. They appeared to move around on a particular hill, never completely abandoning it (Johnsgard 1986). In cold weather, they were seen as low as 1,220 m and in summer at 3,048 m or higher (King 1981, Johnsgard 1986).

Cheer pheasant are becoming increasingly rare in the western Himalayan foothills, where habitat destruction and hunting have seriously reduced their populations (King 1981). Mirza (1980) concluded that illegal hunting and habitat destruction were the main reasons for their extirpation in Pakistan.

**Daily activities**

Cheer pheasant feed in the mornings and evenings and, unless it is very cloudy, remain under cover during mid-day. At night, they roost on stunted trees, high bushes, or on
high rocks (Johnsgard 1986). Ali and Ripley (1978) reported that cheer pheasant roost in patches of oak trees or overhanging gullies. They are surprisingly noisy when approaching their evening roosts, rendering them vulnerable to poachers and predators. They lie very close in cover and are almost impossible to flush without a dog. When flushed, they usually fly down the hill with great speed with wings tucked to their sides.

**Food habits and feeding behavior**

Major food items are roots, tubers, seeds, berries, and grain when available. Insects and grubs are also taken (Johnsgard 1986). The birds have also been observed chasing winged insects. Ali and Ripley (1978) did not observe grass and leaves in the diet of cheer pheasant but Beebee (1936) reported leaves of trees in their diet.

Cheer pheasant feed in pairs or coveys. A single bird or pair, when searching for grubs, may dig 25 cm or more below the surface until almost hidden from view, looking around every few seconds to detect possible danger (Johnsgard 1986). The covey usually remains together when feeding.

**Breeding season and nesting**

The breeding season extends from late April to early June. The nest consists of a scrape or depression lined with leaves and grass and is located at the foot of a
boulder or on rugged hillsides usually well concealed by overhanging grasses (Ali and Ripley 1978, Delacour 1977). Some nests also have been found at the foot of nearly vertical cliffs and relatively inaccessible sites (Baker 1930). Nesting at lower elevations begins at the end of April and at the highest elevations as late as early June. The clutch size is 9 to 14 eggs in the wild and 9 to 12 in captivity (Delacour 1977, Ali and Ripley 1978, Johnsgard 1986). The incubation period is 26 days. Although incubation is performed only by the female, the male remains close most of the time. Along with the female, he broods the chicks after they hatch. Family groups remain intact through the winter until the start of the next breeding season and may be the basis of the covey size of 5 to 15 birds. Sexual maturity is attained after one year (Johnsgard 1986).

**Social behavior**

Cheer pheasant tend to be fairly gregarious. Where population densities permit, they are often found in groups of 5 to 15 birds except during the breeding season (Johnsgard 1986). Smaller groups of 5 to 6 birds have been reported by Ali and Ripley (1978). The species is monogamous although the length of the pair bond under natural conditions is unknown. Both sexes crow at daybreak and at dusk. The call is loud and can be
heard for at least 1.6 km (Baker 1930). Although Lelliot (1981) reported an average territory size of 12 ha during the breeding season, not much else is known about territoriality.

The male courtship display is a lateral pattern common to most Phasianids. Males move around the females in semi-circles holding the head in, the nearer wing dropped, and the body feathers fluffed. They are said to lack wing-whirring displays (Delacour 1977). Copulatory behavior has not been observed. The absence of iridescent coloration in this species is perhaps related both to the reduction of sexual selection pressure associated with monogamy and to the open grassland habitat which with iridescent plumage would not provide maximum visual concealment.

Management

Cheer pheasant were previously found in the Margalla Hills, which was declared a national park in 1979. The CDA protected and managed the area for its flora and fauna which was one of the reasons for establishing this national park. The WPA established a branch in Pakistan in 1975 to start practical conservation of pheasants. Knowing that cheer pheasant were extirpated in Pakistan in 1976, and that suitable habitat in the MHNP still existed to support the
species, the WPA and the CDA began a joint effort to reintroduce cheer pheasant in the MHNP.

The reintroduction program for cheer pheasant was started in 1978. A release site was selected within habitat known to have been previously occupied. A pre-release pen, 1.8 m high and covering a perimeter of 183 m, was constructed at the site. Cheer pheasant were released annually at the site from 1978 to 1981.

The release site had some constraints. These included higher temperatures than normally required by cheer pheasant, high humidity, thick scrub around the pen, and a lack of roosting trees. Therefore, this site was not suitable for cheer pheasant. A new site was selected at Jabri in 1982 (Fig. 9). It was larger and had a variety of vegetation types in the vicinity providing food, cover, and roosting trees. Temperatures were also suitable. Although habitat at this site was potentially optimum for cheer pheasant, much of it had been impacted by humans and livestock, a major cause of their original extirpation (Mirza 1980). A larger pen was constructed at Jabri along with hatching facilities. Releases from this site began in 1982 (Table 11).

Cheer pheasant eggs were received from various pheasantries in Britain, Belgium, and the Netherlands. Eggs from local captive stock were also used. Chicks were reared in Pakistan and released into the wild at fledging. Only 26
percent of the total hatched chicks survived to be released into the wild. Various causes of chick mortality are given in Table 12.


<table>
<thead>
<tr>
<th>Year</th>
<th>Eggs Set</th>
<th>Hatched percent</th>
<th>Survived percent</th>
<th>Released</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978</td>
<td>172</td>
<td>86 (50)</td>
<td>12 (14)</td>
<td>12</td>
</tr>
<tr>
<td>1979</td>
<td>279</td>
<td>120 (43)</td>
<td>45 (38)</td>
<td>30</td>
</tr>
<tr>
<td>1980</td>
<td>229</td>
<td>49 (21)</td>
<td>19 (39)</td>
<td>6</td>
</tr>
<tr>
<td>1981</td>
<td>130</td>
<td>76 (58)</td>
<td>26 (34)</td>
<td>26</td>
</tr>
<tr>
<td>1982</td>
<td>199</td>
<td>79 (40)</td>
<td>3 (4)</td>
<td>-</td>
</tr>
<tr>
<td>1983</td>
<td>266</td>
<td>94 (35)</td>
<td>60 (64)</td>
<td>50</td>
</tr>
<tr>
<td>1984</td>
<td>296</td>
<td>83 (28)</td>
<td>38 (46)</td>
<td>38</td>
</tr>
<tr>
<td>1985</td>
<td>299</td>
<td>120 (40)</td>
<td>91 (76)</td>
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<td>1986</td>
<td>385</td>
<td>197 (51)</td>
<td>129 (65)</td>
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<td>1987</td>
<td>1073</td>
<td>481 (45)</td>
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<td>Total</td>
<td>3328</td>
<td>1385 (42)</td>
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</table>

Data from: Ridley and Islam (1982) and Burt (1987)

<table>
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<th>Year</th>
<th>Disease</th>
<th>Accident</th>
<th>Weather</th>
<th>Predation</th>
<th>Unknown</th>
<th>Percent total chicks</th>
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<td>11</td>
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<tr>
<td>1984</td>
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<td>12</td>
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<tr>
<td>1985</td>
<td>6</td>
<td>8</td>
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<td>-</td>
<td>1</td>
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<td>-</td>
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<td>318</td>
<td>61</td>
<td>-</td>
<td>3</td>
<td>91</td>
<td>98</td>
</tr>
<tr>
<td>Total</td>
<td>484(58)</td>
<td>112(14)</td>
<td>49(6)</td>
<td>35(4)</td>
<td>217(26)</td>
<td>61</td>
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</table>

Data from: Ridley & Islam (1982), Hussain (1986), and Burt (1987)

Over half of the chicks died due to disease (Table 12). Previous studies have shown that cheer pheasant are particularly susceptible to coccidiosis, sinusitis, and pneumonia because of their digging habits and preference for dry conditions (Lee 1980). Most of the deaths due to
disease, weather, and accidents occurred during the first eight weeks after hatching, primarily because of untrained and uneducated staff to handle the chicks. Although predation apparently accounted for very little overall mortality, it has been shown to be a major cause of mortality in released birds (Ridley and Islam 1982, Burt 1987). Possible predators of cheer pheasant poults in the MHNP included red fox (Vulpes vulpes), jackal, mongoose (Herpestes edwardsi), yellow-throated marten (Martes flavigula), masked palm-civet (Paguma larvata), small Indian civet (Viverricula indica), leopard cat (Felis bengalensis), and Eurasian sparrowhawk (Accipiter nisus). Foxes were the major predator, a situation similar to that reported for pheasants in North America and Britain (Gill 1977).

A wild population of cheer pheasants has not yet been established. Although a few birds have survived in the wild, much needs to be done to help these birds establish healthy wild populations. The habitat of cheer pheasant should be kept as free of disturbance as possible from humans and livestock. Poaching has to be controlled either by relocating human populations from cheer habitat or by strong protection of the birds. A public education program emphasizing the importance of reintroductions will help reduce human impact on the birds and their habitat.

Predation which is difficult to control in the wild was the major cause of mortality in released birds. According
to Kleiman (1980), captive birds lose their fear of man and the ability to escape from predators. Some conditioning of the birds is probably necessary before release. The birds should be held in a place where they cannot see humans. Only one person should feed the birds, probably when it is dark or using a mask. This person should periodically threaten the chicks so they learn to avoid predators.

Captive populations can lose genetic variability. This is caused by limited population size and is an important concern of conservation biology. Studies with domestic animals have shown that loss of genetic variation has harmful effects on development, survival, and growth rate (Falconer 1981). Wild populations possess heterozygosity, which is an important component of fitness; including survival, disease resistance, and growth rate (Allendorf and Leary 1986). Therefore, releasing birds which are genetically similar to wild populations may enhance the chances of their survival. Breeding of released birds in the wild is essential for the propagation of the species. Released birds may be unable to find mates because of dispersal in remote areas. Therefore, birds should be released in restricted areas to facilitate pairing.

Monitoring of released animals should be an integral part of any reintroduction program. Studies on dispersal and survival of released birds, causes of mortality after release, and reproductive success are needed. Results from
these studies will help to minimize the chances of repeating mistakes, and improve the program.

Comparison of reintroduction plans

Both reintroduction sites, i.e., the MHNP and the LSNP, were established with three objectives: (1) preservation and promotion of wild flora and fauna and other special features of the area, (2) provision of facilities for local public and foreign tourists, and (3) provision of research and educational facilities. These objectives cannot be achieved without first minimizing human impacts, either by relocation from the area or gaining their full cooperation. The situation differs in each area. Because of the small human population, it was possible to relocate people from the LSNP. However, because of the larger human population living in and around the MHNP, the same policy was not effective there.

The MHNP park administration needs to consider people in the development program and gain their cooperation for conservation of wildlife and other park resources. However, the CDA has not seriously explored this policy.

There are some commonalities and differences between these plans. Common factors included: (1) the source of animals, (2) predation, (3) human-related problems, and (4) inadequate staff and funds.

(1). In both programs, animals were acquired from captive
stock, hence, homozygosity may have been a problem. Animals that come from successive generations of captive breeding stock are less successful in the wild (Campbell 1981). Heterozygosity in these animals decreases as inbreeding increases. With the decline of heterozygosity, fecundity of parents and survival of offspring decline. Also, inbred animals are more likely to be sterile. Inbreeding also increases the homozygous genes which decreases mean fitness. This may result in reduced survival of reintroduced animals in the wild (Senner 1981).

Inbreeding depression and high fawn mortality may have contributed to the slow increase in the blackbuck populations. Because blackbuck need to establish territories during the breeding season, the small size of enclosures early in the program may also have affected their breeding efficiency. The poor hatching and survival rate in cheer pheasants may be the result of inbreeding depression and homozygosity.

(2). Predation was a major factor in both programs. Although blackbuck are increasing in number, they have been kept in the enclosures to prevent mortality due to predation. Before predator control began in 1980, a large number of these animals were killed by predators. There are no statistics available but several fawns were killed by jackals and caracal (A.Ahmed unpublished manuscript, M.H.Shah, personal communication). During cheer pheasant
radio telemetry studies, predation was shown to be the main cause of mortality in released chicks. These studies have shown that in 1981 and 1986 more than 65 percent and 40 percent of radio-tagged cheer pheasant were killed by predators (Ridley and Islam 1982, Burt 1987).

(3). Poaching was an important human-related factor in both cases. Telemetry studies have shown that poaching was the second major cause of mortality in released cheer pheasants (Burt 1987). Presently, poaching is controlled in blackbuck by keeping them in enclosures but cannot be ignored under natural conditions. One of the reasons for poaching is the lack of awareness about the importance of conservation and reintroduction programs. Pakistanis also have a hunting tradition and wildlife are considered a source of cheap, quality food. People who live inside national parks are reputed to be responsible for most poaching. However, it is difficult to control poaching with limited park staff. Poaching can be reduced by educating the people about the importance of reintroduction programs. Conservation education and public awareness to the importance of these programs will reduce human impact on these species.

(4). Both reintroduction plans lacked sufficiently educated staff and the equipment to implement the plans and protect the animals. There are five to six technically educated employees in each of these parks, but none of them
is a trained wildlife biologist. Not enough funds were available for feasibility and follow-up studies, which are important phases of reintroduction programs. Due to this constraint, only one post-release study on blackbuck (A. Ahmed, unpublished manuscript) and two on cheer pheasant (Ridley and Islam 1982, Burt 1987) have been conducted.

Strong legislative action was also missing from these plans. At present, hunting and capturing of wild animals, wood-cutting, grazing, and mining are prohibited in national parks (Rao 1986) but these laws are not effectively enforced. Provision of funds for these operations is a political decision. Delays, decreases, and interruptions in funding have affected these programs. Because of poor in country funding the cheer pheasant reintroduction program has been largely dependent on the WPA. As a result, a small number of chicks was available for release, which affected their survival in the wild (M. Hussain, personal communication). Blackbuck were initially kept in an enclosure of 0.8 ha and a predator control program could not be started until 1980 due to insufficient funds (M. H. Shah, personal communication). These factors may have affected blackbuck populations in the beginning of the program.

The reintroduction program for blackbuck has been partially successful, but release into the wild has not yet occurred. Success of the program will depend on the method of reintroduction, natural characteristics of the animals,
control of disease and predators, and provision of supplemental food.

Reintroduction procedures is very important in determining the success or failure of reintroduction attempts. A small number of cheer pheasant were released during the initial years and may have influenced survivorship. If enough captive-bred birds are released at one time, some should become established and propagate. Due to limited resources and high mortality of chicks, enough stock could not be maintained for large releases. Also, the birds were released at only one site within the park. This may have facilitated predation. No data are available to address this concern.

Cheer pheasants were released into the wild from semi-captive conditions where the birds did not develop the anti-predator behavior needed under wild conditions. The same was true with masked bob whites which were then subjected to simulated attacks by coyotes, raptors, and men before release to teach them to avoid predators (Campbell 1981). Cheer pheasant may have been especially vulnerable to predation and poaching. To combat this, blackbuck were kept in enclosures and a predator control program was also started in 1980 (M.H.Shah, personal communication). Blackbuck and cheer pheasant may face the same problems in the wild.
Because blackbuck were in enclosures, it was possible to control disease and provide supplemental food under adverse conditions. Such controls were not possible in released cheer pheasants. These factors may have contributed to the failure of the cheer pheasant reintroduction plan. There are no data available on weather patterns and mast crop and seed production during the period of the cheer pheasant release program. However, three diseased pheasants were found during a radio-telemetry study in 1986 (Burt 1987).

Blackbuck can be kept in enclosures for long periods of time to build large populations and to prepare them for natural conditions. In bigger enclosures, there is a chance that they will develop some element of wildness needed in free-ranging mammals. Early learning of fawns may be critical for survival under natural conditions. There is enough time to study conditions in the wild to determine whether they are suitable for blackbuck.

On the other hand, cheer pheasants cannot be retained in pens for long periods of time. Their chances of becoming cage-oriented are greater, and this is not conducive to survivorship in the wild. Cage-orientation can be reduced by keeping the birds away from humans, feeding them in the dark or using a mask, and threatening them from time to time to teach them to avoid predators.
GORAL MANAGEMENT PLAN

The wildlife in the MHNP can be protected and enhanced in one of two ways: either by relocating the people and their livestock from the park or by involving them in park development schemes and educating them to reduce their impact on the park resources. A combination of these two ways can also be tried where the people living inside the critical wildlife habitat, such as goral habitat and cheer pheasant reintroduction area, can be relocated and others can be educated and involved in the park development.

The CDA has tried to relocate people from the park with little success. They tried to pay for their properties and provide alternate lands outside the national park but very few families were relocated. Because of economic and political problems, it will be very difficult to relocate these people from the park. For instance, due to a large population living in the park, the CDA needed a large amount of money to pay for their properties. Moreover, the people who were entirely dependent upon park resources and had no businesses or jobs found it difficult to establish themselves at a new place. The CDA could not force them to leave because the federal capital was nearby and they did not want to create any unrest. These residents also used
political influence by pressuring their representatives, who did not want to lose their votes, to let them stay in the park (M. Hussain, personal communication).

The education and development option is more likely to work in this park. This strategy has been tried in the Kirthar National Park, Pakistan, and was successful (Kermani and Khan 1985). To achieve this goal, park residents were taken into confidence by their leaders, who explained the importance of conservation and the importance that they would themselves assume under the development project. Their economy was improved by employing 108 local villagers in the park. A tourist/visitor complex, that helped park residents to market their products such as poultry, eggs, and handicrafts was also built.

With the education option, the CDA should develop these villages economically so that the residents are not dependent on the park resources. Some alternate income can be provided through employment in the park. Strong protection and education programs also need to be established with full public participation. The CDA has installed some wildlife conservation signs along roadsides and at various public visiting sites in the park. Hunting, wood-cutting, and any other activity that can affect the flora and fauna of the park are prohibited. The activities of people and livestock should be restricted to park areas which are not important wildlife habitat (Fig. 3). It is
possible by reducing the number of domestic animals per family and imposing fines on grazing in the important wildlife habitat. These actions will help reduce the impact of people on park resources. If these policies are adopted by the CDA, the goral population can be increased to 200–300 animals in the MHNP based on their present and potential habitat which is about 7,000 ha (Fig. 3). If goral territory size is from 22 to 25 ha (Mead 1989), 300 goral can easily be accommodated in 7,000 ha, provided there is enough food available.

To achieve this target, the following factors should be considered in the goral management plan.

**Biological factors**

**Habitat**

Every animal species is as safe as its habitat is secure (Frankel and Soule 1981). The number and population health of most wildlife species are directly related to the habitat quality and often heterogeneity. One characteristic of most endangered species is their requirement for unique habitat (Temple 1977).

Food is a basic component of any animal habitat. In the goral habitat in the MHNP, adequate forage is available year round. I found that more than 60 percent (by composition) of the vegetation in the goral habitat is comprised of plant species commonly eaten by goral.
Therefore, goral should not experience food shortages. Food preference varies with season (Fig. 6), and goral appear to utilize these plant species quite efficiently. During the early dry season, I generally observed them eating leaves of dry grass although green leaves of some shrubs were available. Goral may have continued this throughout the whole dry season.

Goral were never seen drinking, although water is available in their habitat in the MHNP throughout the year. Some park employees who also live inside the park reported that goral usually drink water only once a week in winter, whereas in summer, they may drink water more frequently. Lekagul and McNeely (1977) observed goral drinking water from a stream or pond after feeding in the morning.

I found that goral are confined to areas with steep slopes and sharp ridges. Goral always escaped to a ridge when I alerted them. Vegetation around the ridges provides hiding cover for fawns during the breeding season, and open areas between the ridges were probably used to observe predators. Goral were usually seen standing against the ridges in the early morning in the sun, especially during the winter. They may have been using these cliffs for heat as an aid in thermoregulation. Cliffs may also have been used as cover from cold and rain. As observed by Schaller (1977) in winter, goral largely restrict themselves to steep terrain where snow is rapidly removed by wind and sun. In
summer they may move up to a kilometer from their cliffs.

High ridges and cliff areas may not be the preferred habitat for goral, but rather the only habitat left where they can survive. Ridges and associated vegetative cover are the special features of habitat needed by goral under present conditions. These characteristics need to be maintained in the goral habitat. They appear crucial for their existence. It is the last available relatively undisturbed habitat in the park and is too steep for human and livestock activity. Potential goral habitat should be selected for protection and management for these features to promote goral range expansion and a stable population in the MHNP.

Predation

Predation can be significant on small populations when combined with other factors. For example, when a species is vulnerable because of limited and disturbed habitat and is essentially insular, predation can eliminate the last remaining population (Frankel and Soule 1981). The goral is limited in range and exists in small population numbers in the MHNP. Predators such as jackal, foxes, and feral dogs are regularly seen in the park, and leopard are seen occasionally. According to local villagers, jackal and foxes can take goral fawns, and I myself observed a group of feral dogs chasing an adult goral.
I found that there has been only a seven percent annual increase in the goral population in this park. There are no other demographic studies on goral, but McCullough (1983) calculated an annual increase of about 50 percent in a white-tailed deer population in Michigan. This much higher rate of increase may be due to the twinning in white-tailed deer. According to Schaller (1977), some Himalayan ungulates which have commonly a single young, have much higher rates of population increase than goral. For example, he observed a 14 percent increase in Betsi ibex, 13-16 percent in Chitral Gol markhor, and 21 percent in Lapche bharal. These are empirical values, largely dependent upon local conditions and population status, but give some indication of the range of values one can expect. Therefore, goral are increasing at a much slower rate than their potential if habitat resources such as food and space were not limited.

It appears that predation might be one of the factors that limit the goral population. A predator control program, therefore, may be useful in a goral management plan. In addition to predation, disease may also be a factor contributing towards slow increase in goral population. Among 18 goral studied in the Indian zoological parks, one died by taeniasis parasite disease, eight by pneumonia, six by gastroenteritis, one by hepatitis, and two by unknown cause (Rathore and Khera 1982).
Natural competition

Barking deer is the only other wild ungulate in this park. There is a slight chance of competition between these two animals. Their habitat overlaps only slightly because of their different requirements (Roberts 1977). Barking deer are found in dense, low thorn scrub of *Acacia modesta*, *Olea ferruginea*, with an understory of *Zizyphus nummularia*. They are not associated with the tropical pine forest zone. Indian porcupine (*Hystrix indica*) are found in the MHNP but they mostly feed on bark of certain tree species, roots, and bulbs (Roberts 1977). There are no other wild animals in the park which actively compete with goral.

**Human impacts**

Reduction in habitat quantity and quality due to various human activities is a major factor in the reduction and extinction of most wildlife species (Temple 1977, Soule and Wilcox 1980, Ehrlich and Ehrlich 1981, Frankel and Soule 1981). According to Ehrlich et al. (1977), no other agent of environmental change is so devastating or so thorough as man. Mead (1989) concluded that presently, humans are the main cause of limiting the range and reducing the goral habitat by over-exploitation. Habitat destruction and poaching are the two main problems associated with human presence in the MHNP.
There are more than 17,000 people living in and around the park, with a density of 120 persons per square kilometer. These people are overusing the limited park resources through activities such as wood cutting and livestock grazing. They are also traditional hunters and kill animals for sport and meat, and no doubt have an effect on goral populations. No estimates are available regarding the number of animals killed, but this may have contributed to bringing goral to its endangered status. Poaching was also a problem in the management plans of blackbuck and cheer pheasant. It is very difficult to control poaching with a limited staff and only one vehicle. They simply cannot cover the whole park and protect it around the clock. Therefore, the best way to ensure the survival of park wildlife would be to involve local people and get their cooperation in the conservation process.

The first step would be to gain the confidence of park residents, win their sympathies, and highlight the benefits they can get through the conservation process. Initially, leaders from local villagers can be contacted and a conservation program and benefits that they will get from it presented to them. Once they are convinced, a mass conservation project can be launched with their commitment and support. With time and effort, people will know that if conservation is correctly practiced, it will bring opportunities of jobs and other economic benefits. They
will realize that their area would one day become a popular place for visitors, which will increase their own importance. Employment of local people in the park is already being practiced. About 50 local villagers have been employed in the park (M. Hussain, personal communication).

Tourist facilities such as visitor center, camp sites, picnic sites, trails, and view points can be increased in the park, providing economic benefits to the local population by increasing tourism and thus giving locals a market for their dairy and poultry products, and even handicrafts. No scientific data are available, but there is some use of these kind of facilities in other parks in Pakistan such as Kirthar and Lal Suhanra National park (Kermani and Khan 1985, M.H. Shah, personal communication). Local people can also derive some benefits by guiding tourists in the back country. Through economic development and education, human impact on park resources could be reduced and the quality and quantity of goral habitat increased. Through this process in the Kirthar National Park, the human impact on park resources was reduced and as a result, populations of ibex and urial increased from 1,200 to 4,000 animals and from very low levels to 1,000 animals, respectively (Kermani and Khan 1985).
Livestock impacts

Park residents have large numbers of livestock that affect the goral population by their activities and presence in the vicinity. As a result, goral may leave or limit their activities to certain areas. It has been observed that livestock may have direct negative effects on wild ungulates where their ranges overlap. There may be an annual or short-term reduction in kind, quality, and amounts of food and cover available to wild ungulates as a result of livestock grazing or other activities (Mackie 1978). Over longer periods of time, livestock may eliminate a wild species from an area by suppressing a preferred plant species. Cover may be very important for fawns during the first few weeks of life. Losses of cover by severe livestock grazing can make these fawns more vulnerable to predation or unfavorable weather conditions (Pyrah 1974).

Berwick (1976) in a study of the Gir Forest in India found that although there was no direct competition for food between wild and domestic ungulates, overgrazing of grass by domestic livestock was the major reason for the deterioration of this ecosystem. He concluded that elimination or reasonable reduction in domestic livestock was the only solution to save this ecosystem. Livestock grazing may affect feeding and range use of wild animals and may also have seasonal impacts on them. Most serious
effects occur in spring when nutritious food is very important for pregnant females and in fall when young are growing. Due to nutritious food requirements and overlap in their ranges with domestic livestock, wild ungulates may be very limited in their distribution during the spring and fall (Mackie 1978). Livestock may also transmit diseases to wild ungulates. A study in Indian zoological parks has shown that 18 goral died of various diseases (Rathore and Khera 1982).

Indirect effects on behavior, distribution, and dynamics of wild ungulates is also possible due to livestock grazing. For example, mule deer suffered high mortalities (McKean and Bartmann 1971), and low fawn production and survival (Knowles 1976), in the livestock grazing areas. Long term behavioral changes through competition may lead wild ungulates into resource utilization patterns away from optimal use (Beament 1961). Through competition with livestock, wild animals may be forced to specialize on fewer kinds of foods and habitat, which can result in a loss of stability in a population if any of these resources fail or there is dramatic change in the supply.

I observed that goats compete with goral for browse, and cows and sheep compete for grasses. Goats and cows were seen in the same area with goral. Due to pressure from these livestock, goral are limited in their range and are only found around very steep ridges. This may have a
negative effect on goral populations. Results from this study show that goral are confined to the areas with low livestock numbers. Cattle activity may be at least partly responsible for the current goral distribution to the areas with difficult access to livestock. Improving goral habitat is unlikely in the presence of livestock. Therefore, livestock should either be excluded from the park or restricted to areas where they cannot compete with goral or affect their present and potential habitat. It is possible by reducing the number of livestock and imposing fines on grazing in the critical goral habitat.

**Economic impacts**

Adequate funding is necessary to ensure the implementation and completion of any management program, including the follow-up studies which are necessary to determine changes in population levels and distribution of a species. Continuous funding is needed for the study and protection of goral.

If people have to be relocated from the park, a sizeable amount of money will be needed to pay for their properties or provide alternate homes and land. If these people are not relocated from the park, they have to be provided jobs or alternate sources of income to reduce their impact on the park. Thus, continuous and adequate funding is required to implement the goral management plan.
Education

Education is a critical part of any conservation strategy. To solve the problems created by the rapid and dangerous misuse of the environment, a change in values and attitude of the people towards the use of their environment is needed. As Coe (1981) has pointed out, some money also should be spent on public education along with research on wildlife species that are to be protected. The chances of survival of these species will be significantly increased after communicating with and educating the people living around the parks.

The literacy rate in Pakistan is less than 30 percent and even lower in the remote countryside. Along with the economy of the people, the lack of knowledge about the importance of conservation also contributes towards poaching and habitat destruction. For instance, released cheer pheasants, even with radio collars, were killed by people. A leopard, which is an endangered species in Pakistan, was also killed by local villagers in this park. This happened because very few people understand the significance of the cheer pheasant reintroduction program or the conservation of endangered wildlife. Therefore, wildlife conservation education should be an essential part of the management process. Park residents need to be educated about wildlife conservation as well as economic values of wildlife.
Recreation

Parks should be accessible to the public, thus providing greater opportunities for both education and recreation. There, young people can learn the value of these diverse and relatively stable environments. Parks should be training grounds where people can learn about wild flora and fauna and also enjoy the natural scenery. Visitors would bring money to the park which can be used for park development. By visits to the parks, people will be more aware of the importance and realize the need of conservation of natural flora and fauna. This is not possible if people do not visit these areas. There will be no financial and moral public support for conservation if they do not visit and realize the importance of natural resources. But overuse of the park resources may have a negative impact on these resources. Therefore, park managers should be careful of the level of use of park resources.

Wild flora and fauna in the MHNP can be improved if we are able to stop the over-exploitation of the park resources. Over-exploitation can be stopped by providing alternate income sources to the local villagers. Improved conditions could provide more recreation and education opportunities for tourists and aid the local economy. The
construction of roads, viewpoints, trails, and picnic sites will bring more visitors and money to the park. However, these facilities may also increase disturbance and have adverse impact on wildlife, vegetation, and spectacular scenery which in large part attract the visitors. Therefore, we need careful management and control of the visitors and park resources. The recreational facilities should be developed outside the goral habitat so that the animals are not disturbed. Park managers should also determine the use level of these facilities and other park resources in order to save them from overuse. Visitors may be allowed to go to the designated areas in the park to avoid their impact on natural flora and fauna.

Through proper management, goral populations may be increased in the future to the level where limited hunting permits could be issued to interested persons, as is now being practiced in the Kirthar National Park on other ungulates. Revenues from hunting and other sources, such as park entry fees, can provide partial funding for the management of wildlife and other natural resources of the park.

**Politics**

Politics play an important role in wildlife management decisions. Because there are few professional wildlife
managers in Pakistan, most of the wildlife management decisions are made by non-professionals. Ehrlich and Ehrlich (1981) observed that the most powerful and influential individuals in governments and corporation leaders have strongly exploitative attitudes. The provision of funds for research, management, and protection of wildlife is usually in the hands of politicians. The public and conservation agencies can put pressure on politicians through their representatives to foster enlightened attitudes and decisions in favor of wildlife.

Non-government agencies such as the WWF, the WPA, International Union for the Conservation of Nature and Natural Resources (IUCN), and United States Agency for International Development (USAID) are working in Pakistan. These agencies have been successful in doing some conservation work in the country. For example, the WWF is helping in the blackbuck reintroduction project (Sheikh 1982), the WPA is cooperating with the CDA to reintroduce cheer pheasant (Hussain 1986), and the WWF and the IUCN are jointly assisting in the marine turtle (*Chelonia mydas* and *Lepidochelys olivacea*) management project along the Karachi coast (Firdous 1986). A study to control wild boar (*Sus scrofa*) damage to agricultural crops is being funded by the USAID. These agencies could use their influence to prevent unfavorable government decisions towards natural conservation.
An example of political influence is the stone-crushing machines which were installed in the MHNP inside the goral habitat, even though alternate sites were available. This was a decision of influential people and agency leaders. Park managers were not consulted (M. Hussain, personal communication). This operation will no doubt cause disturbance to goral and other wildlife. Besides continuous disturbance from machines and trucks, workers will be present on site around the clock, and will use wood from the park. This decision may therefore reduce goral habitat, and in the long run have a negative impact on their populations. Although goral habitat is on higher elevations than the machines are, it is still under continuous disturbance by the noise of the machines and the presence of workers.

These kinds of political actions play an important role in the life of wildlife species. The case of the snail darter (Percina tanasi) vs Tellico Dam on the Little Tennessee River in the USA can be cited as an example. The snail darter is a small fish that was found only in this river above a dam site. It was very clear that completion of the dam and filling of the reservoir would completely destroy the habitat of this little fish. Public and conservation agencies tried to save the fish but finally, politicians decided to complete the dam. The decision pushed this species close to extinction (Ehrlich and Ehrlich 1981). Strong wildlife protection laws with provisions for
enforcement are needed to modify these kinds of decisions in favor of the environment.

Presently, killing, hunting, capturing, and export of wild animals and reptiles (and their parts, products, and derivatives) is banned by the government. Export of birds for commercial purposes is also banned. But there are still deficiencies in the law. For instance, captive breeding and the import and export of captive-bred animals in not considered in the law. The introduction and reintroduction of species (intentional and accidental) is not restricted. Law enforcement has also been very weak in the past. More effective improvements in legislation are necessary to protect Pakistan's wildlife and its habitat (Rao 1986).
RECOMMENDATIONS

Habitat protection

Protection of present and potential goral habitat is essential to ensure survival and expansion of their populations. This cannot be achieved without controlling the human and livestock activities in the park. Goral currently remain only in habitat which is too steep for human and livestock activity. A law already exists which prohibits livestock grazing in the entire park (M. Hussain, personal communication). The CDA should enforce this law vigorously through park rangers and guards. A fine of Rs. 100 (US $5.00) per head on livestock grazing in the goral habitat could be charged. Park rangers should be given the authority to impose fines and arrest people involved in such illegal activities in the park. It will make the enforcement more effective and efficient. But this action should be implemented through the court so that it is backed by the court in case of appeal. The law enforcement officers should also be serious and honest. To improve the quality of potential goral habitat, livestock should also be strictly controlled in these areas by park staff.

Human impact on park resources should be minimized. This is possible with enforcement and with the cooperation
of the local population. Participation of local people at every stage of park development projects is necessary for their success. This strategy has been demonstrated in many countries and regions including Great Britain (Phillips 1985), Indonesia (Robinson and Bari 1982), the Caribbean (Geoghegan 1985), and even in Pakistan (Kermani and Khan 1985). These and many other countries have shown that development projects based on local people's priorities and needs create trust and cooperation, and those designed elsewhere and imported without modification for local conditions are rarely implemented. Conservation depends entirely on public will and perceived benefits, which are powerful reasons for local participation (Geoghegan 1985). The following steps should be considered to accomplish this objective.

1. Representatives of local villages should be approached and a conservation program laid before them.

2. The benefits people will get from this conservation program should be explained.

3. More people from local villages should be given the job opportunities in the park and in the nearby city.

4. Park residents should be cognizant of the economic benefits and importance associated with visitors and
park development. These steps will help to gain their cooperation and participation in the park development.

The CDA should also address the needs of the park residents. As is already being done, more local people should be employed in the park. Other park residents should be encouraged to go to the city for jobs. As the CDA is responsible for development of the whole capital area, it should be able to provide more jobs to park residents in the city. One road has already been constructed connecting many villages in the park and provides public transport for park residents. Most of the villagers are now able to go for work daily to Islamabad and adjacent areas. This practice has reduced the intensity of use and dependence of these people on the park resources (M. Hussain, personal communication). More villages should be connected through roads to enable local residents to go to the city for jobs. However, roads may also increase disturbance to park wildlife.

Kerosine oil and liquid gas should be provided to park residents by the CDA on concession rates for at least the first two to three years. But concession should be given to only those who will not use wood from the park after this program. This can be accomplished only if oil and gas are more economical than wood cutting. To ensure this, there should be frequent and unannounced checking on these people
by the park officials. This will reduce fuelwood cutting in the park.

When most of the park residents are able to get jobs in the park and in the city, and get fuel on concession rates, they will not be dependent on park resources. Livestock grazing and wood-cutting will not be necessary for their living. Then, the CDA will be able to strictly enforce the laws prohibiting grazing and wood-cutting and these should work. These steps will help to reduce human impacts and human dependence on the park resources.

Public education

People living in and near the park, as well as visitors, should be educated about wildlife conservation. The protection of flora and fauna will be difficult unless there is significant participation by the people. The CDA should hire at least one trained person to develop education programs for the people in the park. Conservation education should start in the several primary and middle schools in and around the park. Education officers of the CDA should arrange lectures, and slide and video shows in the schools and public places. A person can be hired, or an employee of the park can be trained, to prepare slides and videos on the park flora, fauna, and scenery. Wildlife movies from other countries can also be imported to develop public interest in
wildlife. These movies can be very effective in the villages where movie-watching is a luxury.

School children can be taken on park visits by the rangers to show and tell them the importance of the flora and fauna of the park. Local school teachers could be involved in this education program. They can be very effective in carrying the message of conservation to the local population because they are respected by the villagers.

The CDA should also establish conservation societies consisting of local villagers and the park rangers of that area. These societies can serve to facilitate education and conservation centers. Respected local teachers can play a very important part through these societies. Through this activity villagers will realize their importance, gain confidence, and will be more involved in conservation programs. These societies can also initiate small projects like primary health care, proper agricultural methods to increase crop yield, cooperative stores, and expansion in marketing local products.

A visitor center should be built by the CDA at the entrance to the park. Plant and animal specimens of the MHNP can be displayed there for public education and information. Short slide and video shows can be arranged at the center for visitors. Pamphlets, brochures, and booklets containing information about the park flora and fauna can
also be distributed to the visitors at the center. Wildlife signs should also be prepared and installed by the park administration at different public places and along roadsides in the park. The estimated cost of all these operations is about Rs.500,000 (US $25,000). This program will bring about positive changes in the public attitude towards wildlife and other natural resources.

Legislation

Legislation for the protection of park resources already exists but it is not being strongly enforced, primarily because the staff lacks sufficient equipment and reasonable authority to enforce the law (Rao 1986). There are three or four park rangers and each has two or three forest guards working with him. This staff is enough for a 14,000 ha park area if they have sufficient vehicles and equipment, such as binoculars and guns which will make them efficient and more effective. Existing personnel should be trained and provided with equipment and each park ranger should have a vehicle. The park ranger should be authorized to charge fines for illegal grazing and wood cutting. This action should be implemented through legislation authorities so that it is supported when challenged in the court.

Most of the park employees live in and around the park and are personally acquainted with the park residents.
Therefore, they are reluctant to strongly enforce laws and prevent illegal activities by these people. Park employees who do not do their jobs should be dismissed. Park rangers and other high officials not affiliated with the park should conduct periodic evaluations by making surprise visits to the park. Poachers should be arrested and heavy fines levied against them. If the park administrators were severe in handling a few cases of poaching and illegal grazing, other people would refrain from these activities.

**Funding**

Continuous funding is essential for the implementation of a goral management plan. These funds are needed for protection of goral habitat, education of park residents, further goral studies, and staff and equipment for the management and maintenance of the park. Currently, funds are needed to hire technical staff, arrange training for present staff, and provide necessary equipment for research and protection of wildlife. Once sufficient trained staff are available, they can educate the people, protect wildlife, and carry out research studies.

Duryat and Lavieren (1982) have identified three kinds of management personnel for protected areas. At the highest level are the directors and biologists/ecologists who should be trained in habitat and wildlife management, develop
programs for conservation education, and establish laws and regulations. The CDA can cooperate with universities or research institutes to obtain this expertise.

The second category includes intermediate staff such as park rangers and wildlife wardens. These persons should be, (1) involved in the supervision and implementation of management programs, (2) aware of undesirable biological and ecological changes, and encroachments on critical habitat adverse to protected wildlife. Proper training of these persons is necessary for the success of management programs. The CDA, with the help of the Pakistan Forest Institute should arrange a short continued education program for these persons.

The third category includes guards, guides, and subordinate staff. They are required to make routine observations of wildlife and habitat, control visitors, maintain park facilities, and perform various law enforcement activities. The CDA will need at least Rs. 500,000 (US $25,000) during the first year for all these activities. Out of this amount, Rs.70,000 are needed for the education program, Rs.30,000 for training of personnel, Rs.100,000 for research studies and Rs.300,000 for vehicles and equipment.

International conservation agencies such as the WWF and the IUCN can provide expertise for development and management programs, as well as funds for research and
management studies. The WWF has helped in the blackbuck reintroduction program (Sheikh 1982), and IUCN has provided financial and technical expertise for the marine turtle management project along the Karachi coast (Firdous 1986) and management of wildlife in the Kirthar National Park (Kermani and Khan 1985).

The technical staff of the CDA should develop research proposals on goral and other wildlife to get funding from these agencies. Studies on nutritional value of goral food, and such human pressure on goral populations as wood cutting and poaching, are needed in the future. Other agencies and organizations such as the Pakistan Agricultural Research Council (PARC) and the National Council for Conservation of Wildlife (NCCW) can also be consulted for technical help. Both organizations are involved in determining the status of wildlife and its habitat in the country and research on different ecological and biological aspects of various wildlife species. They can help the CDA in carrying out the above mentioned studies on goral.

**Predator control**

This study suggests that predation may be one of the factors contributing to the slow increase in goral populations. Goral predators in this park include leopard, jackal, fox, jungle cat, and feral dogs. Leopards are seen
occasionally in the park and every time they are seen, there are reports of predation on livestock. Information from local villagers and park officials indicate that leopards are not permanent inhabitants of the MHNP. They visit the park every one to two months from the nearby Murree hills. In northern India, it was estimated that an adult leopard travels a hunting circuit of 48 to 64 km during the year (Champion 1933). In Pakistan, where human disturbance is high and food is scarce, leopard may need to travel over much larger areas. I uncovered no reports of predation on goral by leopards in the MHNP. Even if there are occasional kills, leopards should not be killed because of their endangered status in Pakistan.

On November 26, 1987, I saw feral dogs chasing an adult goral. Some feral dogs were shot by forest guards during the study period. Remaining dogs can also be eliminated by these guards if guns are provided. Although no data on predation level of goral was collected, based on the predation in the blackbuck and cheer pheasant reintroduction programs and low annual increase in goral population (7%), it can be deduced that predation may have been effective on this small goral population. The CDA may need to control some predators during the fawning and lactation period through trapping or shooting. This program can be terminated later when goral populations increase. The CDA
has live traps; thus this operation may cost as little as Rs. 2,000 (US $100).

Recreational use fees

Although no visitor surveys have been conducted in the MHNP, approximately 100,000 people visit the park annually. These visitors come from the city of Islamabad, as well as other areas of the country. Currently no entry fee is charged to visitors to the park and to the small zoo adjacent to the park. More visitors can be attracted by developing various recreation facilities in the park.

The majority of the park visitors are seen along the scenic view points and hiking trails. Currently, there are only six or seven view points and a few hiking trails in the park. Sites of especially scenic value or with enduring scientific, geologic or other values should be identified and more view points and trails for visitor use developed by the CDA. Picnic sites and camp sites should also be developed. There are three rest houses in the park rented to the public for overnight use. Additional cabins and huts can be constructed for tourist and visitor use. The park can be divided into areas of low and high sensitivity to human impacts. Areas which are important for such wildlife habitat as goral, barking deer, and cheer pheasant, should be grouped into highly sensitive areas. All facilities
should be constructed outside the sensitive areas to avoid disturbance to these animals. Park managers should be aware of potential conflicts between wildlife and visitors while developing these facilities.

An entry fee, for example Rs.10 (US $0.50) per vehicle and Rs. 2 (US $0.10) per pedestrian, could be charged park visitors. Fees of Rs. 20 (US $1.00) and 40 (US $2.00) per person could be charged for overnight use of camp sites and tourist huts and cabins, respectively. Guided tours could also be provided on hiking trails to remote park areas. Park visitors will boost the local economy where local people can sell products such as milk, eggs, and poultry to the visitors. This will in turn reduce human impact on park resources by providing them alternate income sources.

With effective implementation of the goral management plan, their populations in future may increase to the level where limited hunting may be possible. This will also earn revenue for the park. Currently, limited hunting is allowed for Sind ibex in the Kirthar National Park where an amount of Rs. 5,000 (US $250) is charged resident hunters and Rs. 10,000 (US $500) foreigner hunters for one animal. The total population of ibex in the Kirthar National Park is 4,000 animals, and 20 head were allowed for hunting in 1985 (Kermani and Khan 1985).
Research needs

I tried to collect as much information on the biology and ecology of goral as possible. My analysis indicates that some aspects of their biology need further study. Mead (1989) has urged the need to study this endangered species in its native habitat.

Data on specific food items of goral and their nutritional value are lacking. Nutritious food is very important during reproduction and lactation of females. Studies have shown that overgrazing by livestock may force wild ungulates to feed on less-preferred plant species which can affect their health. This becomes critical during spring when females are pregnant, during summer lactation, and during the fall when the young are growing (Mackie 1978). In addition to direct mortality due to predation and poaching, nutritional deficiency may be a factor contributing to slower population growth in goral.

Studies such as nutritional analysis of goral forage, population size and composition, and any change in their range of distribution in the MHNP are needed. Data on visitor and resident population pressure such as recreation, wood cutting, and poaching should also be collected. Currently, no data are available on goral diseases in the MHNP. Studies on goral diseases should also be conducted because diseases may be one of the causes of the slow
increase in their populations. All this information along with reproduction data will give an indication about annual increase in goral populations. These studies may cost Rs. 100,000 (US $ 5,000) annually.
Policy and management

The protection and management of natural habitats and ecosystems is essential to preserve the national heritage of Pakistan and its natural flora and fauna. At present, natural areas can only be protected through legal designation of the land as nature reserves, national parks and wildlife sanctuaries. In Pakistan, 6 national parks, 72 wildlife sanctuaries, and 76 game reserves have been established. Most of the other natural areas have been lost and it is difficult to bring those back to their original state. Thus, the only option at present is to protect and manage the remaining areas of wildlife habitat.

A national park in Pakistan is conceptually an area of outstanding scenic and natural interest where flora and fauna are protected and preserved in their natural state. These areas are available for public recreation, research, and education. In Pakistan, there is no central park service or federal agency responsible for all areas, and these parks are managed by individual agencies. Each department has its own policy of park management, with apparently little inter-agency coordination (Rao 1986). Lessons can be learned from wildlife protection and management policies in other countries such as the USA and Canada.
Wildlife conservation on public lands in North America is based on the primary policies of 1) no legal markets for meat, parts, and products of game animals, or shore and song birds, 2) allocation of wildlife benefits by law and not by social status, ownership, birthright, or market place, which makes the public shareholders in this valuable natural resource, and 3) the prohibition on frivolous killing of wildlife (Geist 1988).

As a result, there was an increase in wildlife populations and economic return from them through a large service and manufacturing industry based on living wildlife. Moreover, a conservation attitude was developed in the public, many conservation societies were established, and a national park system was created. Later, teaching and research institutes for the advancement of wildlife were established. On the other hand is the German wildlife conservation system which is based on paid hunting and needs markets for venison. This system encourages poachers and needs comparatively extensive and expensive system of protection for wildlife. It has proved to be a poor conservation system, and is struggling to exist as hunting has become less popular in Europe (Schroeder 1986).

The government of Pakistan should adopt the North American conservation strategy and strongly enforce the already existing laws that prohibit the trade and export of any wildlife species or their products. Pakistan simply
cannot afford an expensive wildlife protection system in a society where poaching already exists. Any markets for wildlife parts and products in the country should be strictly banned. Every citizen should be given the same right to benefit from wildlife and made to realize that they are shareholders in this national resource. They will then better cooperate in the protection process.

One option for Pakistan is the establishment of a central park service. Presently, national parks are under the respective provincial governments which are also managing wildlife in the sanctuaries and reserves. The new park service should manage wildlife in all national parks as well as migratory wildlife species. This park service can better coordinate with international agencies for migratory species management. As national parks in Pakistan were basically created to save wildlife, especially endangered species, the central park service will be able to carry out research and management of these species in better way. Being a federal agency, it will be easier for the service to get funding and expertise from international conservation agencies such as the WWF and the IUCN. It can also set the hunting regulations in national parks by looking at overall status of wildlife species in the country. The revenue from hunting in the national parks should go to the central park service and from sanctuaries and reserves, to the provincial wildlife departments.
The NCCW can be given this responsibility. Initially, the management personnel working in the country's national parks can be pooled under the new park service. This will add little additional cost to the government. More staff can be added to the service as needed in the future. In this way, the management of national parks and reserves will be more coordinated and systematic. As Grobler (1984) observed "A coordinated systematic approach to planning for management of conservation areas has become essential with the increase in our knowledge of natural systems, and of man's influence on them". Federal oversight with local management will provide the consistency necessary to ensure that nature reserves, national parks, and wildlife sanctuaries are the show place for Pakistan's natural treasures.

National parks and reserves can be managed either for state values (manage for what is present) or for the natural process. In Pakistan, the population density is about 130 persons per square kilometer and it is difficult to find any area unaffected by humans. Currently, the national parks of the country are no exception. Therefore, it is difficult to manage these areas for natural processes in the presence of human influence.

The second option will be to manage the parks for their state values. Here, human presence can also create problems. It is difficult economically as well as socially
to relocate people from parks because they have been living there even before these areas were designated as national parks. I propose that in Pakistan, the parks should be managed for state values by incorporating local people into the process. An example has been set by the Sind Wildlife Management Board in the Kirthar National Park near Karachi. This same strategy can be successful in other areas with effort, and careful planning.

Apart from the management of existing natural reserves, more areas should be designated as parks and reserves. The Zoological Survey Department has responsibility for identifying these areas after careful survey of wildlife and their habitats in Pakistan. Establishment of these areas will help to save remaining wildlife habitat and promote healthy populations of wildlife species in the country. After these areas are recommended by the Zoological Survey Department, the government should bring those areas under the umbrella of legal protection.

**Education**

Education is the key to conservation efforts. At present, the attitude of the public living in and around the national parks is unsympathetic. Although efforts are being made to educate people about conservation, the results are far from satisfactory. These efforts include an
environmental education program by the WWF-Pakistan. This program involves school children, teachers, interest groups, and professionals. Lectures, video and slide shows, field trips, and materials about conservation are presented to these groups for their awareness of conservation (Kabraji 1986).

The overall aim of conservation education should be to change people's ideas with respect to nature and to teach them the proper treatment of natural resources so that they are not depleted. Much needs to be done to change public attitudes toward the use of wildlife and other natural resources.

The first step should be to teach the educators. The NCCW should request the WWF or the IUCN to provide experts in conservation education and should arrange a training course for university and college teachers with the help of these experts. These teachers can then start training courses for school teachers and conservation agency personnel in their respective regions. These courses should highlight the methods and materials for conservation education. Primary schools are the best places to start. Children should be made aware of the importance of conservation through lectures, field trips, and videos. Courses about the conservation, preservation, and protection of wildlife should also be included in the school curriculum and taught up to matriculation classes.
Each provincial wildlife department should start an extension program. Movies and slides on different wildlife species should be prepared and shown in schools, colleges, and public places. Wildlife movies from other countries can also be imported and dubbed in Urdu to create public interest in wildlife. The NCCW should arrange to show these movies on national television. Brochures, pamphlets, and small booklets containing information about wildlife species should be prepared by local conservation agencies with the help of WWF-Pakistan. A monthly magazine publishing articles on wildlife should be started by the NCCW.

A radio program about the importance of wildlife and other natural resources should also be started. This can be a very effective medium because people even in remote villages can listen. This means of conservation education has proved very useful in Nepal, where in response to this program, people from remote villages write letters and comment on these programs. People from one area even wrote a petition to establish a national park in their area (Dhungel 1982). Seminars and lectures on research and management of wildlife should be arranged by universities and research institutes with the help of conservation agencies.

A staff of professional wildlife researchers and managers should be trained. Currently, only the Pakistan Forest Institute (PFI), Peshawar, is offering courses in
wildlife management. No academic institution in the country offers a degree in wildlife biology and management. One reason for this might be that there are no job opportunities for wildlife biologists. Wildlife management agencies should create jobs for wildlife biologists, which will encourage universities to start degree programs in this subject. More students should be sent abroad for training in wildlife research and management. These personnel can serve as teachers at local universities after returning to the country and can also carry out research studies on different wildlife problems. In addition, conservation education programs can play a key role in wildlife management and other conservation efforts.

Legislation

The protection of wildlife against illegal killing is necessary and becomes even more important when people live in close proximity. Before 1960, wildlife legislation in Pakistan concerned only hunting of game species and protection of timber. As a result, many wildlife species were extirpated and many more have been listed as endangered. In 1981, this legislation banned the killing, hunting, capturing, and export of many wild mammals, birds, and reptiles in the country. The law still does not address such issues as habitat protection and introduction of exotic species. Law enforcement is also very weak. As a result,
the populations of many wildlife species are still decreasing.

Today, the most common threats to wildlife in Pakistan include hunting and collection (for sport, food, trophies, skins, medicine), killing of endangered predators considered to be pests, competition with livestock for limited food and habitat, and deforestation, brush clearing, and other kinds of habitat destruction (Rao 1986). These acts should be strictly prohibited or regulated. The government should improve the present wildlife laws and give full protection to wildlife species and their habitat by imposing fines on illegal hunting and habitat destruction. Hunting regulations are set by the concerned agencies. But hunting permits in these areas tend to be issued depending on local influence rather than based on sustained yield (Rao 1986). This is a weak point in giving protection to wildlife in reserves.

Law enforcement will be much more effective if wildlife wardens are given more authority. This is already being practiced in Punjab, where wardens have been given magisterial powers. These officials will be able to charge the fines at the time of arrest instead of going to court and waiting several years. They will also be able to arrest poachers and persons involved in other illegal activities. The Army also can be called to help protect wildlife when and where needed. In the USA, the US cavalry protected
wildlife in Yellowstone and other parks from 1886 to 1918 (Hampton 1971). Legislation should also be provided to establish new conservation areas. All other efforts to manage wildlife species will be in vain without providing strong, legal protection to these species.

**Research and management plans**

Wildlife species themselves need proper management in addition to all other efforts. Because of the lack of sufficient funds and scientific staff, management plans for only a few wildlife species and natural areas could be developed initially. Each wildlife department (federal and provincial) should begin to develop management plans for the areas under their control. Because no wildlife species can be managed properly without basic scientific knowledge, they can cooperate with universities and research institutions for technical help. Students of wildlife science can be of great help for the inventory of these areas. The wildlife departments can provide funds for these studies where students can work for the agency as well as for their theses. Agencies can also employ students after they finish their degrees.

A volunteer conservation corps consisting of students from colleges and universities could be started. Because it is very difficult for students to get jobs, they will be happy to work for these agencies during summer vacations.
only for living expenses. If properly arranged, these corps will be very helpful in the development and management of the national parks and reserves.

In addition to this, wildlife management agencies should develop their research, educational, management, and law enforcement staff. The research and management personnel should clearly understand the objective of establishing a park or reserve. These areas should be thoroughly inventoried for wildlife and other natural resources. Management programs should be developed by the agency officials based on this information. The government should also initiate an awards program for outstanding performance in the field of wildlife research and management to encourage personnel in this field.

**Funding**

Few nationwide programs are possible without funds. Money is needed for habitat management, law enforcement, education, and research. Federal and provincial governments are the major source of funding for these programs. The government should recognize wildlife conservation in its annual economic planning by providing at least one percent of the National Budget for wildlife and forestry.

Presently, international organizations such as the WWF, the IUCN, the WPA, and the United States Fish and Wildlife
Service are funding various wildlife projects in Pakistan. These agencies could be convinced to provide more funds if sound research and management proposals on important and endangered wildlife species are developed and presented to them. Some private organizations, like the Pakistan Wildlife Conservation Foundation, are also making efforts to collect money from their members and private industries for wildlife research and management. Wildlife exhibitions and postal stamps can also generate some money. But much more effort is needed to protect Pakistan's wildlife and natural resources for future generations.

Wildlife conservation is a long process which may take decades. At present, the most important need is to protect wildlife and their habitat. Therefore, more effort and funds should be allocated for this activity. After a period of years, we may need funds for further research and transplant studies of some wildlife species. More money and man power can then be allocated to that activity. Meanwhile, a few big game species may increase in number to the level where limited hunting can be allowed. The revenues from hunting in national parks will go to the central park service and from sanctuaries and reserves, to provincial wildlife departments. These agencies then can spend this money for further development of the parks and reserves. Initially, management in national parks and reserves should be started with present available staff and
funds but in more systematic and organized way by allocating funds for high priority tasks.
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