B.K. Sharma
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Asad R. Rahmani *Editors*

# Faunal Heritage of Rajasthan, India

## Conservation and Management of Vertebrates

Volume 2

Springer

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*I hold that, the more helpless a creature,*
*the more entitled it is to protection*
*by man from the cruelty of man.*

Mahatma Gandhi*

**Mohandas Karamchand Gandhi, popularly known as Mahatma Gandhi or Bapu (Father of Nation), was an iconic leader of the Indian freedom struggle during 1917–1947 who uprooted the British rule and led India to Independence by employing nonviolent civil disobedience and civil resistance which he called Satyagraha (Satya in Hindi meaning "truth" and Agraha meaning "insistence"). He deployed the philosophy and practice of Satyagraha in the Indian Independence Movement. Mahatma Gandhi is known to have greatly inspired movements for nonviolence, civil rights, and freedom across many parts of the world, the most famous being Nelson Mandela's struggle in South Africa under apartheid and Martin Luther King Jr.'s campaign during the civil rights movement in the United States.*

*Vivid memories of childhood still gleam in my heart, when he taught me English grammar even while running in his late 70s. His spirit to fight with odds gives me strength and incessantly inspires me to never give up. He actually laid the foundation for my academic pursuits, as the values instilled by him breathe in me and his profound persona enlightens me in the midst of challenges even today. His journey of life proved that quest for knowledge coupled with hard work and passion can only give contentment and helps us realize our dreams. This effort is a reflection of that passion which might have silently got passed from him to me!*

*With reminiscence, I dedicate this volume to one of the best English teachers of his times and the founder Principal, Shri Khandelwal Vaish Central Senior Secondary School, Station Road, Jaipur, my grandfather (Late) Pt. Jai Nath Sharma (1892–1979).*

7 July, 2013

Dr. B.K. Sharma,
Chief Editor

# Foreword

The contents of this diligently edited work enrapture me. They have an intimate link not only with my core subject of Zoology but also other areas of my interest as Secretary of the Zoological Society of London (ZSL) responsible for London and Whipsnade Zoos, the Institute of Zoology and our worldwide conservation programs. Fauna have always attracted me as an avid observer, interpreter, and reader; the present volume wonderfully describes and analyzes the vertebrate faunal abundance of Rajasthan, currently the largest state of the Indian republic.

Being home to the most exotic biological diversity, splendid ecosystems and colorful cultural heritage, Rajasthan has fascinated researchers, conservationists, academics, travelers, and tourists from around the globe. I am particularly impressed with the fact that through this well-researched work, the editors have achieved an extraordinary accomplishment not only in further unveiling the well-known Thar or Great Indian Desert but also putting in the spotlight the much lesser known yet ravishing wilderness, communities, lush green landscapes, and wetlands of Rajasthan. More than 600 illustrations are a direct testimony to this. These two volumes are an assemblage of what is bound to become some of the most sought after chapters and brilliantly

synthesized scientific information available. The content of this monumental yet modern faunal treatise will surely make it a distinguished contribution to knowledge in the area of faunal ecology and conservation. The first book (Volume-1) entitled "*Faunal Heritage of Rajasthan, India: General Background and Ecology of Vertebrates*" in its 24 chapters covers a spectrum of vertebrate fauna of the region. Individual chapters dedicated to threatened faunal species are of special significance in the contemporary setting. The second book (Volume-2) entitled "*Faunal Heritage of Rajasthan, India: Conservation and Management of Vertebrates*" aptly describes the conservation- and management-related aspects spread over 20 chapters.

This publication will be highly appreciated since there is no comparable account currently available. I am delighted to find that the physiographic and biodiversity profile of Rajasthan, conservation strategies covering a vision on the future of the fauna of Rajasthan, and information that fills significant gaps in research each find a bold presence in these superbly edited volumes. In addition, separate chapters on ecotourism, community conservation, and wildlife trade covered in Volume-2 will be useful resources, introducing concurrent themes for researchers interested in this part of the world. The editors have effectively revised the image of the Thar from that of merely a desert to a more vivid landscape housing some of the most resplendent and majestically unique fauna and flora.

The opening chapters of the first volume provide a well-focused introduction to Rajasthan as a vivacious state of India. The historical, sociocultural, mythological, and anthropological aspects of faunal conservation and the tribes of Rajasthan together with the fossil records set the scene for the book. I am certain that this work will serve not only zoologists, wildlife biologists, conservationists and natural scientists, and social scientists but also the general reader. Students, teachers, and active researchers on wildlife and conservation biology will find these volumes particularly valuable as an important reference and textbook. Although, there are many lacunae in our knowledge about faunal ecology and its conservation, this formidable twin volume set will surely help in bridging the gaps, while enabling conservationists and policy makers to arrive at a consensus regarding future strategies in Rajasthan. The editors have superbly compiled the latest information on both the ecology of Rajasthan and the conservation of the region's myriad vertebrates.

Today, when mankind has encroached, exploited, and decimated the natural habitats of our planet, and we find ourselves in the midst of impending environmental calamities, these volumes will spur a sense of responsibility towards nature; they deserve to create mass awareness about sustainable development, conservation, and management of our forests, wildlife, and natural resources.

I extend my hearty congratulations on the publication of *Faunal Heritage of Rajasthan, India* as two separate yet closely linked volumes. I further take this opportunity to congratulate wholeheartedly the dynamic chief editor Dr. B.K. Sharma, for it was he who conceived, carried forward, and delivered this massive work. I wish him further good fortune in his academic and professional endeavors.

March 21, 2011

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# Preface

Today, when the ecosystems of the planet Earth are fast changing and habitats of wildlife are being rapidly destroyed due to unsustainable development, the present edited volume is expected to give a bird's-eye view of the state of fauna in Rajasthan. Like other parts of the globe, Rajasthan, too, has faced rapid climatic changes recently; flooding in the desert being the most striking phenomenon. It is well known now that many plant and animal species are disappearing from the face of the earth at an alarming rate, some even without being discovered or known. In this situation, when it is widely believed that human activity is largely responsible for this inhuman destruction, should we not make consented efforts to modify human behavior and limit population growth for sustainable biodiversity? In fact, the inordinate exploitation and prodigal wastage of natural resources that preceded and followed establishment of a materialistic and so-called prosperous civilization has put a question mark on the existence of both wildlife and mankind. Rajasthan and India are no exceptions, as similar conditions have existed in the past in western countries when forests were massively cut down, water sources were polluted, wildlife was ruthlessly hunted and livestock was exterminated to meet the demands of the moment without thinking of tomorrow. Eventually, it was felt that if strict measures to save the environment from human tempering were not taken, all of this pollution and waste may inevitably pose a serious threat to the very existence of man. Actually, such a fear has compelled us to take time out of the blind race for material gains and look into this issue on priority. This attitude subsequently paved way for massive environment and conservation-related studies.

With only 2.4% of the world's land area but with 16.7% of human population and 18% of its livestock, India contributes about 7% of Earth's known biodiversity. India is home to world's largest tiger population and has a unique assemblage of globally important endangered species. Wildlife conservation and management in India is currently facing a myriad of complex issues that are both ecological and social in nature. Issues such as habitat loss and/or fragmentation, overuse of biomass resources in the context of biotic pressures, increasing human-wildlife conflicts, livelihood dependence on forests and wildlife resources, poaching and illegal trade, and the need for maintaining a broad base of public support for wildlife

conservation exemplify and characterize the contemporary wildlife conservation scenario in India. The government and the civil society are taking several measures to address these issues. Improved synergy and better coordination amongst the wide array of stakeholders are needed to meet the challenges of conserving India's wilderness. These and other conservation management related aspects apply to the other states of the country too, though with a varying degree depending on the physiographic and other features.

A network of 668 protected areas (PAs) exists in India as of today and the output of such massive in-situ conservation effort in restoring a viable population of large mammals such as tiger, lion, rhinoceros, crocodile, and elephant has been significant. There are four categories of the Protected Areas (PAs) namely, National Parks, Wildlife Sanctuaries, Conservation Reserves and Community Reserves. The Ministry of Environment and Forests (MoEF), Government of India provides financial assistance to the State/Union Territory Governments for protection and management of the PAs under three main Schemes viz., Integrated Development of Wildlife Habitats, Project Tiger and Project Elephant. Formation of the *State Compensatory Afforestation Fund Management and Planning Authority* (State CAMPA), intended as an instrument to accelerate activities for preservation of natural forests, management of wildlife, infrastructure development in the sector and other allied works, is one of the major conservation initiatives by the MoEF. The State CAMPA would undertake compensatory afforestation, assisted natural regeneration, conservation and protection of forests, infrastructure development, wildlife conservation and protection and other related activities and for matters connected therewith or incidental thereto. The state forest department is responsible for the management of forests and wildlife in the state. It implements three major acts, viz., Rajasthan Forests Act 1953; Indian Wildlife (Protection) Amenment Act, 2006 and Forest (Conservation) Act 1980. The various activities undertaken by the department include forest protection, forest development works, wildlife management, soil and moisture conservation works, forest planning, harvesting, ecotourism activities, research, extension and training.

Conservation landmarks of the state cover 2.80% (9,121.61 sq km.) of the total area with three national parks namely, Keoladeo and Ranthambhore and the recently notified Mukundra Hills; 26 wildlife sanctuaries (WLS); four conservation reserves; two eco-sensitive zones; two Ramsar Sites (Keoladeo National Park [KNP] and Sambhar Lake); one proposed biosphere reserve (Desert National Park [DNP]); two tiger reserves (Sariska Tiger Reserve and Ranthambhore National Park); five zoos/zoological gardens at Jaipur, Udaipur, Bikaner, Kota and Jodhpur; one private zoo at Panchwati, Pilani; two biological parks; 10 safari parks/deer parks; and 24 Important Bird Areas (IBAs) as identified by Bombay Natural History Society, Mumbai, India. KNP and Sajjangarh Wildlife Sanctuaries are the walled protected areas (PAs) while the National Chambal Water Sanctuary is a ravine system. On the other hand, Taal Chhapar and Gajner Wildlife Sanctuaries in Churu and Bikaner districts are the PAs of the arid zone. On May 17, 2013, the State Wildlife Board, Department of Forests, Government of Rajasthan has declared Jeenmata (Sikar district), Mansamata (Jhunjhunu district), Grass-farm Nursery (Jaipur district) and Mokhla (Jaisalmer district) as new conservation reserves. The board also decided to

increase the forest area of Sawai Mansingh WLS (situated near Ranthambhore Tiger Reserve) to 4137.40 ha; of Kailadevi WLS to 9624 ha; of Sariska Tiger Reserve to 39816.98 ha and of Bassi WLS to 5396 ha. 86.26 km sq revenue area of Todgarh-Raoli WLS and some area of Ramgarh WLS which falls under the Bundi city will be excluded. It is interesting to note that majority of PAs of Rajasthan initially came into existence as hunting reserves and private zoos of former kings and royals. *Shikar* (hunting) was a favorite sport of the erstwhile rulers which always found a place in the itinerary of visiting viceroys and British officers in the pre-Independence era. Royal families in Rajasthan also owned private zoos, most of which were taken over by the government following independence and later developed as wildlife sanctuaries and national parks. Governed by the National Tiger Conservation Authority (NTCA, formerly "Project Tiger"), the tiger reserves of Rajasthan are of global significance. Following a ruling by the Supreme Court of India and subsequent orders issued by the Central Government, tourism activities will now be shifted from core areas of National Parks to buffer areas. To this end, a tiger safari will be created at the Olwari-Niwari forest area of Ranthambhore Tiger Reserve and Nahargarh Biological Park.

The faunal richness of Rajasthan encompasses 140 species of fishes, 14 amphibians, 67 reptiles (including eight endangered reptiles and five falling under Schedule I of the Indian Wildlife [Protection] Amendment Act, 2006), 477 birds (including six Critically Endangered, Five Endangered, 12 Vulnerable, 19 Near Threatened, 14 Red Data and one Conservation Dependent species as per IUCN Redlist of Threatened Animals) and 87 species of mammals (including seven of Endangered mammals and 10 species falling under Schedule I of the Act.

The religious beliefs and socio-cultural traditions of the people of Rajasthan have contributed a great deal to the preservation of wildlife. Temples dedicated to various animals are a strong testimony to this, indicating the faunal linkages of the people, whereas birds such as *Kurjan* (Demoiselle Crane), Parakeet, Indian Peafowl, and House Crow are favorite themes of the Rajasthani folk music since time immemorial. *Bishnois* of Rajasthan stand apart from countless other sects and communities in India for their commitment to protect wild plants and animals. Amrita Devi, a *Bishnoi* lady who along with 363 villagers was martyred in the year 1730 while trying to stop tree-cutting by men of the then-ruler at the Khejadi village near Jodhpur district, is a burning example of the passion of *Bishnois* toward biodiversity conservation. Saako-363 Amrita Ki Khejadi (Hindi: साको - ३६३ अमृता की खेजडी) is an upcoming Hindi movie produced by Suraj Bishnoi and directed and written by Kalyan Seervi under the banner of Shri Maruddhara Films Pvt. Ltd. This film is based on the true story of Amrita Devi – a Bishnoi woman who fought with and revolted against the Deewan (Chief Minister of the Ruler) of the then *Jodhana* realm and his men to save Mother Nature and to particularly protect the ambient flora and fauna in her locale, *Khejarli* village near Jodhpur. Planned to be shot in Rajasthan, the movie has the famous Bollywood actress Gracy Singh as the main lead and is expected to release in December 2013. The story is about a fearless woman's trials and tribulations to save the environment, a topic so relevant in the present times. The makers of the movie who belong to the Bishnoi Community have added a special clause in the film agreement whereby the cast and crew have been asked to abstain

from non-vegetarian food and alcohol till the shooting is completed. The ethics of conservation nurtured by saints and spiritual teachers such as Guru Jambheshwarji, the great environmentalist of the fifteenth century, are deep-rooted in the religions and culture of Rajasthan. Unfortunately, the current generation seems to have been distancing from religious ethos and values regarding zoolatry.

Biotic pressure continues to be one of the most important conservation problems in Rajasthan. Other prominent conservation issues include encroachment and mosaic human settlement inside PAs; scarcity of surface water, exotics and weeds; destruction of grasslands; drought; pollution; myths and zoophobia; mining; habitat loss, habitat alteration, habitat fragmentation and loss of eco-corridors; the presence of canals, roads, railway track and electricity lines inside of PAs; *Aida* (tribal treat)—a communal *shikar* (hunting) operation in the Udaipur– Rajsamand–Bhim area; wells and water-storing tanks without parapet wall inviting accidents of wild animals and incorrectrescue practices. For example, starred tortoises are unfortunately thrown in water in the name of rescue, ultimately killing these non-aquatic reptiles. Poaching records of Wildlife Flying Squad (eastern zone) reveal 383 cases during 1974–1975 and 1997–1998. In addition, as many as 51 tribes/communities were found indulged in these heinous offenses. This is the reason editors have added a separate chapter on tribes [Ch.4. In: Faunal Heritage of Rajasthan, India: General Background and Ecology of Vertebrates Volume-1. Sharma BK et al. (eds.), Springer, 2013.].

The state of Rajasthan is under the clutches of further desertification due to the ongoing climate crisis, already existing xeric ecosystem, fast pace of urbanization, mining, oil extraction and nuclear tests. On the other hand, the Indira Gandhi Irrigation Canal Project has completely changed the landscape in some regions of the Thar Desert. Fauna in the rest of Rajasthan are dwindling in population due to habitat loss and habitat fragmentation. Tremendous ecological changes are believed to have taken place in Rajasthan, especially in the Thar, due to the development of the 649 km long Indira Gandhi Nahar Pariyojna (IGNP) in Bikaner, Jaisalmer and Jodhpur districts and heavy afforestation activities.The habitat, cropping pattern and avian spectrum has drastically altered in many pockets. If proper conservation measures are taken, this canal can benefit both humans and wildlife. However, incorrect agricultural and water-use policies are putting desert life at a great risk. In addition, the expansion of agriculture and decreasing availability of surface water, especially in the northern Rajasthan has considerably affected the faunal abundance, replacing the native xeric elements by mesic forms. It is clearly felt that establishment of the Desert National Park (DNP) in Rajasthan by Indian government has positively affected wildlife in addition to promoting international tourism. Apart from its strategic importance for Indian defense, the park attracts a large number of investigators from the realms of zoology, botany, agriculture, sociology, geology, geography, non-conventional sources of energy and pedology. Though deficient in water resources, the DNP has rich mineral deposits, oil and natural gas. However, expansion of settlements on account of increase in human population, uncontrolled tourism and over-exploitation of natural resources may prove detrimental to the park. Another major threat is the proposal to build a canal that will bisect the park and bring many ecological changes. The unparalleled floral and faunal diversity of

the DNP not only provides a rich feast to the ecologists and historians but also shows the intricacies of a natural ecosystem. The DNP is perhaps among the most unique parks in the desert region of the world. Proper management plans for the DNP and surrounding PAs are imperative for the conservation management of Rajasthan's wildlife.

The Eastern Plains are famous for Keoladeo National Park (KNP), the only World Heritage site in Rajasthan and home to thousands of migratory avifauna and other rare and endangered animals. Unfortunately, the Siberian Cranes stopped visiting the area in 2003. Southern Rajasthan harbors mammalian fauna such as the Mouse Deer or White-spotted Chevrotain (*Tragulus meminna*), Common Palm Squirrel (*Funambulus palmarum*) and Elliot's Giant Flying Squirrel or Large Brown Flying Squirrel (*Petaurista philippensis*) which are not found anywhere else in Rajasthan. Despite being rich in biodiversity, this part is fighting to save its large number of wetlands and dense forests due mainly to unsustainable development and excessive human encroachment. The River Chambal has Gharial (*Gavialis gangeticus*), Marsh Crocodile or Mugger (*Crocodylus palustris*) and Gangetic River Dolphin (*Platanista gangetica*) apart from a variety of fishes. Mass mortality of *Gharial* in Chambal has recently shocked both conservationists and common men. The presence of Wild Dog or the *Dhole* (*Cuon alpinus*), also known as the Asiatic Wild Dog, Indian Wild Dog, or Red Dog and Wild Ass (*Equus hemionus khur*) also called Khur continues to be doubtful in Rajasthan. Two major carnivores, the Asiatic Lion *Panthera leo persica* and the Asiatic Cheetah *Acinonyx jubatus venaticus* became extinct during the last 65–100 years. Moreover, escalating human population and the resultant expansion of rain-fed cropping has resulted in shrinking grazing area for wild herbivores. Furthermore, overgrazing by livestock (their number being much above the carrying capacity of arid land) has almost reversed the natural vegetational succession leaving very little edible plants for the fauna in wilderness. As a consequence, the overall number of larger species is fast declining and that of smaller ones such as destructive rodents and insect pests is increasing. These facts point towards a dire state of affairs as far as conservational planning of the state is concerned.

On the other hand, continuous mining activities (Rajasthan has near monopoly with respect to mineral wealth and large deposits of stone) are posing a serious threat to the Aravalli Ranges and thus, to the faunal species present in this area. The Aravalli Ranges and its dry deciduous forests provide shelter to the threatened fauna such as the Sloth Bear (*Melursus ursinus*), Grey Wolf (*Canis lupus*), Striped Hyena (*Hyaena hyaena*), Leopard or Panther (*Panthera pardus*) and a variety of cats. The destruction of the Aravalli Ranges due to mining is having a negative impact on the ecosystem and wildlife.

We are also not able to save the wetlands and lakes of the state which are either dried or vanished and are never filled in their full capacity. The Sambhar Lake, a Ramsar Site of the arid zone, is continuously deteriorating and is being visited by only a few hundreds of wintering migratory birds such as the Greater and Lesser Flamingos (*Phoenicopterus roseus and Phoeniconaias minor*) since last decade while some of the other rare birds have stopped visiting the lake altogether due to

drastic shrinkage in the water spread. Likewise, the White-naped Tit also known as the White-winged Tit (*Parus nuchalis*) has completely disappeared from some pockets of the state. This has happened due to the callous attitude of administration towards the existing threats to its conservation. If proper conservation measures are taken, other wetlands of the state can greatly benefit both humans and wildlife. On the occasion of World Wetland Day (February 4, 2012), the Ministry of Environment and Forests (MoEF), Government of India's indications toward reviving Siberian Crane breeding project at KNP is a welcome first step for the conservation of this magnificent migratory bird which altogether stopped visiting the park in 2003. The MoEF plans to develop this project in association with the WWF-India and International Crane Foundation. On the same lines, the MoEF has plans to revive and conserve Sambhar Salt Lake, which is spread over an area of 225 sq km. Illegal salt extraction, mining, encroachment, anicut formation and drainage has caused severe shrinkage of the lake reducing its area to 100 sq km. during past decades. The tourism department, Government of India has recently decided to develop Sambhar Lake as a tourist spot which is again a welcome first step towards the conservation of this ancient lake.

Things were in a bad shape from 1980–2000 so far as implementation of wildlife laws is concerned. This was a crucial period for wildlife, particularly for the carnivores and schedule I animals due to the heavy demand from western countries for fur, skin, bones and other body parts. A separate chapter mentions some of the infamous wildlife crimes and notorious smugglers from the state which have attracted both national and international attention namely, Sansarchand and Shabeer Hasan Qureshi—both international wildlife smugglers responsible for the poaching of hundreds of tigers, leopards and other endangered wild animals including a variety of small cats, pangolins and porcupines. This chapter also describes the ensuing Sariska debacle, trade of critically endangered animals like Peregrine (resident species) and Shaheen Falcon (migratory species) in Jaisalmer district, recovery of 250 kg of elephant tusks (ivory) in Jaipur, film star Salman Khan's case of Blackbuck and Chinkara killings in Jodhpur district and Kaliya Bawaria case—a tribal who killed large number of leopards in Rajasthan. The chapter also mentions flaws and loopholes in the laws, taking advantage of which maximum number of accused are discharged even after following long legal battles. Indiscriminate cutting of the state tree *Khejadi*, parts of which have been recently found to be effective in the treatment of cancer. is another serious problem.

After the shocking news of January 2005 that no tigers are left in Sariska, the Government of Rajasthan in cooperation with the Government of India and the Wildlife Institute of India (WII) planned re-introduction of tiger which was accomplished in three stages, i.e., in June 2008, February 2009 and July 2010. At present, five tigers - two males and three females - are dwelling in the reserve. The state of affairs at Ranthambhore National Park is also worrying wildlife lovers and conservationists. Tigers leaving their protected territory to reach faraway places has given a hard time to forest guards with six of them leaving the park during recent years to inhabit other forests far and near. The death of tigers following territorial fights resulting from shrinking forest cover and human encroachment has now become a

serious concern. Nine tigers have been killed during the past four years. It is worthwhile to mention here that this book is covering in an altogether separate chapter, the first hand account of the historic tiger re-introduction in Sariska written by the scientists and forest officials who were actually involved in the entire operation. It is a sigh of great relief that, besides 26 adult tigers, 25 cubs born during January, 2011 to June, 2012 currently inhabit the Ranthambhore Tiger Reserve.

Besides, there exist a number of still-unexploited potential ecotourism sites boasting dense forests rich in biota, natural scenic beauty, waterfalls and monuments including palaces, forts and temples. Hadoti region and Abu Hills of southwestern Rajasthan are key examples which are likely to attract thousands of native and international tourists, naturalists and researchers. Rajasthan has extensive wetlands too. In addition, the traditionally conserved *Orans* and *Gauchars*, or common property reserves, and the age-old water conservation structures are also indicative of the wise use of the limited natural resources since ancient times. This volume also analyses the biodiversity protection of the Thar Desert by its village institutions and their immense utility as the common pool resources to rural population. These village institutions are *Gaucher, Oran* (common property), fallow lands, plough fields, sand dunes, forest enclosures, gravel lands, wasteland and agriculture land. Approximately 5.6% of total land area is covered by these village institutions and they support the faunal diversity and its conservation in a great manner.

The state forest department is currently playing an important role in the conservation of rare and endangered wild animals and "Village Displacement Schemes" in and around Protected Areas. As most of the biodiversity-rich dense forest areas are situated in and around the wildlife sanctuaries and national parks, efforts have been made to reduce the biotic pressure caused by the human settlements. The end result of such biotic and anthropogenic pressures is reflected as everyday conflict between wildlife managers and local villagers. In a bid to handle this tension and competition, buffer zones lying close to protected areas are being developed so that the dependence of locals on these areas for various reasons e.g. fodder and fuel wood etc. could be minimized. Apart from this, habitat improvement programmes, development of water bodies, food resources and roads/passages inside forests are being undertaken in these rapidly declining wildlife-rich areas. The major efforts completed or proposed by the state forest department from 2009–2011 include: deployment of ex-army personnel and home guards in Ranthambhore and Sariska Tiger Reserves to strengthen security; displacement of villages from Ranthambhore and Sariska Tiger Reserves and Karouli buffer zone; water restoration to the World Heritage Keoladev National Park via Goverdhan Drain and Panchna Dam; establishment of "Tiger Conservation Foundation" for Ranthambhore and Sariska to facilitate ecotourism activities and other eco-development programmes like water-harvesting projects, eco-corridors at Sawai Mansingh and Kailadevi Wildlife Sanctuaries, especially created for tigers to stop territorial fights; management of wildlife outside protected areas targeting the satellite wetlands of the Thar Desert and Keoladeo National Park, development of Kumbhalgarh and Hadoti as potential ecotourism destinations; development of Kheechan and Tal Chhapar WLS; relocation of two more tigers to Sariska; establishment of "Rajasthan Protected Area

Conservation Society" for the management of national parks and wildlife sanctuaries of the state; Bustard Conservation Project; Mount Abu declared as an "Ecosensitive Zone" and meeting of the Directors of all the national parks and tiger reserves falling under "Project Tiger" held at Sariska Tiger Reserve during July 2009 to discuss management of tiger projects. The newly notified national park by NTCA, Mukundra Hills in Kota district of Hadoti region shall be the major conservational strategy in coming years. Efforts are being made to develop and include this area as a tiger reserve which is popularly known as the "maternity home" for Ranthambhore tigers. The world famous Ranthambhore National Park and tiger reserve is fighting with problems related to shrinking territory. Very recently, the Central Government has asked all the state forest departments of the country to establish Ecosensitive Zones/buffer areas in a 10 km radius around national parks and wildlife sanctuaries. This plan was dormant for the past nine years due to pressures created by local people, miners and hoteliers; there are a number of mines and hotels running in many of these areas. In addition, the Government of Rajasthan has decided to conserve Sariska Tiger Reserve by developing a 10 km-long ring road in Thanagazi area around the reserve for vehicular traffic which is presently running through Sariska Tiger Reserve. Plans to develop eco-corridors between Ranthambhore and Kailadevi WLS and Sariska Tiger Reserve to Kunho–Palanpur of Shivpuri district of Madhya Pradesh are being pursued in otder to eliminate the frequent territorial fights among tigers. In addition, places of pilgrimage and historical importance in and around the reserve are also being constructed. This scheme, apart from the Sariska Tiger Reserve will include Ajabgarh–Bhangarh, Taal–vriksha and Garhi Mamund, Virat Nagar, Parashar and Jahaaj, Bhrathari, Pandupol and Neelkanth Mahadev.

The grasslands of the eastern Rajasthan hold significant number of important species including Lesser Florican and Godavan or Great Indian Bustard (GIB).Oon June 05, 2013, Rajasthan became the first state to launch "Project Great Indian Bustard". To this end, development of enclosures in an area of 400 ha will be created at Ramdeora and Saunkhalia for these birds in the first phase. In addition, a separate task force will be set up for stepping security for these birds apart from strict monitoring of their habitat and poaching related issues. The Government of Rajasthan also plans to write to international agencies like WWF to persuade Pakistan to protect these endangered birds in its territory. According to recent media reports and population estimates by the central environment and forest department, less than 200 GIBs are left in India as of today and half of them are in western Rajasthan. The bird is now confined only to eight pockets in the six states of India including Rajasthan. Forest Department has received 50 million Indian rupees as the first installment of project GIB and the total budget for this project for 2013 is 680 million Indian rupees.

Other in situ conservation initiatives taken on this day by the state forest department include restoration of Sariska Tiger Reserve; panther conservation project at Pali; semicaptive exhibit centre for the Siberian Crane at Bharatpur; Notification for Shakambhari, Gogelav, Rolu, Beed Jhunjhunu, Ummedganj and Jawaibandh (leopard) Conservation Reserves; corridor restoration in Ranthambhore Tiger Reserve;

recruitment of 1800 forest guards and strengthening protection force with 144 new vehicles; setting up of a centre for excellence in forestry and wildlife at Jaipur with a subcentre at Sawai Madhopur; and notification regarding Mukundra Hills Tiger Reserve and National Park at Kota and Kumbhalgarh National Park at Rajsamand (Udaipur).

Rajasthan Government's forest department in conjunction with the MoEF, Government of India has recently taken some serious steps towards in situ conservation. On July 9, 2012, the Government of Rajasthan cleared the forest department's plans to create buffer zones in the peripheries of Ranthambhore National Park (RNP) where in the future the growing population of tigers can move from the park's core area. This will be investigated and finally approved by the National Tiger Conservation Authority (NTCA). These buffer zones would be developed in the 647 sq km Kailadevi Sanctuary and the 127 sq km Sawai Mansingh Sanctuary adjoining the 392 sq km core area of the RNP. In addition, plans to develop natural corridors or eco-corridors connecting the Ranthambhore forest with Kailadevi Sanctuary have also been finalized. To accomplish this, 23 villages from the sanctuary will be relocated outside the forest area and the forest land thus vacated will be used to develop prey base for the tiger. Conservationists, however, are in favor of developing corridors connecting all the tiger reserves in Central India in order to have a natural mix of genes among the entire tiger population thriving at Ranthambhore and Sariska in Rajasthan and that of Palampur Kuno in the adjoining state of Madhya Pradesh.

The present volume endeavors to function as a compendium on the habitat level and other pressures faced by the existing species and their conservation both in situ and ex-situ. In addition, wetlands, community conservation and resource dependency, legal measures, ecotourism, gaps in research and restoration efforts currently being done are also covered. To keep the readers abreast with the overall view of the subject, relevant appendices have also been included. This volume is expected to contribute greatly to the further study of vertebrate conservation while the contents will surely stimulate, hasten and strengthen the march towards faunal conservation and management. It is hoped that the book in hand will serve as a useful and indispensable text and reference material for teachers; researchers; amateur and advanced students of Zoology, Environmental Science, Wildlife and Conservation Biology, Animal Behavior and Biodiversity; wildlifers and forest officials; conservationists; ecologists; wildlife organizations; freelancers; nature lovers; wildlife photographers; policy makers; sensible and sensitive citizens; intellectuals; the public and the young minds.

To this end, the editors have tried to gauge the progress while covering the burning issues like vulture crisis (the world famous Diclofenac issue), crocodile mass mortality, water crisis and the disappearance of the Siberian Crane from Keoladeo National Park (KNP), territorial fights among Ranthambhore tigers and the missing tigers of Sariska Tiger Reserve in addition to the vanishing fresh water and salt lakes, changing desert climate and destruction of Aravalli Hills due to mining. Upcoming government policies on serious issues like creation of new national parks, conservation and community reserves across the state, and conservation

efforts done by both small regional groups and leading NGOs of the country have also been incorporated. This edited volume deals with a range of still other important issues and topics like the trade in animals and animal parts and wildlife crimes; the impact of altered land use pattern on small mammalian diversity of hilly tracts; in situ conservation; conservation and management of wetland birds; extension of the protected areas; the hunting tribes; community conservation; rehabilitation of tribes such as the *Mogiya* rehabilitation initiative; the age-old concept of *Oran*; ecotourism and heritage tourism; gaps and impetus in research and initiatives and awareness programmes of wildlife groups and other premier agencies towards faunal conservation in Rajasthan. All these topics are discussed at length with their related prospects, perspectives, ramifications, development schemes and so on with penetrating insights with reference to the state of Rajasthan. Contributors to this volume include both seasoned and young scholars, experienced conservation practitioners and managers, forest officials, teachers, social scientists and life scientists. The editors have meticulously attempted to compile various important recommendations from experts with respect to conservation of the wonderful faunal heritage of Rajasthan. Please also see *Faunal Heritage of Rajasthan, India: General Background and Ecology of Vertebrates.* Sharma BK et al. (Eds), 2013, Springer (ISBN: 978-1-4614-0799-7) for an overview about Rajasthan in general and the fauna of Rajasthan focusing ecology of the vertebrates in particular.

It is high time to conduct intensive surveys to monitor these altered land use patterns, the status of endangered species from various geographical and ecological regions of the state and other faunal species lying on the verge of extinction in order to chalk out conservation strategies and eradicate existing potential threats as early as possible. Applying relevant forest management technologies, making ecotourism more attractive and productive, rehabiliting hunting tribes and minimizing the impact of mining activities on faunal abundance and survival are the issues which need intensive research, concrete action plans and strategies. The present volume stresses upon the dire need for further research on the ecology and status of various faunal groups in the light of alarmingly changing climatic conditions. At this juncture, the need of an efficient database centre for providing updates on the current status of existing faunal species, their population and distribution has long been felt. On May 12, 2013, the Forest Department, Government of Rajasthan proposed to set up a training institute in the state where appropriate training in connection with wildlife, forests and related aspects would be made available by experts from India and abroad. A branch of this 'institute of excellence' would be opened at Ranthambhore National Park in Sawai Madhopur. It is worthwhile to mention here that, the Wildlife Institute of India (WII) situated at Dehradun (Uttrakhand) is currently the only such institute in India.

Initially, it seemed difficult to present the aspects of conservation management in a tightly edited volume but soon after the volume's inception, we chose the most relevant topics to be covered . For convenience of understanding by the reader, the entire manuscript has been further splitted into four major sections. It was indeed tricky to provide appropriate headings to cover the wide variety of chapters under

these heads. Last but not the least, the present edited volume is an earnest attempt towards the scientific documentation of existing vertebrate fauna of Rajasthan and under a single cover. We hope that this volume will be useful for wildlife specialists, conservationists, environmentalists, zoologists, ecologists, researchers, students, policy makers and education administrators not only in Rajasthan and India but throughout the Globe.

At this crucial juncture when natural resources of the planet earth are depleting rapidly, the animal life is being driven to its ultimate retreat in the fast diminishing ecosystems, wild creatures are annihilated, the insensitivity of humans towards fellow creatures is increasing and when man's outlook upon the domain of nature has drastically changed, the teachings of Indian philosophy, theology, moral and social sciences can help us to relive the times when the human race had comfortably flourished by affectionately mingling with Nature. A serious approach towards wildlife and forests is still lacking in India, but the need for such an approach is paramount. In fact, the callous attitude of policy makers, administrators, politicians and the intelligentsia coupled with the greed of businessmen have badly affected the pace of welfare efforts and implementation of laws. The forgotten concepts of social sciences and the concepts of animal liberation and animal rights also seem pertinent in the present milieu if India has to survive as a country which always commanded respect of the rest of the world on account of the culture and traditional values. The biggest testimony to this is our honest consideration of the protective umbrella or the environment around us as Mother Nature. A few quotes relevant to the present context and worth mentioning here are: *Man is the only creature that consumes without producing. He does not give milk, he does not lay eggs, he is too weak to pull the plough, and he cannot run fast enough to catch rabbits, Yet, he is the lord of all the animals*—George Orwell; *Life is life—whether in a cat, dog or man. There is no\ difference there between a cat or a man. The idea of difference is a human conception for man's own advantage*—Saint Sri Aurobindo; *We can judge the heart of a man by his treatment of animals*—Immanuel Kant; *The Greatness of a nation and its moral progress can be judged by the way its animals are treated*—Mahatma Gandhi.

According to a recent report by The Asian News International (ANI), "Any truly meaningful biodiversity conservation effort must take the expanding human population footprint into consideration". It is estimated that, there would be 3.3% more threatened species in the next decade and 10.8% of species would be threatened with extinction by 2050. The data speak loud and clear that not only human population density but the growth of the human population is still having an effect on extinction threats to other species. The report points out that 'increase in human population could inevitably crowd out mammals'.

With thousands of years of culture, India will surely act as the *Vishwaguru* (world teacher) in the times to come. In the present scenario of terrible unrest, biodiversity conservation is something pragmatic that must be directly linked with education and incorporated in the curricula at schools, colleges and universities not only in India but the whole world. In a country of rich traditional heritage where *ahimsa parmodharma*

(a phrase in Sanskrit language which means that "non- violence is the topmost duty to the extent that it supersedes all other duties") and *Vasudhaiva Kutumbakam* (a phrase in Sanskrit language which means that "the whole world is one single family") are the guiding principles, destruction should have no place. It's high time that we come together to live alongside nature, commiserate with the harmless animals and join hands to create a symphony of peaceful coexistence. Nature conservation is the key to this concept.

It is a pleasant coincidence that the book was accepted for publication in 2010— the international Year of Biodiversity and was written through 2011 which marked the beginning of a crucial decade in the international calendar for biodiversity. This was the start of the United Nations "Decade on Biodiversity" and was declared "International Year of Forests". It was a great delight to witness that the final proof reading of the manuscript was completed towards the end of 2012— which is marked as the "International Year of Sustainable Energy" and when India hosted the XI Conference of Parties (CoP) on Convention on Biological Diversity (CBD) at Hyderabad.

Jaipur, Rajasthan, India
July 07, 2013

Dr. B.K. Sharma
Chief Editor

# Acknowledgements

At the outset, I would like to thank the residual faunal wealth of Rajasthan and the Bishnoi community that had inspired me to create this book. This volume is also dedicated to all life forms (both companion and free-living animals) flourishing in the lap of Mother Nature. In addition, the handful of people I wanted to thank but the list swelled as it generally happens.

Writing acknowledgement for something one has been doing for years can be both easy and tricky. Easy because the person is quite intimate with the innumerable events that have quickly passed by and quietly slipping down the memory lane is the only way to gather them back, this is generally a pleasure. However, it becomes tricky because one cannot always lay down the pain and unpleasant facts and circumstances associated with such a task.

The book actually got conceived during my involvement as Organizing Secretary of the "National Conference on Conservation and Management of Faunal Diversity of Rajasthan" (NCCMFDR) held during August 11–13, 2006. Sponsored by the University Grants Commission (UGC)—the apex body governing the higher education sector in India and the Department of Science and Technology (DST).

Government of Rajasthan, deliberations of this meeting formed the basis of the need to bring out such a publication. The idea of compiling the faunal abundance of Rajasthan and aspects of its conservation management at one place arose from the fact that when I desperately searched for a book describing the fauna of Rajasthan, I was wonderstruck not to find one. I wish to humbly acknowledge Dr. A.K. Mathur, the then Principal, R.L. Saharia Government PG College, Kaladera (Jaipur), Rajasthan, India, for rendering his support while I organized the above conference.

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I would like to express my gratitude towards my teachers Professors A.L. Bhatia (Late) and Reena Mathur, Former Heads and Prof. Shekhar Verma, Department of

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Apart from agreeing to write a chapter at a short notice, Dr. Jeffrey Snodgrass of Colorado University, USA rendered fruitful suggestions which helped in improving the manuscript; I gratefully acknowledge his inputs.

I feel greatly privileged to have received valuable contributions from eminent authors without whom this volume would not have seen the light of the day. I am fortunate that apart from experienced teachers and colleagues, I enjoyed the counsel of some very competent wildlife experts and conservationists during the preparation of this volume.

I take this opportunity to profoundly thank Professor Paul Harvey, FRS, Head, Department of Zoology, University of Oxford, for he penned the foreword despite other potential academic and professional commitments. Without expressing deep gratitude and thanks towards my scholarly co-editors, the thanks giving will not culminate whose active cooperation actually helped me to complete the book. Were it not for the encyclopedic knowledge of Dr. Rahmani and the hard work of Dr. Kulshreshtha, this volume would have lacked in substance.

My heartfelt thanks to Mr. Sunil Singhal, Mr. Devendra Bhardwaj, Dr. Tejveer Singh, Mr. Niranjan Sant, Mr. Aditya Roy, Mr. Jaysukh Parikh, Dr. Ashish Kothari, Mr. Arfi n Zukof (Listening Post), Dr. Rakesh Vyas, Ms. Sonali Singh, Dr. Anil Chhangani, Mr. J.K. Tiwari, Prof. K. Sankar, Ms. Urva Sharma, and Ms. Babette de Jonge (Wild Cats Magazine/Wild Cats World, Masai Mara 2009), Sanctuary Asia Photo Library and the Victoria & Albert Museum, London for providing rare and beautiful pictures from their personal collection. Thanks Mr. Rajiv Lochan; Drs. Narendra Jain and R.S. Bhatnagar, Mr. Anshul Sinha, Ms. Vartika Sinha and Mr. Umakant Baluni (UGC) for all your concern and support.

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It is worthwhile to mention here that right from the call for papers and collection of manuscripts to the interactions with the publishers, editing and proof reading the entire work stretched over five long years. I owe much to my charming daughter Anushka, and son Divyam, who actually grew up with the preparation of this volume and most of the time witnessed me working in my study, enriched the result and remain a great source of comfort for me.

While writing the acknowledgements, my heart goes out to *Jugal Bhawan*—the 65-year-old ancestral house in Jaipur built by my grandfather (Late) Pt. Jai Nath Sharma where I was born with four siblings and lived as a joint family until the end of 2011. The building has been demolished only to be reborn as an apartment called *Jugal Enclave*. The place not only witnessed my upbringing but also my struggles and survival in connection with this writing project. In fact, majority of the work related to the book was completed in a quiet corner of this palatial bungalow.

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For the one person who supported me selflessly and out of the way while I was putting all my heart and soul into this book, working long hours and late nights despite occasional illness and loads of other commitments, she cheerfully stood beside me, I am short of words to wholeheartedly thank my spouse without whom, this mammoth task would not have reached fruition.

I must share with the readers that I had originally planned an almost 1,200 pages-long single volume entitled "*Faunal Heritage of Rajasthan, India: Ecology and Conservation of Vertebrates*" covering both ecology and conservation management under one cover. In order to make a hefty volume handy, Janet Slobodien suggested me to split this book into two volumes, rather two separate books titled "*Faunal Heritage of Rajasthan, India: General Background and Ecology of Vertebrates*" and "*Faunal Heritage of Rajasthan, India: Conservation and Management of Vertebrates*." The splitting may has caused marginal delay in the publication of this work but I am sure, the readers and contributors would appreciate the need to do so.

Above all, I profusely thank God Almighty for giving me enough courage during the gestation and prolonged labor and as always for everything. I would be grateful

to the esteemed readers for their comments on the newborn twins. I hope the editors justify their aspirations; however, constructive criticism and suggestions are invited to further improve this volume in its future revisions. The only thing now left to be added is that responsibility for imperfections and failings, if any, are mine alone.

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# Part I
# Faunal Conservation as a Pragmatic Approach: Aspects and Challenges

# Chapter 1
# *In Situ* and *Ex Situ* Conservation: Protected Area Network and Zoos of Rajasthan

**B.K. Sharma, Seema Kulshreshtha, Shailja Sharma, Sonali Singh, Anita Jain, and Manoj Kulshreshtha**

**Abstract** The astonishingly diverse wildlife of Rajasthan and the varied ecological habitats of the desert, wetlands, and rivers have supported its proud people for centuries. Focusing on *in situ* conservation efforts in the state, an elaborate account of the large number of sanctuaries and national parks, most of which existed as the hunting reserves and private zoos of former kings has been aptly described in the chapter. At present, there are three national parks and 25 wildlife sanctuaries in Rajasthan covering 2.80% of the total geographical area of the state. Ranthambhore National Park and Sariska Tiger Reserve are known the world over for their tigers

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while Keoladeo National Park (KNP) and Sambhar Salt Lake are the two Ramsar Sites of Rajasthan. Keoladeo is a World Heritage site too. The state treasures three conservation reserves and one eco-sensitive zone. Besides, ten deer parks and seven medicinal plant conservation areas also exist in the state. KNP and Sajjangarh Wildlife Sanctuaries are the walled protected areas (PAs) to ensure better safety of the wildlife while the National Chambal Water Sanctuary is the only ravine system of Rajasthan. Extinction of tigers in Sariska Tiger Reserve during 2005 has been the biggest wakeup call in the country's conservation history. The rapidly declining faunal diversity and other individual problems prevailing in most of the PAs reflect unsustainable development. Authors also highlight *ex situ* conservation and the ongoing breeding programs in the zoos of Rajasthan. The existing zoos of the state are not in a good condition except the Jaipur Zoo and shifting of them in their respective neighboring biological parks is currently being undertaken. This chapter also reveals the present status of zoos in Rajasthan and their role in conserving threatened fauna. Current status of the fauna, threats, issues, and future planning for the ecological recovery of the PAs are also discussed in this chapter.

## Introduction

The rapid depletion of wildlife is currently an alarming issue the world over. Conservation of plants and animals in their native or man-made ecosystem is termed as *in situ* conservation. It applies to wild flora and fauna and not to the domesticated ones. The World Biodiversity Conservation Strategy [1, 2] suggests that, the initial effort of *in situ* conservation should aim at establishment and maintenance of Protected Area (PA) Network System by making policy changes, involving local people in the management of PAs, and mobilizing financial resources for their conservation and protection. We have to keep in mind that PAs make vital contribution to the conservation of the world's natural and cultural resources.

The IUCN's Commission of National Parks and Protected Areas (CNPPA) [3] has been deliberating on the issue of conservation since 1978. During the Steering Committee meeting of the CNPPA in 1993, a consensus was reached regarding categorization of the PAs as given below:

Category I: Strict Nature Reserve/Wilderness Areas: Managed for science and wilderness protection.
Category II: National Parks: Managed for conservation of natural ecosystem and recreation.
Category III: Natural Monuments: For the management of specific natural features.
Category IV: Habitat/Species Management Areas: For conservation through management interventions.
Category V: Protected Landscape/Seascape: Managed for the landscape/seascape conservation.
Category VI: Managed Resource Protected Areas: Managed for the sustainable use of natural resources.

In India, Categories II, IV and VI are being managed. Category I corresponds to sanctum of the PAs and Category III sometimes occur incidentally in PAs, but, very often, these areas may be occurring outside PAs also. National parks in India fall in Category II and Wildlife Sanctuaries (WLSs) and Biosphere Reserves come under Category IV [4, 5].

According to Chapter IV of the Wildlife Protection (WPA) Amendment Act, 2006 of India, "protected area means a national park, a sanctuary, a conservation reserve, or a community reserve notified under sections 18, 35, 36A, and 36C of the Act" [6, 7].

## *National Park*

As per WPA, 1995, whenever it appears to the state government that an area, whether within a sanctuary or not, is, by reason of its ecological, faunal, floral, geomorphologic, or zoological association or importance, needed to be constituted as a National Park for the purpose of protecting and propagating or developing wildlife therein or its environment, it may, by notification, declare its intention to constitute such area as a National Park. No alteration of the boundaries of a national park shall be made except on a resolution passed by the legislature of the state [6].

## *Wildlife Sanctuary (WLS)*

The state government may, by notification, declare its intention to constitute any area other than the area comprised with any reserve forest or the territorial waters as a sanctuary if it considers that such area is of adequate ecological, faunal, floral, geomorphologic, natural, or zoological significance, for the purpose of protecting, propagating, or developing wildlife or its environment [7].

Insertion of new sections 18A and 18B states that no person shall destroy, exploit, or remove any wildlife including forest products from a sanctuary or destroy or damage or divert the habitat of any wild animal by any act whatsoever or divert, stop, or enhance the flow of water into or outside the sanctuary, except under and in accordance with a permit granted by the Chief Wildlife Warden, and no such permit shall be granted unless the state government is satisfied in consultation with the board that such removal of wildlife from the sanctuary or the change in the flow of water into or outside the sanctuary is necessary for the improvement and better management of wildlife. It may be used for meeting the personal bonafide needs of the people living in and around the sanctuary and shall not be used for any commercial purpose [7].

## *Conservation Reserve*

According to Section 36A of Chapter IV of the Wildlife (Protection) Amendment Act, 2006 of India, "the state government may, after having consultations with the

local communities, declare any area owned by the government, particularly the areas adjacent to national parks and sanctuaries and those areas which link one protected area with another as a Conservation Reserve for protecting landscapes, seascapes, flora and fauna and their habitat".

### *Community Reserve*

As per subsection 36C of the Wildlife (Protection) Amendment Act, 2006, "The state government may, where the community or an individual has volunteered to conserve wildlife and its habitat, declare any private or community land not comprised within a national park, sanctuary or a conservation reserve, as a Community Reserve, for protecting fauna, flora and traditional or cultural conservation values and practices." Community reserves in India are currently being evaluated [8]. No community reserve has been formally declared in Rajasthan till date.

### *Eco-sensitive Area*

In the year 2000, a committee constituted by the Ministry of Environment, Government of India approved guidelines laying down parameters and criteria for declaring Eco-sensitive Areas (ESAs) which included species bases (endemism, rarity etc.), ecosystem bases (sacred groves, frontier forests etc.) and geomorphological feature bases (uninhabited islands, origins of rivers, etc.). The legal regime has the flexibility in the protection of different ecosystems as well as the kinds of protection; therefore, provides an opportunity for regional planning which can take into account both ecological and livelihood security. Each notification can actually direct the master plans for the "development" of the region be done only with effective participation of local communities, where local needs and priorities can be built in. ESAs are primarily restricting industrial and/or developmental processes which disturb the natural setup of the place

### *Community Conservation Area*

This term comes under the "Wildlife (Protection) Amendment Act, 1972 as amended in 2003" in India [7]. According to this many tribal communities and other traditional forest-dwelling communities living in close proximity to and dependent on the natural ecosystems for their survival have a rich history of living in harmony with their surroundings and such areas could be declared as a Community Conservation Areas (CCAs). CCAs can be defined as natural or modified ecosystems (with minimal to substantial human influence)—providing significant biodiversity, ecological services, and cultural values; voluntarily conserved by indigenous people or other local communities through customary laws or other effective means. These CCAs

have their own institutions and relevant rules and codes that are site specific and depend on the nature of the environment, the nature of the community and other local social, political, and economical factors.

### *Medicinal Plant Reserved Area*

The areas with rich medicinal plant diversity have been conserved as Medicinal Plant Reserved Areas (MPRAs).

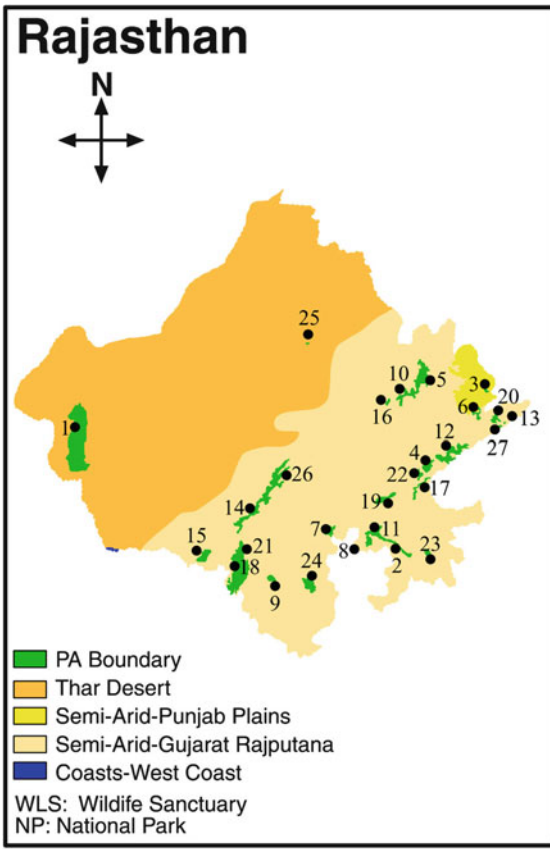
## Protected Areas of Rajasthan

A detailed coverage of protected areas of India has been taken into account at the World National Parks Congress, held at Bali, Indonesia [9]. A network of 668 protected areas (PAs) has been established, extending over 1,61,221.57 sq km (4.90% of total geographic area), comprising 102 national parks, 515 WLSs, 47 conservation reserves, and four community reserves. Thirty-nine tiger reserves and 28 elephant reserves have been designated for species-specific management of tiger and elephant habitats. UNESCO has designated five PAs as World Heritage site [10, 11]. The output of this network in restoring viable population of large mammals such as tiger, lion, rhinoceros, crocodiles, and elephants has been significant [12].

Rajasthan and its austere jungles are extended from the vast sands of the Thar Desert and the rugged slopes of the ancient Aravalli Ranges, to the magical forests of Sajjangarh, Kumbhalgarh, Udaipur, Kota, Bundi, Sitamata, Ranthambhore, Jamwa Ramgarh, and Sariska. The entire 3,42,000 sq km of Rajasthan's landscape including dunes, hills, lakes, and rivers such as Banas and Chambal is imbued with history. This living wealth was superbly documented in the bygone days in the form of Mughal miniatures and the ornate stones and friezes in hundreds of temples, royal palaces, and forts and even hunting reserves of, the then, erstwhile Maharajas, which were later converted to protected areas [13]. Rajasthan proudly owns three national parks (NPs) and 25 wildlife sanctuaries (WLSs) (Fig. 1.1). As on today, four conservation reserves, seven medicinal plants reserve areas, and one eco-sensitive zone exist in the state and a total of 9,485.4621 sq km area falls under the protected area category [14] (Table 1.1).

### *National Parks*

The three national parks of Rajasthan, namely, Ranthambhore National Park (RNP), Keoladeo National Park (KNP), and Mukundra Hills National Park have a total area of 510.31 sq km.




| S. No. | PA Name | Area in Sq km |
|---|---|---|
| 1. | Desert WLS | 3162.00 |
| 2. | Darrah WLS | 239.76 |
| 3. | Keoladeo NP | 28.73 |
| 4. | Ranthambhore NP & Tiger Reserve | 282.03 |
| 5. | Sariska WLS & Tiger Reserve | 492.00 |
| 6. | Bandh Baratha WLS | 199.24 |
| 7. | Bassi WLS | 138.69 |
| 8. | Bhensrodgarh WLS | 229.14 |
| 9. | Jaisamand WLS | 52.00 |
| 10. | Jamwa Ramgarh WLS | 300.00 |
| 11. | Jawahar Sagar WLS | 220.09 |
| 12. | Kailadevi WLS | 676.38 |
| 13. | Kesarbagh WLS | 14.76 |
| 14. | Kumbhalgarh WLS | 610.528 |
| 15. | Mount Abu WLS | 326.1 |
| 16. | Nahargarh WLS | 52.4 |
| 17. | National Chambal WLS | 280.00 |
| 18. | Phulwari Ki Nal WLS | 511.41 |
| 19. | Ramgarh Vishdhari WLS | 307.00 |
| 20. | Ramsagar WLS | 34.40 |
| 21. | Sajjangarh WLS | 5.19 |
| 22. | Sawai Man Singh WLS | 113.07 |
| 23. | Shergarh WLS | 81.67 |
| 24. | Sitamata WLS | 422.94 |
| 25. | Tal Chhapar WLS | 7.90 |
| 26. | Todgarh Raoli WLS | 475.23 |
| 27. | Van Vihar WLS | 25.60 |

**Fig. 1.1** Wildlife Protected Areas (PAs) of Rajasthan. *Courtesy: Drs. B.K. Sharma and Seema Kulshreshtha*

## Ranthambhore National Park (RNP) or Ranthambhore Tiger Reserve (RTR), Sawai Madhopur

The tiger reserve was among the first nine reserves to be protected under the Project Tiger initiated in the year 1973 (Fig. 1.2). Back then, it was a long struggle to protect the tiger in this forest. Today, not withstanding the determined attacks by poachers and encroachers, this is probably the only forest in the world where a wild tiger can still be seen with relative ease along with other key fauna (Fig. 1.3a–g).

Ranthambhore Tiger Reserve lies at the junction of Aravalli and Vindhyas, 14 km away from Sawai Madhopur city in eastern Rajasthan (Fig. 1.4). The Vindhyan Hills are characterized by their flat tops while the Aravalli Hills have sharp ridges. This famous tiger reserve sprawls over a varying and undulating landscape with an area of 1,394 sq km, out of which, 392 sq km is an ecological island surrounded by 91 villages and three townships. A tenth century Ranthambhore fort also blends amicably with the background. Pure sands of *Axelwood or Dhawra* (*Angeoissus pendula*)

**Table 1.1** Protected Areas (PAs) of Rajasthan

| S. No. | Protected Area | District (s) | Area km$^2$ |
|---|---|---|---|
| **National parks (NP)** | | | |
| 1 | Keoladeo National Park or Ghana | Bharatpur | 28.73 |
| 2 | Ranthambhore National Park | Sawai Madhopur | 282.03 |
| 3 | Mukundra Hills National Park* | Kota and Chittourgarh | 199.55 |
| | | Total NP area | 510.31 |
| **Wildlife sanctuaries (WLS)** | | | |
| 1 | Bandh Baretha WLS | Bharatpur | 199.24 |
| 2 | Bassi WLS | Chittourgarh | 138.69 |
| 3 | Bhensrodgarh WLS | Chittourgarh | 201.40 |
| 4 | Darrah Game Sanctuary | Kota, Jhalawar | 239.76 |
| 5 | National Desert WLS or the Proposed Desert National Park (DNP) | Barmer, Jaisalmer | 3162.00 |
| 6 | Phulwari ki Nal WLS | Udaipur | 511.41 |
| 7 | Jaisamand WLS | Udaipur | 52.34 |
| 8 | Jamwa Ramgarh WLS | Jaipur | 300.00 |
| 9 | Jawahar Sagar WLS | Kota | 220.09 |
| 10 | Kailadevi WLS | Karoli, Sawai Madhopur | 676.82 |
| 11 | Kesarbagh WLS | Dholpur | 14.76 |
| 12 | Kumbalgarh WLS | Udaipur, Rajsamand, Pali | 610.528 |
| 13 | Mount Abu WLS | Sirohi | 326.1 |
| 14 | Nahargarh WLS | Jaipur | 52.4 |
| 15 | National Chambal WLS | Kota, S. Madhopur, Bundi, Dholpur, Karouli | 280.00 |
| 16 | Ramgarh Vishdhari WLS | Bundi | 307.0 |
| 17 | Ramsagar WLS | Dholpur | 34.40 |
| 18 | Sajjangarh WLS | Udaipur | 5.19 |

(continued)

**Table 1.1** (continued)

| S. No. | Protected Area | District (s) | Area km$^2$ |
|---|---|---|---|
| 19 | Sariska WLS | Alwar | 492.29 |
| 20 | Sawai Mansingh WLS | Sawai Madhopur | 113.07 |
| 21 | Shergarh WLS | Kota | 81.67 |
| 22 | Sitamata WLS | Chittourgarh, Pratapgrah, Udaipur | 422.94 |
| 23 | Tal Chhapar WLS | Churu | 7.19 |
| 24 | Todgarh Raoli WLS | Ajmer,Pali,Rajsamand | 475.235 |
| 25 | Van Vihar WLS | Dholpur | 25.60 |
| | | Total area of WLSs | 8,950.123 |
| | | Grand total area of NPs and WLSs | 9,260.883 |
| **UNESCO World Heritage sites** | | | |
| 1 | Keoladeo National Park | Bharatpur | 28.73 |
| 2 | Jantar-Mantar (not related to wildlife) | Jaipur | – |
| **Ramsar Sites** | | | |
| 1 | Keoladeo National Park | Bharatpur | 28.73 |
| 2 | Sambhar Lake | Jaipur | 230 |
| **Walled protected areas** | | | |
| 1 | Keoladeo National Park | Bharatpur | 28.73 |
| 2 | Sajjangarh WLS | Udaipur | 05.19 |
| **Tiger reserves** | | | |
| 1 | Ranthambhore National Park | Sawai Madhopur | 392.0 |
| 2 | Sariska WLS | Alwar | 492.0 |
| **Protected ravine system** | | | |
| 1 | National Chambal WLS | Kota, Bundi, Dholpur, and Sawai Madhopur | |
| **Conservation reserves** | | | |
| 1 | Beesalpur Gaadwla | Tonk | 48.31 |
| 2 | Jodbeed Gaadwala | Bikaner | 56.4662 |
| 3 | Sundamata | Jalore, Sirohi | 117.4892 |
| 4 | Gudha Bishnoiyan | Jodhpur | 2.3137 |

**Eco-sensitive Area:** Mount Abu (please see text for details)

Medicinal Plants Reserved Areas in Udaipur, Chittourgarh, Ajmer, Banswara, Jaisalmer, Badmer, and Jodhpur districts have been established very recently and two more areas are in the process of being included.

| | | |
|---|---|---|
| **Zoos/Biological Parks (The existing Zoos are in the process of being converted to Biological Parks)** | | |
| 1 | Nahargarh Biological Park (Jaipur Zoo) | Jaipur |
| 2 | Sajjangarh Biological Park (Udaipur Zoo) | Udaipur |
| 3 | Machia Biological Park (Jodhpur Zoo) | Jodhpur |
| 4 | Abheda Biological Park (Kota Zoo) | Kota |
| 5 | Bikaner Zoo | Bikaner |
| **Deer Parks (Recognized by Central Zoo Authority (CZA), Govt. of India as Mini Zoos)** | | |
| Chittourgarh Fort Deer Forest | Chittourgarh | |
| Pushkar Deer Park | Ajmer | |
| Sanjay Deer Park, Shahpura | Jaipur | |
| Machia Safari Deer Park | Jodhpur | |
| Sajjangarh Deer Forest | Udaipur | |
| Ashok Vihar Deer Park | Jaipur | |
| **Private zoos/deer parks** | | |
| Panchwati Zoo, Pilani | Jhunjhnu | |
| Govardhan Vilas Deer Park | Udaipur | |
| Haridasji ki Magri Deer Park | Udaipur | |
| Birdhwal Deer Park | Jodhpur | |
| **Nature park** | | |
| Nature Park, Bagdara | Udaipur | |

* The area of Mukundra Hills National Park includes 156.32 sq. km. of Darrah Wildlife Sanctuary, 37.98 sq. km. of Jawahar Sagar Wildlife Sanctuary. 5.25 sq. km. area of National Chambal Sanctuary is already included in the total are of the above three sanctuaries. Mukandra Hills National Park was notified vide order no. F11 (56) Forest/ 2001/ part dated 09.01.2012

**1. Total Area of the Protected Area Network = 9485.46 sq. km. 2. Total Area of Conservation Reserves = 224.57 sq. km.

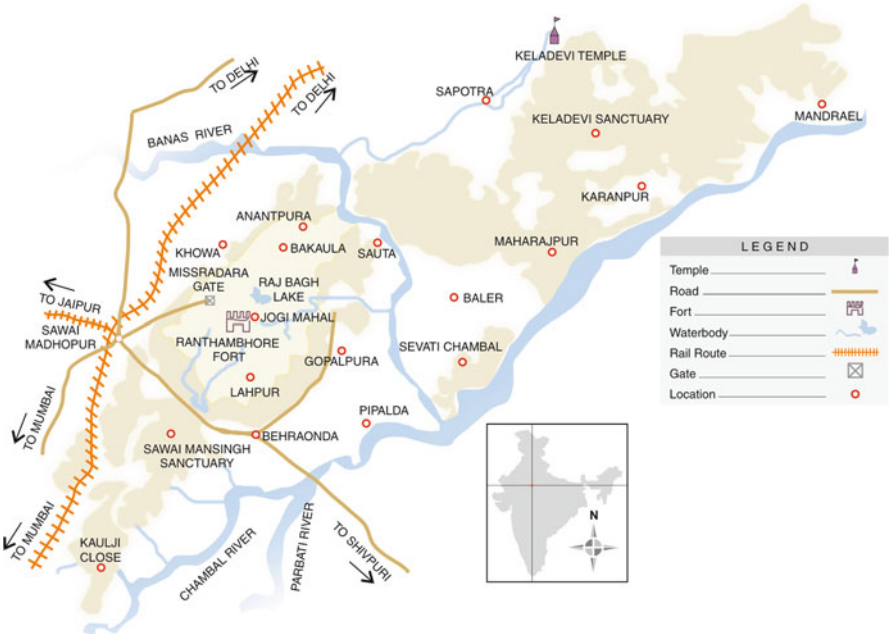



**Fig. 1.2** Map of Ranthambhore National Park (RNP), Sawai Madhopur. *Courtesy: Bittu Sahgal, Sanctuary Asia Photo Library*

interspersed with grasslands at the plateaus and meadows in valleys, and luxuriant foliage around the canals actually make the jungle attractive (Figs. 1.5a, b and 1.6). The national park is divided into two divisions namely, core division of 640 sq km and buffer division of 754 sq km which includes Sawai Madhopur Sanctuary (131.30 sq km), Sawai Mansingh Sanctuary (113.07 sq km), Qualji Closed Area (37.858 sq km), Amli, Gazipur, Papada, Polghate and Balban Reserve Forests, and protected forest (75.76 sq km). The buffer division includes Kailadevi Sanctuary (672.82 sq km) and Nibhera, Nehargarh, Viram Ki Guari Rodhain and Kureri reserve forest and protected forest (81.64 sq km). Three big lakes—Padam *Talab* (meaning lake), Malik *Talab*, and Raj Bagh are similar turquoises studded in the vast forest that abounds with aquatic vegetation including duckweeds, lilies, and lotus. The Rivers Chambal in the south and the Banas in the north, bind the national park. The RNP has tropical dry deciduous forest as per Champion and Seth classification [15] with *A. pendula*, *Butea monosperma*, *Acacia catechu* and *Boswellia serrata* being major plant species. In all, 402 plant species are present in the park [16].

The Aravallis have inclined beds of rock which form continuous strike ridges and long and narrow valleys called "*Khos*." These "*Khos*" are important tiger niches and can be found scattered throughout this tiger reserve. They also become reservoirs for pools of water and in certain areas are the coolest places for sheltering the tiger.

In the year 1973, when Sawai Madhopur Sanctuary was included in the Project Tiger, there were only 14 tigers [17], which had gone up to 36 in 1999 [18], 38 in 2001, and 43 in 2002. It is important to note that in 2004, the tiger population was

47 and in 2005, it surprisingly came down to only 26, showing a rapid decline due mainly to poaching. Basically tigers are nocturnal creatures, but in the RTR, they have become diurnal, i.e., they may be sighted hunting at water holes and following gypsies and canters at any time during the day [13] (Fig. 1.7).

The tiger is not the only attraction at Ranthambhore, it is also home to six species of cats, four species of canids, three species of mongoose, Marsh Crocodile or Mugger and three species of antelopes namely, Chinkara, Nilgai and Blackbuck. An estimated 38 species of mammals, 315 species of birds, 14 species of reptiles, and 402 species of plants clearly indicate the biodiversity richness at RNP [16]. RNP fauna include owlets, the ubiquitous Northern Plains Grey Langur or Hanuman Langur *Semnopithecus entellus*, Leopard, Caracal, Striped Hyaena, Golden Jackal, Wild Boar, Sloth Bear and various species of deer (Figs. 1.8 and 1.9). Swamp Deer namely, Barahsingha is the major prey base for tiger but occasionally the Wild Boar too satiate the hungry big cat at RNP.

Ranthambhore is also plagued by the typical problems generally encountered by all such game reserves of India, namely disturbances created by human settlements

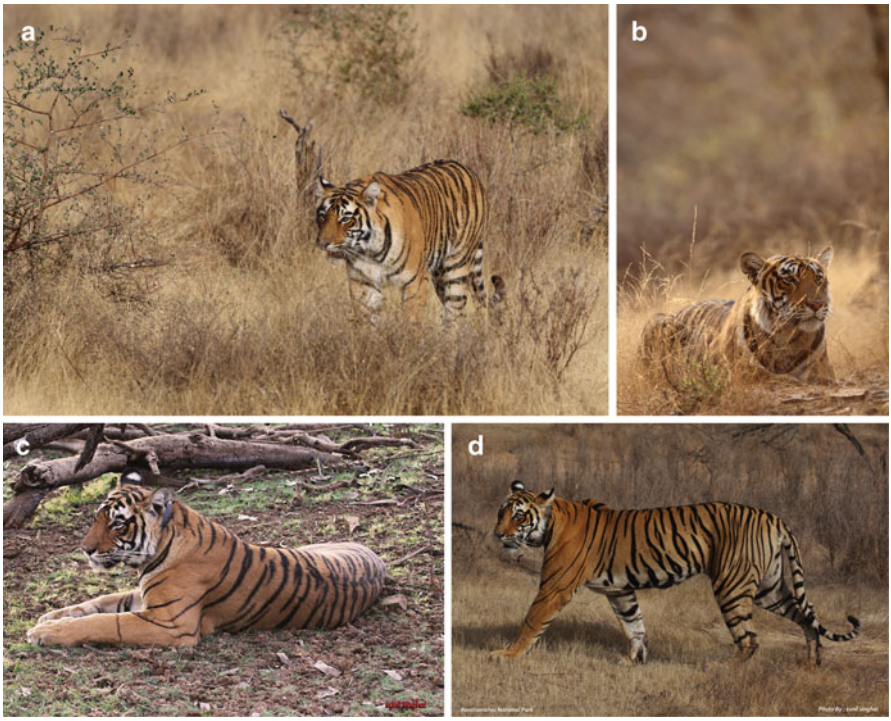



**Fig. 1.3** (**a**) Ranthambhore National Park, Sawai Madhopur is the only PA where Bengal Tiger can be seen with ease. *Courtesy: Sunil Singhal*, *Kota*. (**b**) Tiger looking at a distant prey. *Courtesy: Gobind Sagar Bhardwaj*. (**c**) Tiger relaxing in the open space. *Courtesy: Gobind Sagar Bhardwaj*. (**d**) A tiger walking through the jungle. *Courtesy: Sunil Singhal*, *Kota*. (**e**) A tiger chasing a herd of deer at RNP. *Courtesy: Gobind Sagar Bhardwaj*. (**f**) A large herd of deer and antelope grazing at RNP. *Courtesy: Gobind Sagar Bhardwaj*. (**g**) A tiger roaming around the Ranthambhore Fort. *Courtesy: Gobind Sagar Bhardwaj*


**Fig. 1.3** (continued)


**Fig. 1.3** (continued)

**Fig. 1.4** Ranthambhore Tiger Reserve lies at the junction of Aravalli and Vindhyas. Picture shows the terrain at RNP. *Courtesy: Dr. Satish Kumar Sharma*

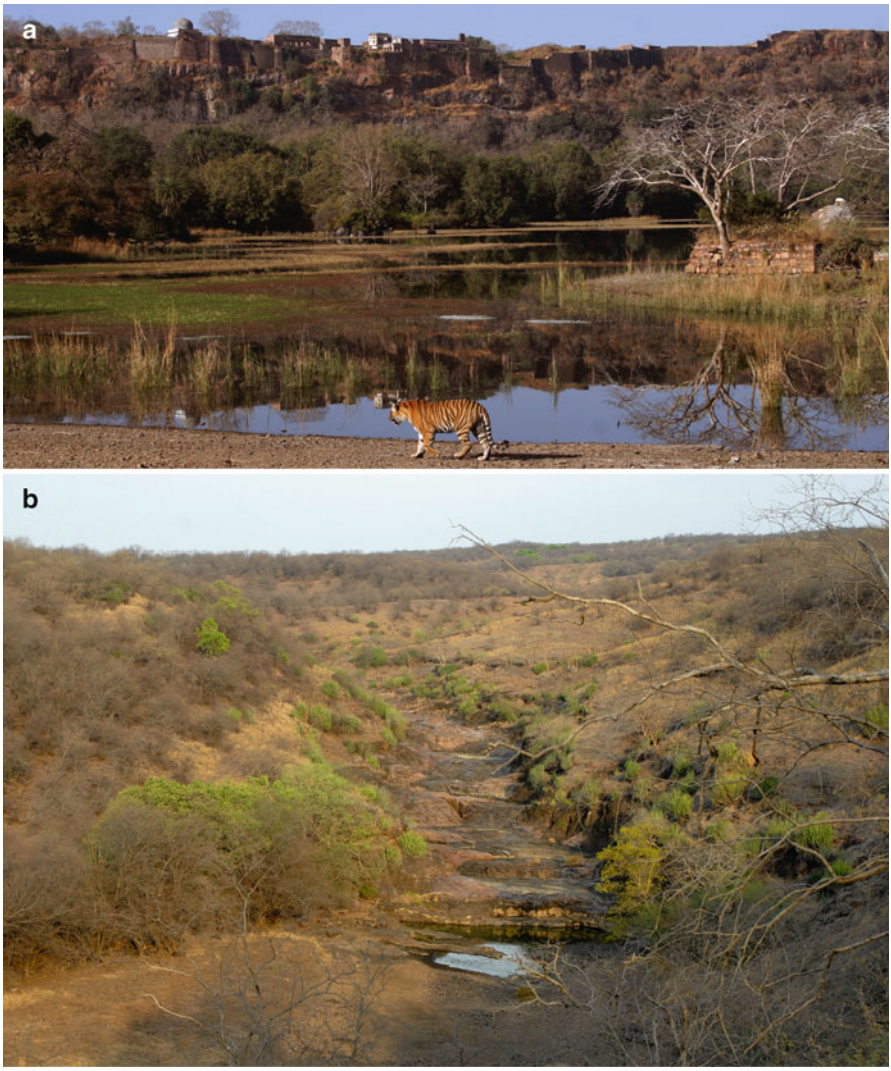



**Fig. 1.5** (**a**) The forest at RNP sprawls over a varying and undulating landscape. (**b**) Another view at RNP. *Courtesy: Sunil Singhal*

and villages in and around the park and grazing by livestock. Actually, there existed several villages and pilgrimage centers both in the core and buffer zones even before the establishment of the reserve. Village Padra, on account of being situated within the reserved forest of Ranthambhore Tiger Reserve, poses great difficulties to the inmates in every respect from basic amenities to schooling of children, marriages; and even after the relocation of some villages, their temples still lying in the reserve core area attract pilgrims from various parts of India especially during the age old Lord Ganesha temple festival. Such pilgrimages also cause noise, water, and solid wastes pollution creating unnecessary pressure and disturbance to the wildlife especially the big cats.

**Fig. 1.6** A picturesque landscape at RNP. *Courtesy: Anish Andheria, Sanctuary Asia Photo Library*


**Fig. 1.7** Ranthambhore tigers have become diurnal. They can be seen following visitor's vehicle. *Courtesy: Sunil Singhal, Kota*

**Fig. 1.8** A herd of Chital *Axis axis* at Ranthambhore National Park. *Courtesy: Bernard Castelian/ Sanctuary Asia Photo Library*

**Fig. 1.9** Another landscape at RNP with a herd of Chital *Axis axis*. *Courtesy: Devendra Bhardwaj*

Between 1976 and 1979, 12 villages within RNP were resettled outside the designated park area with only a few people left in scattered hamlets within the park. Indala village has been completely shifted and shifting of the village Machanki is underway. The Project Tiger was launched by the Government of India at RNP in 1973 only to save the tiger from imminent danger of extinction. Ranthambhore and Sariska in Rajasthan were one of the first nine wildlife areas selected as Project Tiger reserves. Presently, there are a total of 28 tiger reserves in the country and five more are being included in the list. Project Tiger since more than 30 years has helped a great deal in protecting endangered species and has put tiger on the path of recovery.

The *Mogiya*—a nomadic hunter tribe fully dependent on the forest and its produce has been rehabilitated as per the approved package of rehabilitation of villagers at the RNP. As a result, the vacated villages of Lakarda and Semli and the Bakaula valley are now densely populated with wildlife. Today, while driving through Nalghati, Semli, Kachida and Guda, it is impossible not to come across tiger pugmarks or droppings. But, the worry is that the noose is tightening around the park. Villagers are getting restive and this often turns to aggression that manifests in the form of forest fire, massive tree cutting, and poisoning of tigers by the villagers [13].

**Keoladeo National Park, Bharatpur**

KNP is a massive wetland covering an area of 2,873 ha enclosed by a two meters high stone wall. It lies in a natural depression 172–175 m above sea level at the western end of the chain of freshwater wetlands lying along the Indo-Gangetic Plains. Situated two kilometers southeast of Bharatpur City and 180 km south of Delhi (Fig. 1.10), it was originally known as "Ghana," which means a "thicket." Radiocarbon dating of pottery shards suggest that people lived and worked here even around 1,000 B.C. Geologists say that a major river used to water the region and an artesian well at a village called Mallah (meaning boatman) further underscore this possibility. In addition, less than a kilometer towards west of the sanctuary, hunting implements including harpoons, spears, and swords were discovered. These are estimated to be 3,000 years old, suggesting that elephant, wild buffalo, and even rhino might have lived here during the Copper Age. According to (Late) Kailash Sankhala—a renowned forest officer who took charge of Keoladeo Ghana in 1954, the british used to shoot at the Keoladeo Lake and the then, Maharaja of Bharatpur had to create a shooting preserve. Originally developed as a duck shooting reserve by the Maharaja in the 1850s, the area was partly man-made with earthen dykes dividing the area into blocks and sluice gates controlling the flow of water to and from the blocks. This system is still in use today. After Independence, the area was declared a Bird Sanctuary in 1956, although the Maharaja retained the shooting rights for birds and other animals until 1972. The park, a protected forest since its declaration in 1967, was declared a Ramsar Site in 1981 in recognition of its value as a unique man-made freshwater wetland which serves as a staging ground for migratory waterfowl and forms an important wintering ground for the Critically Endangered Siberian Crane *Leucogeranus leucogeranus* (IUCN Red List, 2012). It was included in the list of national parks in 1982 and later declared a World Heritage site in 1985.

**Fig. 1.10** Keoladeo National Park (KNP), Bharatpur. *Courtesy: Sonali Singh*

The park is surrounded by nine villages with a total population of around 15,000 people who originally depended on the park for fuel, fodder, timber, etc. and have no more access to this protected forest after its declaration as a national park.

A total of 350 species of plants have been recorded in KNP [19]. The aquatic vegetation is rich and includes 96 species of submerged and emergent plants as well as a diversity of scrub forests including woodlands, scrub woodlands, woodland savannahs, and the shrub savannahs consisting of various floristic combinations of trees and grasses, namely, *Mitragyna parvifolia*, *Syzgium cumini*, *Ziziphus mauritiana*, *Prosopis cineraria*, *Acacia leucophloea*, *A. nilotica*, *Capparis sepiaria*, *Vetiveria zizanoides*, *Desmostachya bipinnata* and *Cynodon dactylon.*

The marshes (Fig. 1.11) at KNP support a high vertebrate diversity including fishes (50 species), amphibians (5 species), reptiles (28 species), birds (369 species), and mammals (28 species). Of the bird species present, a significant number are considered Threatened (IUCN Red List 2012) (Fig. 1.12). The list includes White-throated Kingfisher *Helcyon smyrnensis*, Common Coot *Fulica atra*, Pheasant-tailed Jacana *Hydrophasianus chirurgus*, Chestnut-bellied Sandgrouse *Pterocles exustus*, Brown Fish-Owl *Ketupa zeylonensis*, Lesser Whisteling Duck *Dendrocygna javanica*, Bar-headed Goose *Anser indicus*, Great Egret *Casmerodius albus* (Fig. 1.13a, b), Spot-billed Pelican *Pelecanus philippensis*, Dalmatian Pelican *Pelecanus crispus*, Greater Adjutant *Leptoptilos dubius*, Lesser Adjutant *Leptoptilos javanicus*, Baikal Teal *Anas formosa*, Baer's Pochard *Aythya baeri*, Marbled Teal *Marmaronetta augussirostris,* Cinereous Vulture *Aegypius monachus*, Imperial Eagle *Aquila heliaca*, Pallas's Fishing Eagle *Haliaeetus leucoryphus*, Siberian

**Fig. 1.11** Marshes of KNP. *Courtesy: Anish Andheria/Sanctuary Asia Photo Library*

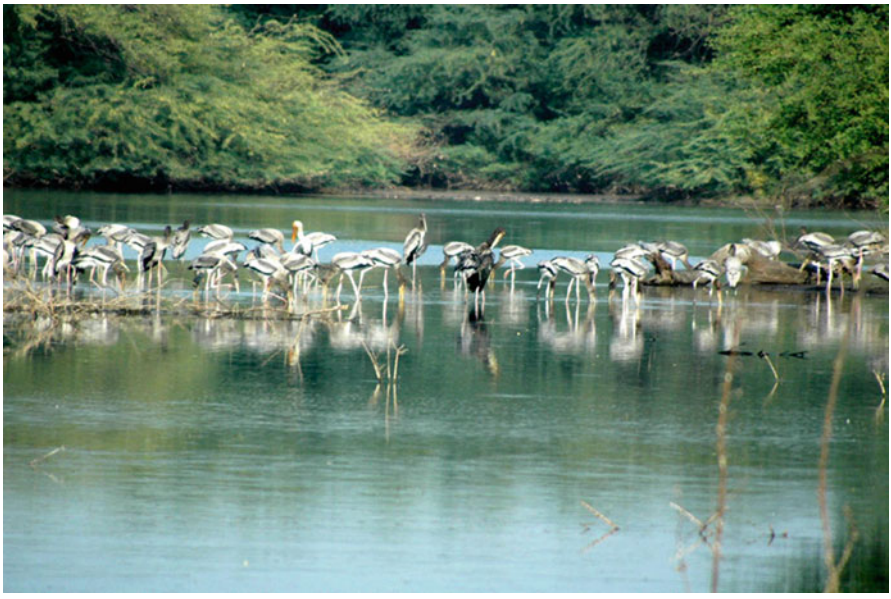


**Fig. 1.12** A large group of a variety of waterbirds at Keoladeo Lake. *Courtesy: Devendra Bhardwaj*

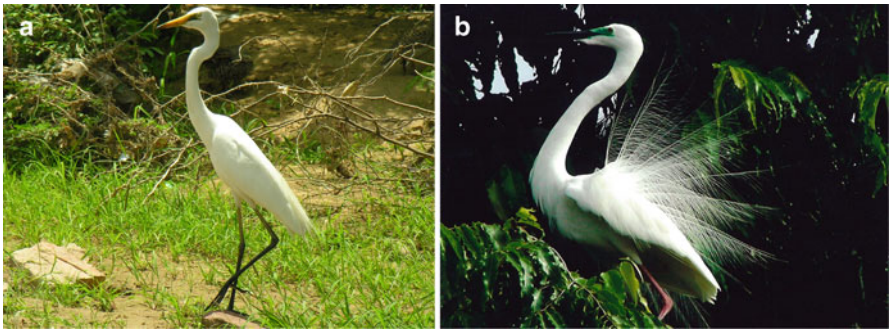



**Fig. 1.13** (**a**) Great Egret *Casmerodius albus*. *Courtesy: Dr. Anil Kumar Chhangani*. (**b**) Great Egret *Casmerodius albus* breeding. *Courtesy: Dr Satish Kumar Sharma*

**Fig. 1.14** A male Sambar *Rusa unicolor*. *Courtesy: Devendra Bhardwaj*

Crane *Leucogeranus leucogeranus*, and Sociable Lapwing *Vanellus gregarius* [20, 21]. Threatened mammals recorded within the park include Sambar *Rusa unicolor*, Fishing Cat *Prionailurus viverrinus*, and Smooth-coated Indian Otter *Lutra perspicillata* (IUCN Red List 2012) (Fig. 1.14). Nilgai *Boselaphus tragocamelus* and Rock Python *Python molurus molurus* are also found here (for details please also see Chap. 8). KNP continued to remain an important wintering ground for the Critically Endangered Siberian Crane *Leucogeranus leucogeranus* (IUCN Red List, 2012) until 2003. Since then, no sighting has been recorded. The reason may be attributed to the severe water crisis in the lake.

The KNP or Ghana over the years has become one of the world's best studied wetland ecosystems [22]. Water is of critical importance for the ecological health of this wetland. Although once a flood prone area, water became scarce particularly after construction of the Panchna Dam in the catchment area and the Keoladeo faced drought

for about seven years. The Rajasthan government took a major decision to bestow priority to the park mainly focusing the irrigation needs of the farmers and now the water to this wetland is being supplied via the Panchna Dam. A little earlier, water was being supplied via the Govardhan Drain. The park is a popular rendezvous for tourists coming from all over the world attracting more than 100K visitors annually. This has encouraged hotel construction in the immediate surroundings of the park and thereby increasing pollution and disturbance to the wildlife. Such activities can be controlled by enforcing the Environmental Protection Act, 1986 but it needs both political and administrative will. However, *Paspalum distichum*—an amphibious grass which has formed a thick mat in the water areas is being effectively checked by controlling water levels and allowing the villagers to collect grass from the park. In addition, the *khus* grass *Vetiveria zizanioides* invading the water areas during drought periods expands in some areas for which various management strategies are being employed.

#### Mukundra Hills National Park, Kota and Chittourgarh

The biodiversity rich area falling under Kota and Chittourgarh districts has been declared as the new national park of the state on January 9, 2012. It will include Darrah, Jawahar sagar, and National Chambal WLSs. The national park has massive tracts of forests which formerly remained a part of Kota Maharaja's private hunting grounds. Mukundra has great ecological importance since tigers used to inhabit the area once. The government decided to develop the hills as national park so that more space for tigers of Ranthambhore National Park could be created. According to the bi-monthly outreach journal STRIPES published by the National Tiger Conservation Authority (NTCA), Government of India, Volume 2, issue 4, May–June, 2011 an in-principle approval was accorded for creating Mukundra Hills as a new tiger reserve of Rajasthan with a proposed area of 484.17 sq km. The official website of the forest department, Government of Rajasthan vide order no. F11 (56) Forest/2001/Part dated 09.01.12 shows a different statistics in terms of the total area to be covered (199.55 sq km) and breakup of areas covered by the three WLSs (Darrah: 156.32 sq km; Jawahar Sagar: 37.98 sq km and National Chambal Sanctuary: 5.25 sq km). The Government of Rajasthan had identified Damodarpura, Girdharpura, Kolipura, Laxampura, Rooppura, Harli Bawri, and Bhookhi Akhawa villages and decided to relocate the villagers to some other place. Further details on this national park are still awaited.

### *Wildlife Sanctuaries*

All the 25 wildlife sanctuaries (WLSs) of Rajasthan cover a total area of 8,950.123 sq km [14]. Following is a glimpse of the major WLSs of Rajasthan.

#### Bassi WLS

Located 25 km from Chittourgarh with an area of 138.69 sq km, this sanctuary was notified in 1988. The habitat constitutes the hilly areas of Aravalli and Vindhyan

**Fig. 1.15** Bhainsroadgarh WLS and a view of Chambal. *Courtesy: Rakesh Vyas*

Ranges. Flora of the sanctuary comprises of *Dhawra*, Golden Sal and *Butea* while Panther, Chital, Wild Boar, Striped Hyaena, Golden Jackal and Four-horned Antelope are the characteristic and conservation-dependent fauna. In addition, a pack of wolves is still known to be wandering here (pers. comm., 2008 via Mr. Manoj Parashar, the then DFO, to Dr. Satish Kumar Sharma, Assistant DFO, Sajjangarh WLS).

### Bhensroad Garh WLS, Chittourgarh

The sanctuary, situated at a distance of 60 km from Chittourgarh was notified in 1983 and covers an area of 229.14 sq km (Fig. 1.15). The main tree species are *Dhawra*, *Khair* (Kutch tree), *Ber* or *Ziziphus* sp., etc. along with mixed woodlands. The key wildlife is represented by leopard, Wild Boar, Chinkara, Nilgai, wolf, Golden Jackal and Striped Hyaena.

### Bund Baretha WLS, Bharatpur

199.50 sq km area of the sanctuary constitutes partly hilly and watershed area and partly a wetland habitat near village Baretha located 45 km away from the Bharatpur town. The sanctuary was notified in 1985. *Dhok* (*A. pendula*), *Churel* (*Holoptela integrifolia*), *Kadamb* (*Mitrasyna parviflora*), *Ber* (*Zizyphus jujuba*), and Date along with some aquatic vegetation are the main floral species of the sanctuary. Leopard, Striped Hyaena, Jungle Cat, Nilgai, Golden Jackal and Gray Wolf and varieties of birds also

inhabit the sanctuary. Leopard, Bengal Fox, Gray Wolf and Striped Hyaena and some migratory waterbirds are the species of conservation interest. An ancient royal palace amid the habitat forms an important attraction for the wildlifers and visitors.

### Darrah WLS, Kota and Jhalawar

A royal hunting preserve of the erstwhile Maharaja of Kota, Darrah WLS is situated along the southeastern border of Kota, 55 km from the main town. This hilly and thickly forested sanctuary is stretched in an area of 250 sq km. *Dhavar* trees on the hills coupled with a number of wild shrubs and herbs along with *Tendu* tree *Diospyros melanoxylon* Roxb*, Butea monosperma*, *Gurjan Dipterocarpus turbinatus*, *Karaya* or *Tragacanth* sp., *Madhuca longifolia (Mahua)*, *Eugenia jambolana (Jamun)*, Peepal *Ficus religiosa*, Bargad or Banyan tree *F. bengalensis,* Tamarind *Tamarindus indicus*, and Margosa *Azadirachta indica* trees forms the key vegetation. The conservation-dependent faunal species include Grey Wolf, Sloth Bear, Chinkara, and leopard.

### The Desert WLS [Proposed Desert National Park (DNP)], Barmer and Jaisalmer

The Great Indian Desert is biogeographically the easternmost edge of the Saharan-Arabian Desert zone, with an extent of 280,000 sq km area consisting 61% of the total geographical area of the state. Popularly called the Desert National Park (DNP; Proposed) is, in fact, a wildlife sanctuary with a massive area of 3,162 sq km situated in Barmer and Jaisalmer districts (Fig. 1.16). It is home to the Great Indian Bustard or Godavan *Ardeotis nigriceps*—The state bird which is at the peril of extinction and also the state animal—Chinkara or Indian Gazelle *Gazella bennettii*. The Sudashri forest post is the most ideal place for observing wildlife in the DNP amidst sand-dunes, craggy rocks, pavements, compact salt lake bottoms, intermedial areas, and fixed dunes.

Grassland ecosystems of Sewan *Lasiurus sindicus* and xerophytes like *Prosobis cineraria*, *Capparis decidua*, *Calotropis procera*, *Salvadora oleoides*, *Laisurus scindicus*, etc. are among the sparse vegetation of the area [23].

The Great Indian Desert is quite rich in animal life, and the fauna of this desert is mainly of the Palaearctic-Oriental origin and exhibit a remarkable diversity in their habitat [24]. Fauna of the Thar Desert have been studied widely for their unique habitat [25–29]. A total of eight species of amphibians, 44 of reptiles, 272 of birds, and 66 mammalian species are present in the park. The inhabitants include Chinkara, Bengal Fox, Desert Fox, Desert Cat, Desert Hare and Desert Gerbil. Sandgrouse, Grey Partridge, Black Drongo, a variety of raptors, Houbara Bustard, Common Crested Lark, Rufous-fronted Prinia, Desert Wheatear, Common and Bush Quail and Indian Rollers are commonly found birds. The insectivore species like Bluetail and Little Green Bee-eater (*Merops orientalis* and *Merops persicus*) have been recorded abundantly in the vicinity of the electric lines and amid agricultural crop.

**Fig. 1.16** Desert National Park Boundary. *Courtesy: Devendra Bhardwaj*

Though rare, orchards also form one of the important habitats in the Thar Desert providing shelter to many species during the summer months, namely, *Psittacula krameri*, *Megalaima haemocephala*, *Dendrocitta vagabunda*, and *Pycnonotus leucotis*. One of the endemic species in the desert, Stoliczka's or White-browed Bushchat (*Saxicola macrorhyncha*) is currently facing severe threat, besides the Great Indian Bustard (*Ardeotis nigriceps*). Common Crane *Grus grus* and Demoiselle Crane *Anthropoides virgo* arrive here in the month of September and return back to breed in Russia by March every year, whereas the Houbara Bustard *Chlamydotis undulata* arrives a month later. These birds must survive a gauntlet of hunters *en route* from Pakistan in order to land safe at the Thar. Raptors of DNP include the Desert Buzzard *Buteo vulpinus*, Common Buzzard *Buteo buteo*, Bonelli's Hawk Eagle *Aquila fasciatus*, Tawny Eagle *Aquila rapax*, Greater Spotted Eagle *A. clanga*, Lagger Falcon *Falco jugger*, Peregrine Falcon *Falco peregrinus peregrinus*, Oriental Hobby *Falco severus*, Northern Goshawk *Accipiter gentilis*, harriers and kites. Perhaps they follow the migratory pattern of their prey species while the desert owls and owlets take over the predation at night. There are six species of vultures: Red-headed Vulture *Sarcogyps calvus*, Cinereous Vulture *Aegpius monachus*, Griffon Vulture *Gyps fulvus*, White-rumped Vulture *G. benghalensis*, Indian Vulture *G. indicus*, and the Egyptian Vulture *Neophron percnopterus*. The high mortality rate of the large population of cattle only ensures vulture's survival in the desert. One might be lucky to spot Rajasthan's state bird, the Great Indian Bustard (GIB) *Ardeotis nigriceps* along with the beautiful sandgrouses and Scaly-breasted Munia *Lonchura punctulata* in the DNP.

Apart from the above, 42 species of reptiles can also be seen here, including the Sandfish *Ophiomorus tridactylus* (which is actually a lizard), Desert Monitor

*Varanus griscus*, Spiny-tailed Lizard *Uromastic hardwickii* (being rapidly wiped out on account of their fat, which is sold being considered an aphrodisiac), Gecko *Hemidactylus triedrus*, Rajasthan Toad-headed Agama *Phrynocephalus laungwalaensis*, *Naja oxiana* and the legendary snake of the desert the *piwana* or Sindh Krait *Bungarus caeruleus*, whose presence is often discovered from the trails it leaves in the dunes. There are no Blackbuck in the park, though they can be seen in Gajner, Doli-Dhawa, and other villages protected by the *Bishnoi* community around Jodhpur, Nagour, Pali, and Talchhapar. Gray Wolf *Canis lupus* and Leopard *Panthera pardus sindico* are now restricted to the Siwana Hills where they lead a tentative existence, surviving exclusively on livestock. With the discovery of oil in the DNP area, one can expect considerable damage to this fragile ecosystem not only from the oil but also from the ancillary compensate for the ecological mayhem that oil can cause.

**Jaisamand WLS, Udaipur**

The sanctuary (Fig. 1.17) area of 52.34 sq km was notified in 1955. It is largely covered by mixed dry deciduous forest with the main tree species of *A. pendula*, *Mitragnya parvifollia*, *Terminalia tomentosa*, *Boswellia serrata*, *Bauhinia racemosa*, *Khair* or *Capparis decidua*, etc. Key fauna of the sanctuary include Leopard, Chital, Golden Jackal, Striped Hyaena, Wild Boar and Indian Peafowl, etc. The famous Jaisamand Lake is an integral part of this sanctuary, situated hardly 150 km from the world famous Udaipur city.

**Jamwa Ramgarh WLS, Jaipur**

Notified in 1982, the sanctuary (Fig. 1.18) is spread over 300 sq km amidst Aravalli Hills near Ramgarh village situated 35 km from the capital city of Jaipur. The thick forest has *Dhok* (*A. pendula*) in plenty. The major faunal species include Panther, Chital, Wild Boar, Bengal Fox, Striped Hyaena, Sambar, Nilgai, Golden Jackal, Jungle Cat, etc. Panther, Striped Hyaena, Golden Jackal and Chital are the species of conservation interest. In addition, the beautiful *Hawa Hodi* is worth seeing.

**Jawahar Sagar WLS, Kota, Bundi, and Chittourgarh**

Notified in 1975, the sanctuary extends over an area of 153.41 sq km. The forest is mixed dry deciduous type having *A. pendula*, *Acacia ketechu*, *Shorea robusta*, *Dipterocarpus turbinatus*, *Syzygium cumini*, and Bamboo sp. The wildlife includes Leopard, Jungle Cat, Sloth Bear, Golden Jackal, Striped Hyaena, Bengal Fox, Chital, Nilgai, Wild Boar, Indian Crested Porcupine, Indian Peafowl, Sarus Crane, Hanuman Or Northern Plains Grey Langur *Semnopithecus entellus*, Caracal, etc. Marsh Crocodile or Mugger and Gharial are also found in the Chambal River which passes through the sanctuary.

**Fig. 1.17** Jaisamand WLS, Udaipur. *Courtesy: Sonali Singh*

**Fig. 1.18** Jamwa Ramgarh WLS, Jaipur. *Courtesy: Devendra Bhardwaj*

**Kailadevi WLS, Karouli**

The 676.40 sq km hilly area of the Aravallis was notified as Kailadevi WLS which is situated barely 25 km from the main Karouli town. This sanctuary constitutes the buffer zone of Ranthambhore National Park. *A. pendula* and *Acacia ketechu* are the main trees while, Panther, Sambar, Sloth Bear, Chital, Wild Boar, Striped Hyaena, Golden Jackal and Chinkara inhabit the forest as key faunal elements. Conservation-dependent species include Panther, Striped Hyaena and Chinkara. The ancient temple of Goddess Kailadevi amid the forests is considered as a major pilgrimage center of Rajasthan, the annual fair of which is famous. The Madanmohan temple of Karouli town and the Jain temple of Mahavira Swami on way to the sanctuary are other major attractions.

**Kesar Bagh WLS, Dholpur**

Situated on Dholpur-Bari road, the sanctuary has an area of 14 sq km. It is only 10.5 km away from Dholpur City. It has a beautiful palace known as the Kesar Bagh Palace which is currently being used as a Military Training School. The biodiversity of this WLS is quite akin to the Ramsagar WLS.

**Kumbhalgarh WLS, Pali, Rajsamand, and Udaipur**

Kumbhalgarh is one of the most rugged of all wildlife habitats in the Aravallis (Fig. 1.19). Named after the erstwhile *Mewar* ruler Maharana Kumbha who built the picturesque Kumbhalgarh fort amid the forest on a hilltop way back in the fifteenth century, the habitat presents a bewildering array of wildlife. The key fauna comprises of about 39 species of mammals and 263 species of birds.

Kumbhalgarh WLS is a typical representative of the Aravalli habitat and its fauna and flora in *sensu stricti*. The 578 sq km area of this sanctuary is extended at an altitude of 500–1,300 m which is home to a large variety of wildlife including some endangered species. The important tree species include *Damara orientalis*, *Mitragya parvifollia*, *Terminalia tomentosa* and Indian Ash Tree or Moya or Wodier *Lannea coromandelica*. Key wildlife includes Leopard, Sloth Bear, Gray Wolf, Striped Hyaena, Golden Jackal, Jungle Cat, Sambar, Nilgai, Four-horned Antelope, Chinkara, Indian Crested Porcupine and Desert Hare. The usually shy Grey Junglefowl, Indian Peafowl, Red Spurfowl, Alexandrine Parakeet, Golden Oriole, Blue Rock-Pigeon, Red-whiskered Bulbul and White-throated Kingfisher can also be seen near the water holes together with a small population of the Critically Endangered Indian White-rumped Vulture *Gyps benghalensis*, Changeable Hawk Eagle *Spizaetus cirrhatu* and Shikra *Accipiter badius*. Spread across the districts of Pali, Rajsamand, and Udaipur, the area forms an ecotone between the hilly forests of the Aravallis and the arid Thar Desert. The forest is a critical catchment area that feeds the human community living downstream with the only reliable source of potable water (Fig. 1.20). Beset by problems including massive and illegal tree cutting, overgrazing and poaching, the poten-

**Fig. 1.19** Kumbhalgarh WLS is the most rugged of all WLSs. *Courtesy: Ashish Kothari*

**Fig. 1.20** A water source near Thandibari Guest house at Kumbhalgarh WLS. *Courtesy: Sonali Singh*

tial of the park to regenerate is high, however, the requisite political will seems elusive for its conservation and hopes of any dramatic recovery are thin in the foreseeable future. Trekking and horse safari here are popular among locals and national and international tourists.

### Mount Abu Wildlife Sanctuary, Sirohi

Located 8 km from the Abu Road town, the sanctuary has benefited from protection when a closed area encompassing 113.70 sq km was created on April 7, 1960 and later bestowed the status of a sanctuary following the enactment of Wildlife (Protection) Act, 1972. The remaining areas of the Abu Hill were added to this sanctuary in 1983 and 1995 making the total area to 326.14 sq km. Abu Hills was also notified as an Eco-sensitive Area on June 25, 2009 covering an area of 45 sq km including the muncipal limits as well as the adjoining parts of the sanctuary. The southwest part of the Aravallis comprises of Sirohi-Abu Hills with prominent peaks. The Abu Hill is detached both from the Sirohi Ranges and the main Aravalli chain and is situated somewhat south-east of the Sirohi district between 24°31′ and 24°43′ North latitude and 72°38′ and 72°53′ East longitude. It is long and narrow in shape with a beautiful spreading of the plateau extending on the hilltop (19 km × 5–8 km) at an altitude of 1,219 msl. Rajasthan's highest peak, Gurushikhar at 1,722 m, located in the southern reaches of the Aravallis is also the highest point on the subcontinent between the Nilgiris and the Himalayas. The sanctuary sits atop Archaean rocks estimated to be between 3.8 and 2.5 billion years old. The igneous rocks of Aravalli here have large cavities due to the weathering effect. The Toad Rock in Mount Abu is one such example located 8 km from the Mount Abu town.

Temperature here ranges from 34 to 24°C in summers and 18 to −4°C during winters. The monsoon usually breaks here in the third week of June and ends in September with a mean annual rainfall of 1,639 mm.

Champion [15] classified the forests of Mt. Abu as Bombay subtropical evergreen forest (C3) and further grouped them under Southern subtropical wet hill forests (Gr. 7A). Mount Abu has a very rich floral biodiversity starting with xenomorphic subtropical thorn forest at the foothills to subtropical evergreen forest along water courses and valleys at higher altitudes. Scientists assert that it harbors 112 plant families (449 genera, 820 species) and of these, 663 species are dicots while 157 species are monocots. Varieties of orchids, bryophytes, three species of wild rose, 16 species of fern, bamboo, and algae are the key flora of interest. Oak, pine, eucalyptus, and mango are the exotic species well-adapted in the ecosystem of Abu. The south-west area also has dense bamboo forests. The sanctuary is rich in herbal medicinal plants, too. About 81 species of trees, 89 species of shrubs, 28 species of climbers, and 17 species of tuberous plants of medicinal importance have been identified [30]. The ground cover comprises of grasses like *Acanthospermum hispidum*, *Blainvillea acmella*, *Sclerocarpus africanus*, species of *Alysicarpus*, *Cassia*, and *Desmodium*. *Borreria articularis*, *B. pusilla*, etc. become very dense at lower elevations.

Interestingly, the history of Mount Abu also indicate the presence of lion last recorded in 1872 and tiger last reported in 1970 while the Leopard *Panthera pardus* is relatively secure in this sanctuary with a small population of 30 individuals and shares space with the occasional Indian Hare *Lepus nigricollis*, Wild Boar *Sus scrofa*, Thick-tailed Pangolin *Manis crassicaudata,* Indian Crested Porcupine *Hystrix indica*, Ratel *Mellivora capensis*, Sambar *Rusa unicolor*, two species of Civet (*Viverricula indica* and *Paradoxurus hermaphroditus*), Jungle Cat *Felis chaus*, Gray Wolf *Canis lupus*, Stripped Hyaena *Hyaena hyaena*, Golden Jackal *Canis aureus,* Indian Fox *Vulpes vulpes*, Bengal Fox *Vulpes bengalensis*, Indian Grey Mongoose *Herpestes edwardsi* and *H. smithi*, and Hedgehog *Paraechinus micropus*. While Panther and wolf are the apex predators, Hanuman Langur *Semnopithecus entellus* is the most abundant nonhuman primate inhabiting the sanctuary. The sanctuary provides an ideal habitat for Sloth Bear *Melursus ursinus* which is abundant on the hilly terrains with a population of more than 150. The population trend over the years (Animal Census 2006–2011) shows that there is a regular increase in the number of this species. The human-bear conflicts are quite common at Mt. Abu. Apart from the above, the Short-nosed Fruit Bat *Cynopterus sphinx* and Pigmy Pipistrelle *Pipistrellus minus* are the two common bat species along with *Pteropus giganteus.* Table 1.2 shows the mammals which have existed in the past and Table 1.3 depicts animal census.

Mount Abu's altitudinal variation has given rise to an impressive bird diversity that has been estimated at 146 species including Griffons Vulture *Gyps fulvus*, Crested Serpent-eagle *Spilornis cheela*, Shikra *Accipiter badius,* Changeable Hawk Eagle *Nisaetus cirrhatus,* and the Peregrine Falcon *Falco peregrinus*. In addition, Jungle Bush-quail *Perdicula asiatica*, Indian Peafowl, *Pavo cristatus*, Indian Scimitar-Babbler *Pomatorhinus horsfieldii*, Alexanderine Parakeet, and Grey-breasted Prinia *Prinia hodgsonii* have also been listed. The presence of threatened species [22] and some Western Ghat, peninsular and endemic avians like Green Munia or Green Avadavat *Amandava formosa*, Stoliczka's or White-browed Bushchat *Saxicola macrorhyncha*, and Pied Tit *Parus nuchalis* make this sanctuary an important bird area (IBA) [31].

Currently, the sanctuary is facing some conservation issues which need to be solved. The status and distribution of Green Munia and Sloth Bear need a detailed scientific intervention. Infestation of *Lantana*, *Prosopis juliflora, Argemone mexicana*, and *Parthenium* has become a severe problem in many areas. Killing of small animals and birds like Grey Junglefowl and bird catching on account of the heavy demand of parakeets, especially the threatened species Green Avadavat and Red Munia by the tribals (*Garasiya* and G*ameti*) living at the foothills is being noticed for many years [32]. Besides, the *Jogi* community based at Sirohi district is involved in trapping reptiles. The most alarming is the local trade of fauna which is not on a large scale at present but can prove to be fatal if not checked at this stage. Ground fire is the most common type of forest fire generally caused due to anthropogenic activities while canopy fire is rare. Fire protection, therefore is a must for the preservation of the forests.

**Table 1.2** Fauna in retrospect at Mount Abu WLS

| S. No. | Species | Scientific name | Local name | Citation (year of extinction) |
|---|---|---|---|---|
| 1 | Indian Muntjac or Barking Deer Southern Red Muntjac | *Muntiacus muntjak* | | Literature of Royal Princely States (Sirohi & Bikaner) & discussions |
| 2 | Spotted Deer or Chital | *Axis axis* | Cheetal | Literature of Royal Princely States (Sirohi & Bikaner) & discussions |
| 4 | Four-horned Antelope | *Tetracerus quadricornis* | Chowsingha | Literature of Royal Princely States (Sirohi & Bikaner) & discussions |
| 5 | Chinkara or Indian Gazelle (may be in lower reaches) | *Gazella bennettii* | Chinkara | Literature of Royal Princely States (Sirohi & Bikaner) & discussions |
| 6 | Wild Dog or Dhole | *Cuon alpinus* | Dhole | Literature of Royal Princely States (Sirohi & Bikaner) & discussions |
| 7 | Bengal Tiger | *Panthera tigris* | Bagh, Nahar, Sher | Literature of Royal Princely States (Sirohi & Bikaner) & discussions (1962 A.D.) |
| 8 | Asiatic Lion | *Panthera leo* | Babar Sher | Literature of Royal Princely States (Sirohi & Bikaner) & discussions (1872 A.D.) |

**Table 1.3** Faunal species on Abu Hills

| | |
|---|---|
| Floral diversity | |
| Angiosperms | 820 species |
| Pteridophyte | 17 species |
| Bryophyte | 88 species |
| Mycophyta | – |
| Thallophyta | – |
| Faunal diversity | |
| Mammals | 37 species |
| Aves | 246 species |
| Reptiles | 33 species |
| Amphibia | 9 species |
| Pisces | – |

### Nahargarh WLS, Jaipur

Nahargarh WLS, notified in 1960 has 1980.98 sq km amidst the hilly terrain of Aravallis in Amber, Jaipur, where one can make entry from Kunda village situated on Jaipur–Delhi national highway (NH-8). Dry deciduous *Dhok* (*A. pendula*), *Salar* (*Boswellia serrata*), *Churel* (*Holoptelia integrifolia*), *Khair* (*Acacia catechu*), and *Palash* (*Butea monosperma*) make the key vegetation cover. Leopard, Striped Hyaena, Jungle Cat, Wild boar, Bengal Fox, Nilgai, Mugger, and about 220 species of migratory and resident birds constitute the major faunal species. Leopard, jackal, and Nilgai are the species of conservation interest. There are three small lakes in the sanctuary. Spread in 720 ha, a part of the Nahargarh WLS is being developed as Nahargarh Biological Park which also houses an animal rescue center where wild animals especially big cats rescued from hunters and the circuses are rehabilitated. Besides the famous Nahargarh fort, it has unexplored heritage structures like Ram Sagar *Shikar Haudi* and Gopal Vilas *Haudi,* a hunting lodge and a tower made by the former rulers of Jaipur. Two ancient water conservation amenities popularly known as step-wells namely, *Raniji ki Baori* and *Sura ki Baori* located at the Bhawni village stand here as proud remnants of the past. Currently, efforts are being made to revive these structures by making a Safari in the proximity of an already existing satellite zoo.

### National Chambal Gharial WLS, Kota, Bundi, Sawai Madhopur, Dholpur and Karouli

The Chambal River originates from the summit of Janapav Hill of the Vindhyan Range in Mhow of Indore district in the adjoining Madhya Pradesh (MP) state. The river has a course of 965 km up to its confluence with the Yamuna River in the Etawah district of Uttar Pradesh (UP) state. [33] From the place of its origin, the Chambal River flows for some 320 km in a generally northerly direction before entering a deep gorge in Rajasthan at Chaurasigarh about 96 km upstream of Kota. The gorge extends up to Kota and the river then flows for about 226 km in Rajasthan in a north-easterly direction before forming the boundary between MP and Rajasthan


**Fig. 1.21** A picturesque view of River Chambal. *Courtesy: Sunil Singhal*, *Kota*

for about 252 km. Thereafter, the river forms a boundary between MP and UP for about 117 km, enters UP near Chakar Nagar village and flows for about 40 km before finally joining the River Yamuna. The main tributaries of the River Chambal are Siwana, Retam, Shipra and Choti Kalisindh, Kuno and Kuanri in MP and Kalisindh, Parvati, Parwan, and Banas in Rajasthan (Fig. 1.21).

It is the only ravine sanctuary of Rajasthan notified in 1979. The area encompasses Jawahar Sagar Dam to Palighat and a 1,000 m strip of land on both sides of the River Chambal in addition to Kaishoray Patan to Palighat and a 100 m strip of land on both sides of the Chambal. From here it forms the boundary between Rajasthan and MP beginning at the center of the river to its bank along with a 100 m wide strip of land up to the tri-junction of Rajasthan, UP, and MP states. Between 1960 and 1972 four dams, namely, Gandhi Sagar, Jawahar Sagar, Ranapratap Sagar, and Kota Barage were built on the Chambal River which considerably affected its flow [34]. The forests in the area are largely tropical dry deciduous (group 5) and tropical thorn forests (group 6) [15] with major tree species comprising of *A. pendula*, *B. serratta*, *A. catechu*, *A. nilotica*, *Butea monosperma,* and *Holoptelia integrifolia*.

Gharial *Gavialis gangeticus* and Gangetic River Dolphin *Platanista gangetica* are the flagship species of the River Chambal and give sufficient reason to naturalists and the policy makers for protecting its environment. The Chambal environs support a large breeding population of the Indian Vulture *Gyps indicus*, and White-rumped Vulture *Gyps bengalensis* both Critically Endangered and Egyptian vulture *Neophron percnopterus* considered endangered by the Birdlife International, United Kingdom. Other species of birds and animals in the threatened category include, Red-headed Vulture *Sarcogyps calvus*, Indian Skimmer *Rynchops albicollis* (Fig. 1.22), Chinkara *Gazella bennettii*, Sloth Bear *Melursus ursinus*, Panther *Panthera pardus*, Smooth-coated Indian otter *Lutra perspicillata*, and eight species of turtles. In addition, well over 250 species of birds have been recorded in the

**Fig. 1.22** Indian Skimmer *Rynchops albicolis* skimming the Chambal waters. *Courtesy: Rakesh Vyas*

National Chambal Sanctuary. The important ones according to their threatened status include Eastern Imperial Eagle *Aquila heliaca*, Painted Stork *Mycteria leucocephala*, Oriental Darter *Anhinga melanogaster* and Black-bellied Tern *Sterna acuticauda*. Some other important migratory and resident bird species seen here are Painted Spurfowl *Galloperdix lanulata*, Indian Peafowl *Pavo cristatus*, Osprey *Pandion haliaetus*, Changeable Hawk-eagle *Spizaetus cirrhatus*, Crested Serpent-eagle *Spilornis cheela*, Short-toed Snake-eagle *Circaetus gallicus*, Bar-headed Goose *Anser indicus*, Brahmini duck *Tadorna ferruginea*, Comb duck *Sarkidiornis melanotus*, Cotton Pygmy-goose *Nettapus coromandelianus*, Western Spot-billed duck *Anas poecilorhyncha*, Alexandrine Parakeet *Psittacula eupatria*, Plum-headed Parakeet *Psittacula cyanocephala*, Yellow-footed Green Pigeon *Treron phoenicoptera*, Peregrine Falcon *Falco peregrinus*, Black Stork *Ciconia nigra*, Pied Cuckoo *Clamator jacobinus*, and Paradise Flycatcher *Terpsiphone paradise* to name a few. The Great Indian Bustard (*Ardeotis nigriceps*) and Lesser Florican (*Sypheotides indicus*) extensively use the grasslands in Sailana, Ralamandal, and Ghatigaon WLSs situated in the basin [34]. Ecology of Gharial (*Gavialis gangeticus*) in the National Chambal basin has been extensively studied by Hussain [35]. It is interesting to mention here that, a sizeable population of Mugger *Crocodylus palustris* also prevails in some *nalluhas* (drains) at Kota.

The birds using the environs of the Chambal River to breed include, River Tern *Sterna aurantia*, Whiskered Tern *Chlidonias hybridus*, Small Pratincole *Glareola lacteal*, River Lapwing *Vanellus duvaucelii,* Red-wattled Lapwing *Vanellus indicus*, Black-winged Stilt *Himantopus himantopus*, Pheasant-tailed Jackana *Hydrophasianus chirurgus*, Bronze-winged Jackana *Metopidius indicus,* Great

Thick-knee *Esacus recurvirostra*, Eurasian Thick-knee *Burhinus oedecnemus*, Little Ringed Plover *Charadrius dubius*, Grey Heron *Ardea cinerea*, Wooly-necked Stork *Ciconia episcopus*, Indian Vulture *Gyps indicus*, Egyptian Vulture *Neophron percnopterus*, Little Grebe *Tachybaptus ruficollis*, Eurasian Eagle-owl *Bubo bubo*, Dusky Eagle-owl *Bubo coromandus*, and Brown Fish-owl *Ketupa flavipes.* These birds use the pebbly river bank, sand bars, islands, ledges, aquatic vegetation, and trees on the cliffs to make their nests. Chambal is also known as the last remnant breeding ground for Small Indian Pratincole *Glareola lacteal.*

The rock cliffs, ledges, and forest in the valley offer excellent habitat to many species of mammals. The Chambal River valley was the only place in India where tiger shoots used to take place via boat in the first half of twentieth century. At present, the river valley is home to Panther *Panthera pardus*, Jungle cat *Felis chaus,* Striped Hyaena *Hyaena hyaena,* Golden Jackal *Canis aureus*, Indian Flying-fox *Pteropus giganteus*, Indian Crested Porcupine *Hystrix indica*, Nilgai *Boselaphus tragocamelus*, and Chinkara *Gazella bennettii*. Rare Gangetic River Dolphin *Platanista gangetica* is commonly seen in the Chambal River at Dholpur and has spread up to about 50 km upstream. On the other hand, the Smooth-coated Otter *Lutra perspillata* sighted during the last five decades only near Dholpur has now made a remarkable comeback in the backwaters of Ranapratapsagar Dam at Rawatbhata and also at the crevices in the gorge upstream of Kota Barrage. The riverine heritage of Rajasthan is largely confined to Chambal River basin barring for Mahi, Luni, and the legendary Saraswati, which the scientists believe flowed through Rajasthan and drained into the ancient Arabian Sea at the Great Rann of Kutch. Chambal River with its huge basin is the lifeline of south-east and east Rajasthan supporting agriculture and economy besides the rich flora and fauna. It is also the cleanest river in India as there are not many large cities or industries on its banks apart from Kota. The status of a sanctuary all along its course in Rajasthan and the presence of Jawahar Sagar in the close proximity have greatly helped in the protection of its environment. The major issues affecting the integrity of the basin are: the burgeoning population, extraction of river water by the states of Madhya Pradesh, Rajasthan, and Uttar Pradesh, discharge of industrial and domestic effluent into the river, and control of soil erosion and ravine formation [35].

**Phulwari ki Nal WLS, Udaipur**

Notified in the year 1983, the sanctuary is situated in southern Aravalli Hills on the border adjoining the Gujarat state. It is spread in an area of 492.68 sq km with its 11 forest blocks including reserve and protected area (Figs. 1.23a, b and 1.24). Phulwari ki Nal is famous for rosewood, teak *Tectona grandis*, and *Madhuca indica* forests while Flying Squirrel is the characteristic fauna. The other wild animals include Three-striped Palm Squirrel, Leopard, Hanuman Langur, Indian Peafowl, Jungle Cat, Bengal Fox, Golden Jackal and Striped Hyaena. Grey Junglefowl *Gallus sonnarattii*, Common Green Whip-snake *Ahaetulla nasuta* and many Western Ghat and peninsular species are also found in the forests. Rock formations in the Aravalli Hills can be explicitly seen here (Fig. 1.25).


**Fig. 1.23** (**a**) Phulwari ki Nal WLS, Udaipur. *Courtesy: Dr Satish Kumar Sharma*. (**b**) Another view of the same. *Courtesy: Ashish Kothari*

## Ramgarh-Vishdhari WLS, Bundi

The sanctuary notified in 1982 encompasses an area of 252. 79 sq km on the Vindhyan Hills covered with dry deciduous forest. *Dhok* (*Angoeissus pendula*), *Khair* (*Acacia catechu*), *Salar* (*Boswellia serrata*), *Khirni* (*Manilkara hexandra*), and mango

**Fig. 1.24** A scenic view of Phulwari *ki Nal WLS*. *Courtesy: Ashish Kothari*

**Fig. 1.25** Rock formations at Phulwari *ki* Nal WLS. *Courtesy: Ashish Kothari*

(*Magnifera indica*) trees are found in abundance. Leopard, Sambar, Wild Boar, Chinkara, Sloth Bear, Gray Wolf, Golden Jackal, Striped Hyaena and Bengal Fox constitute the major faunal species.

### Van Vihar and Ramsagar WLSs, Dholpur

Both the sanctuaries are spread over an area of 59.6 sq km, where the forest area is divided into two parts, namely, Van Vihar and Ramsagar. Van Vihar WLS is about 18 km from Dholpur and Ramsagar sanctuary is just another 18 km. These are natural habitats for a variety of flora and fauna. Van Vihar is located on the Vindhya Plateau while Ramsagar is situated around the picturesque Ramsagar Lake. Both the reserve forests were recognized and declared as wildlife reserves by the Government of Rajasthan in the year 1955. The sanctuaries are dotted with low hills crisscrossed by a large number of streams. The major vegetation here comprises of *Dhok* and *Khair* trees while the key faunal species include Sambar, Leopard, Wild Boar, Nilgai, Sloth Bear, Striped Hyaena, and Chital. The sanctuaries are also home to a variety of birds including patridges, Indian Peafowl, quails, herons, egrets, sandgrouses and spoonbill. In addition, a large number of migratory birds arrive here during different seasons.

### Sajjangarh WLS, Udaipur

The smallest sanctuary of the state, Sajjangarh WLS (Fig. 1.26) is a walled protected forest with an area of 5.19 sq km situated five kilometers on the west extremity of the Lake City Udaipur. The famous Monsoon Palace better known as the Sajjangarh Palace present atop the Bansdara Hill was built by Maharana Fateh Singh of Mewar in 1,899 A.D. Once the hill covered with dense forest was home to a variety of wildlife including the big cats like tiger. It was extensively used as the private hunting ground by the erstwhile rulers of Mewar. Unfortunately, due to the nonjudicious use of biological and nonbiological resources of the Aravallis, by the year 1986, the wildlife of the area was almost destroyed. Later, realizing its strategic location and importance from aesthetical, environmental, and ecological point of view, this area was declared as a wildlife sanctuary in the year 1987. A beautiful view of the Udaipur city can be witnessed from the Bansdara Hill. Following the creation of a safari park in the sanctuary, wild animals like Chital, Sambar, Wild Boar, Jungle Cat and Nilgai were reintroduced and animals like Panther, Striped Hyaena, Indian Hare and Golden Jackal gradually reappeared apart from a variety of reptiles and birds. The boundary wall was extended further and at present the entire hillock has been fenced, thereby improving the vegetal cover of the sanctuary area. Towards the northwest of Sajjangarh, an artificial lake Jiyan Sagar, popularly known as “Bari Lake” or “Tiger Lake” was constructed in 1664 A.D. by Maharana Raj Singhji, the ex-ruler of Mewar. It was later named after Jana Devi, the mother of the Maharana. The lake has an area of 1.25 miles$^2$ with a storage capacity of 400 million ft$^3$.

**Fig. 1.26** Sajjangarh WLS, Udaipur. *Courtesy: Sonali Singh*

*Anogeissus pendula*, *Mitragyna parvifollia*, *Terminalia tomentosa*, *Lania coromandelica* trees, and other typical Aravalli flora make the vegetation cover. Among the mammalian fauna, Leopard (*Panthera pardus*) is the keystone species of the sanctuary and the surrounding areas in addition to animals like Rusty-spotted cat (*Prionailurus rubiginosa*), Jungle Cat (*Felis chaus*), Toddy Cat (*Paradoxurus hermophroditus*), Small Indian Civet (*Viverricula indica*), and Thick-tailed Pangolin (*Manis crassicaudata*). Striped Hyaena, Indian Hare and Golden Jackal are the species of conservation interest. Many of the threatened bird species have also been recorded from the sanctuary including White-naped Tit (*Parus nuchalis*), Aravalli Red Spurfowl (*Galloperdix spadicea caurina*), Red-headed Vulture (*Sarcogyps calvus*), and Indian Vulture (*Gyps indicus*). Among these White-naped Tit (*Parus nuchalis*) is rare and endemic. The "Jhar water hole" amid the forests enhances the attraction of this place. Due to the nonavailability of surface water and various developmental activities like construction of roads, buildings, etc. within and around the sanctuary area, the natural habitats of wild animals are being destroyed.

### Sariska Tiger Reserve (STR), Alwar

The Sariska forests situated 200 km from Delhi and 107 km from Jaipur was initially designated as a wildlife sanctuary in 1955. Located in the Alwar district of Rajasthan, the forest is the legacy of the then Maharajas of Alwar. It was only

**Fig. 1.27** A Leopard in Sariska Tiger Reserve during monsoon. *Anogeissus* and *Boswellia* trees are clearly seen in the backdrop along with *Grewia* shrubs. *Courtesy: Krishnendu Mondal,* WII

**Fig. 1.28** Tiger *Panthera tigris tigris,* the reintroduced top predator in Sariska. *Courtesy: K. Sankar*


**Fig. 1.29** Sambar *Rusa unicolor* at Sariska. (**a**) A male Sambar with horns seen in the front. *Courtesy: K. Sankar*. (**b**) A female Sambar. *Courtesy: Anil Kumar Chhangani*

six years after the Project Tiger was launched in India in the year 1973 that Sariska (Figs. 1.27 and 1.28) was formally declared a tiger reserve. Although larger than Ranthambhore Tiger Reserve, it had lesser number of tigers but a similar topography. It covers a mammoth area of 800 sq km with a core area of approximately 500 sq km. The northern Aravalli Hills dominate the skyline here with their characteristic mixture of sharp cliffs and long narrow valleys.

The STR supports dry deciduous and scrub-thorn arid forests, rocks, and grasses with a variable and erratic climate. It has a broad range of wildlife, presenting a wonderful example of the ecological adoption and tolerance. Ruins of the pavilions and temples within Sariska boldly hint at the past glory. To this end, the Kankwari Fort has a turbulent history. The park is home to numerous carnivores including Bengal Tiger, Leopard, Caracal, Jungle Cat, Common Palm Civet, Striped Hyaena and Golden Jackal where the big cats feed on Sambar (Figs. 1.29a, b and 1.30), Chital, Nilgai, Chau-singha, Wild Boar, and Hanuman Langur. Sariska is also well known for its large population of Rhesus Monkey found mainly around the Talvriksh. The avian world at Sariska is also well-represented by Indian Peafowl, Grey Partridge, Bush-quail, Sandgrouse, Treepie, Black-rumped Flamback, Crested Serpent-eagle and Eurasian Eagle-owl. The Aravalli rock formation (Fig. 1.31) and the largest *Phoenix sylvestris* patch (Fig. 1.32a, b) at Kankwari are worth watching. In the wake of tiger reintroduction program, rehabilitation of certain villages is presently going in the sanctuary [36]. Marble mining at Sariska (Fig. 1.33) and heavy tourist influx (Fig. 1.34) are major conservation issues of the park.

According to the animal census of May 2004, Sariska was inhabited by 15 tigers but to the shocking surprise of all concerned, towards the end of September 2004, no tiger sighting or pugmark or scat or tiger kill was reported by any forest officials or tourists. On February 1, 2005 following a tip, the New Delhi police raided a

**Fig. 1.30** A group of Sambar, Spotted Deer and Indian Peafowls at a water body inside Sariska Tiger Reserve. *Courtesy: Devendra Bhardwaj*

**Fig. 1.31** Aravalli formation in Sariska Buffer Area. *Courtesy: Ashish Kothari*

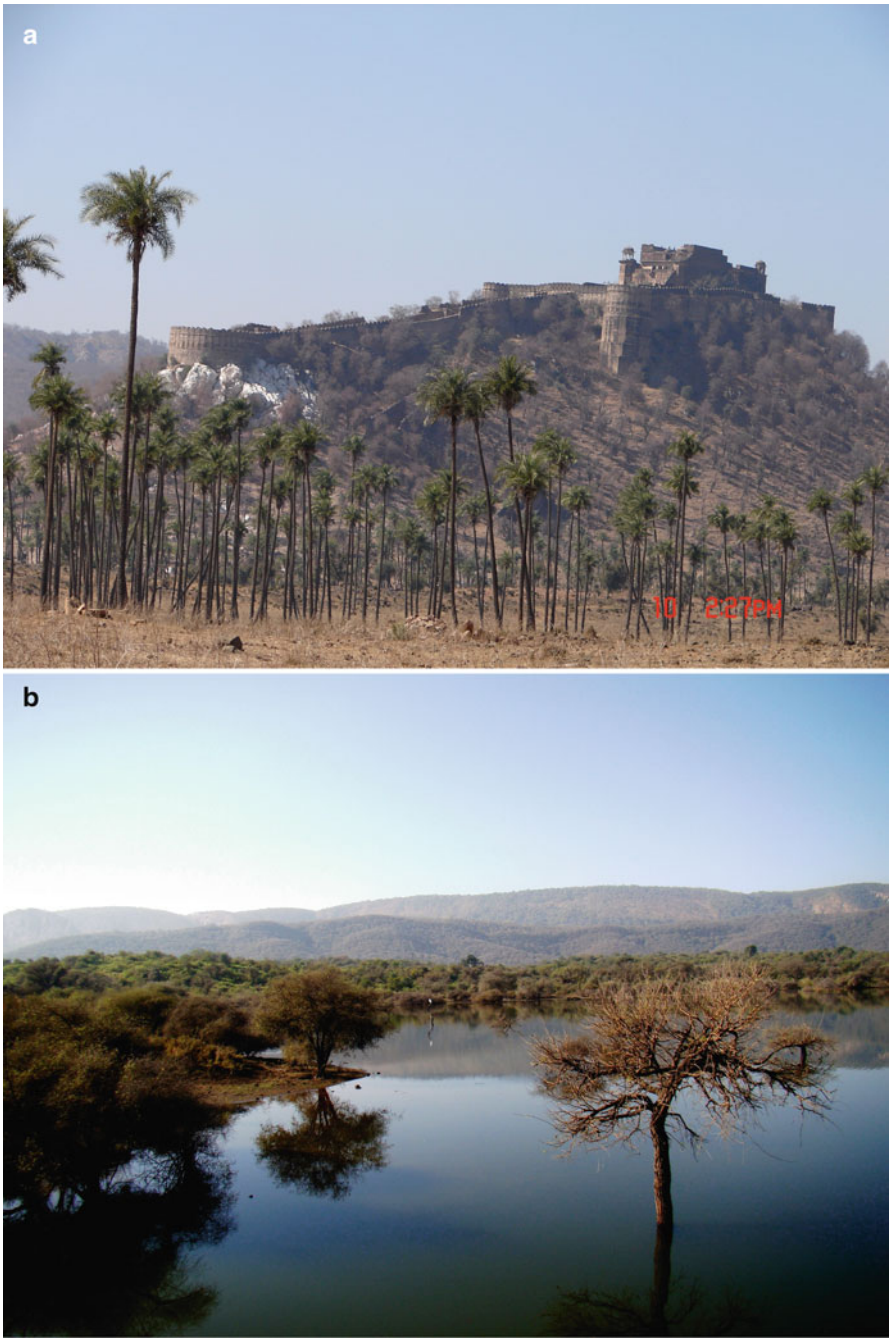



**Fig. 1.32** (**a**) The largest *Phoenix sylvestris* patch in Kankwari at Sariska. (**b**) A scenic view of Sariska. *Courtesy: K. Sankar*

**Fig. 1.33** Marble mining in Sariska Tiger Reserve area. *Courtesy: Ashish Kothari*

**Fig. 1.34** Tourist traffic in Sariska Tiger Reserve. *Courtesy: Ashish Kothari*

warehouse only to discover a huge cache of wildlife products including 39 leopard skins (including one of a snow leopard), 2 tiger skins, 42 otter skins, 3 kg of tiger claws, 14 tiger canines, 10 tiger jaw bones, 135 kg of porcupine quills, 60 kg of tiger and leopard paws, and 20 small pieces of bone that appeared to be of tiger and leopard "floating" clavicle bones. This gave a strong clue to the missing tigers of Sariska and pointed towards the fact that they found their way to the international market [11]. In fact, such raids have now become quite common in the recent years, revealing that instead of working under shadow, the poachers are now able to operate openly and fearlessly. From 2008 onwards as many as five tigers (two males and three females) were shifted from Ranthambhore National Park to the Sariska Tiger Reserve. The recent death of one of the relocated tigers under mysterious circumstances again shook the whole Nation. For the conservation of this beautiful mammal, village Bhagani, 82 families of village Umri, and 67 out of a total 170 families belonging to village Kankwari are being shifted to Badod Rundh village.

**Sawai Mansingh WLS, Sawai Madhopur**

Spread in127.76 sq km, the sanctuary located in the hilly area of Vindhyas, 16 km from Ranthambhore National Park and 10 km from Sawai Madhopur town was notified in 1984. The biodiversity of the forest is as rich as that of Ranthambhore with the main vegetation cover comprising of *Dhok*, *Salar*, *Churel*, and *Butea* trees. Sloth Bear, Wild Boar, Caracal, Chital, Chinkara, Striped Hyaena, Golden Jackal and Sambar are the mammals of common interest. Chinkara, Sloth Bear, Striped Hyaena, Golden Jackal and Sambar are the conservation-dependent species.

**Shergarh WLS, Kota**

Shergarh Wildlife Sanctuary, notified in 1983, is situated near village Shergarh of district Baran in the geographic region of Deccan Plateau. This 98.70 sq km sanctuary has dry deciduous forests of *Tectona grandis*, *A. pendula*, *Acacia catechu*, etc. Leopard, Striped Hyaena, Chital, Chinkara, and Sambar are the major mammals, of which some are conservation dependent.

**Sitamata WLS, Chittourgarh**

Situated 80 km from Udaipur, Sitamata WLS has dense dry deciduous forests comprising of bamboo, *Teak, Dhok, Khair, Salar, Tendu, Gurjan, Beel, Ber,* etc. This sanctuary is famous for Flying Squirrel (Fig. 1.35a, b), Leopard, Gray Wolf, Striped Hyaena and Bengal Fox, Chinkara, Cheetal, and Golden Jackal. Legend says that Lord Rama's spouse Sita had spent her days of exile in the *Ashrama* of Rishi Valmiki (who authored the famous epic *Ramayana*) located in this forest and hence the name.

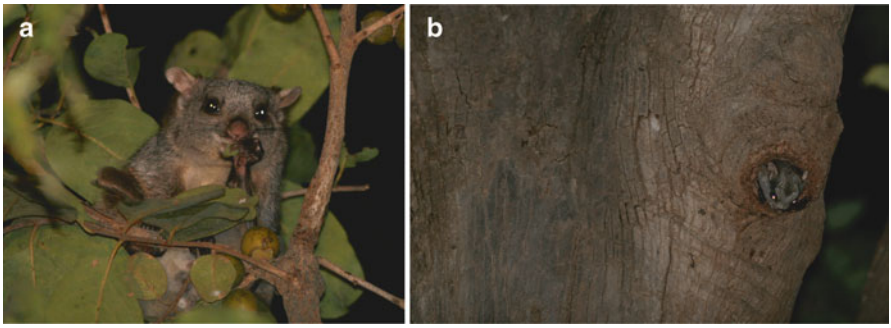



**Fig. 1.35** (**a**) Flying Squirrel on a tree at Sitamata WLS. (**b**) Flying Squirrel peeping out of the hole of a tree at Sitamata WLS. *Courtesy: Gobind Sagar Bhardwaj*

### Tal Chhapar WLS, Churu

Tal Chhapar is located 85 km away from the Churu town in Sujangarh *tehsil* of Churu district on the fringe of the Great Indian Thar Desert. The sanctuary has 7.19 sq km open grassland with an almost flat tract. Some small hillocks and exposed rocks of slate and quartzite are also found on the western side of the sanctuary. The area between hillocks and the sanctuary constitutes the watershed area. Tal Chhapar usually gets flooded during heavy rains causing inconvenience to the wildlife. The sanctuary cradles the most elegant antelope of India, the Blackbuck *A. cervicapra* (Fig. 1.36). The other dominant species present here include Bengal Fox, Gray Wolf, Chinkara, Jungle Cat, Golden Jackal and Nilgai while Cobra, Monitor Lizard, and Spiny-tailed Lizard constitute the reptiles. Open grassland of the sanctuary also attracts a large number of harriers and migratory raptors particularly during winters.

### Todgarh-Raoli WLS, Ajmer, Pali, and Rajsamand

The 463.03 sq km area of the sanctuary is a favorite tourist attraction due mainly to the 55 m high seasonal waterfall. *Dhok*, *Arjun*, and *Khair* dominate the forest while Sloth Bear, Wild Boar and Golden Jackal constitute the key wildlife of the sanctuary.

## *Conservation Reserves*

Four forest areas, namely, Beesalpur Gadwala of Tonk district, Jor beed Gadwala of Bikaner district, Sundhamata Hill Range falling under Jalore and Sirohi districts and Gudha Bishnoiyan of Jodhpur district have been declared as conservation reserve of Rajasthan during 2010–2012 as per Wildlife (Protection) Amendment Act, 2006.

**Fig. 1.36** Taal Chhapar Wildlife Sanctuary famous for a huge population of Blackbuck *Antilope cervicapra*. *Courtesy: Devendra Bhardwaj*

### Bisalpur Gaadwala Conservation Reserve, Tonk

With an area of 48.31 sq km, the Bisalpur Conservation Reserve located near the Tonk town surrounds the catchment of the River Banas. The Bisalpur Dam lies between the mountains. The flora and fauna of this area match that of a typical dry deciduous forest. The near extinct Indian Vulture (*Gyps Indicus*) is making a comeback to the state and to this reserve in particular, where four such birds were spotted in June 2009 on a hilltop close to the Bisalpur Dam.

### Sundhamata Conservation Reserve, Jalore, Sirohi

The Sundhamata Hill Range forest covers an area of 117.4892 sq km in the Jalore and Sirohi districts. The reserve forest has leopard as the key carnivore apart from common Striped Hyaena, Sloth Bear, Golden Jackal, and Jungle cat.

### Jor beed Gadwala, Bikaner and Gudha Bishnoiyan, Jodhpur

Jor beed Gadwala of Bikaner and Gudha Bishnoiyan of Jodhpur district were recently (2011–2012) declared as the new conservation reserves of Rajasthan covering an area of 56.4662 sq km and 2.3137 sq km, respectively. The flora and fauna found in these reserves are quite similar to that found in semiarid and arid climate.

## *Medicinal Plant Conservation Areas*

Seven areas belonging to Udaipur, Chittor, Ajmer, Banswara, Jaisalmer, Badmer, and Jodhpur districts have been recently demarcated as medicinal plant conservation areas in Rajasthan and a few more are in the process of being designated.

## *Mt. Abu Eco-sensitive Area (ESA)*

In 2000, a committee constituted by the Ministry of Environment and Forests (MoEF), Government of India approved the guidelines laying down parameters and criteria for declaring ESAs. Based on species (endemism, rarity, etc.), ecosystem (sacred groves, frontier forests, etc.), and geomorphological feature (uninhabited islands, origins of rivers, etc.). ESAs are meant to primarily restrict industrial and other developmental processes which are likely to seriously disturb the natural setup of the place. To this end, Abu Hills were declared as the first ESA of Rajasthan in June 2009, which includes the municipal limits as well as the adjoining parts of the Mt. Abu WLS covering an area of 45 sq km.

## *Kheechan, Phalodi (Jodhpur): A Potential Bird Sanctuary*

Located at the very edge of the Great India Thar Desert, the tiny Kheechan village lies only 3.6 km from the Phalodi *tehsil* and 150 km west of Jodhpur. The village has justifiably earned the admiration of ornithologists around the world for protecting and offering a safe habitat to a significantly large population of the Demoiselle Crane *Anthropoides virgo*. These birds regularly arrive here during September/October each year after making an almost 5,000 km journey from their original breeding habitat in Kazakhstan and Central Asia. Kheechan is now best known as the "Crane Village" attracting a large number of national and international tourists (Fig. 1.37).

An ancient human settlement that dates back over five centuries, Kheechan once ruled by the *Rajpurohits* (royal priests) is now inhabited by the tolerant communities that willingly share the scarcest water sources with about 10,000 cranes visiting each year. In fact, several ponds and wells are exclusively devoted to these revered "guests" who are looked after by both rich and poor. The Demoiselle Crane Conservation Organization or *Kurjan Sanrakshan Sansthan* as it is locally known, ensures that the birds are never short of either food or water at the special *Pakshi Chugga Ghar* (Bird Feeding Home; please also see Fig. 1.1, Chap. 11). Surprisingly, though the birds often settle in the fields and cause damage to the crops of millet and pulses, they are not attacked by the locals whose tolerance should be an inspiration for the people of India in general and Rajasthanis in particular.

Despite the goodwill that the birds enjoy, they too have their share of problems like other wild species. In times of extreme drought, for instance, many of the ponds run dry and the cranes are then forced to fly at a distant source where protection is

**Fig. 1.37** Kheechan is famous for thousands of Demoiselle Cranes. *Courtesy: Dr Anil Kumar Chhangani*

hardly assured. Tourism-related activities also impinge on their security, primarily when insensitive tourists approach them too close or try to feed them inappropriately. In recent times, the cranes are facing extreme threat from overhead live electricity cables leading to a hundred deaths every year [8].

## Proposed and Ongoing *in situ* Conservation Efforts

Rajasthan's forest department is playing a significant role in conserving the biodiversity of the state. Increasing population of villages situated near the PAs is causing a huge biotic pressure apart from the unnecessary stress and conflict between villagers and wildlife management staff. To this end, habitat improvement in the PAs, water management, forest fire control, and development of forest trails are being seriously looked into. The major accomplishments and key efforts currently underway in this direction are briefly described below [12] (detailed conservation efforts are mentioned in Chap. 20):

1. Creation of buffer zone near the PAs to reduce dependency of the villagers on protected forests.
2. Deployment of a large number of forest guards to ensure better protection of the PAs especially the national parks and tiger reserves following the establishment of Tiger Conservation Foundation.

3. Massive village relocation program at Ranthambhore and Sariska Tiger Reserves.
4. Water crisis at KNP, Bharatpur, solved to the satisfaction of villagers and the wildlife by lifting water from Govardhan Drain situated at Mathura, Uttar Pradesh. Siberian Crane Breeding Program is being initiated to revive them at Ghana.
5. Water-related problem at the PAs is being solved by undertaking novel water harvesting projects.
6. Two mega projects for the conservation of Keoladeo satellite wetlands and other areas lying outside PAs in the desert districts were recently launched.
7. Ecotourism-related projects are being initiated at Tal Chhaapar, Sariska, and Mount Abu WLSs.
8. Tiger relocation program at Sariska Tiger Reserve is underway since July 2008 where till date five big cats have been successfully air lifted from Ranthambhore National Park for re-introduction at Sariska.
9. Rajasthan Protected Area Conservation Society has been formed for better management of PAs directly under the chairmanship of the Chief Secretary.
10. The famous Ranthambhore tigress "Machhli" got "Lifetime Achievement Award" by the British High Commission. Unfortunately, the cat died in April 2012.
11. Conservation Reserve Eco-development Committees (EDC) and Joint Forest Management Committee (JFMC) to be created in every PA by involving local people for better forest and wildlife management.
12. The government of India decides to extend some PAs and develop corridors between (1) Ranthambhore National Park and Kailadevi Sanctuary, (2) Ramgarh Vishdhari Sanctuary to the Kunopalpur Wildlife Sanctuary, Shyopur district of the adjoining Madhya Pradesh state, and (3) Khandar to Darra. In addition, some new conservation and community reserves are also being planned.

## *Ex situ* Conservation: Zoos of Rajasthan

Since time immemorial, animals have been kept as pets or companion animals by people for livelihood, warfare, food, and entertainment. Emperors, kings, and the rich people maintained collection of wild animals in their palaces as status symbol and for amusement. Thousands of years before the Christ, priests in the ancient civilization of Egypt kept small collection of animals at the temples and churches where cats, dogs, baboons, lions, ibises, and many other animals were reared. In the twelfth century B.C., the Chinese Emperor Wen-Wang set up a 600 ha zoo Ling-U or the garden of intelligence which housed a large collection of animals. When the famous traveler Marco Polo visited China, he saw lions and tigers in captivity at the imperial palace [37].

The history of modern zoos in India is 136 years old. The first zoo was established in India in 1854 at Kolkata (West Bengal) by Raja Mullick Bahadur in a private mansion. In 1855, yet another zoo was set up by the Municipality of Madras (South India) in eight hac area close to the railway station which was closed down in 1980 and shifted elsewhere in a 510 ha area. It was named the Arignar Anna Zoological Park,

Vandalur, Chennai and is presently known as one of the modern zoos of India [38]. Likewise, the famous Mysore Zoo was founded in 1892 [38]. The Venkateswara Zoological Park in Tirupati, Indira Gandhi Zoological Park in Vishakhapatnam, Nehru Zoological Park in Hyderabad, National Zoological Park in New Delhi, and Sri Chamarajendra Zoological Garden in Mysore are some of the impressive zoos that have emerged in the last five decades. Zoo authorities aim at conserving the animal species whose populations have declined in order to restock depleted areas.

In India, as of today, there are 179 recognized zoos out of a total of 198 zoos. The existing oldest zoo in India is the Marble Palace Zoo at Kolkata city, established in 1854 while Sri Venkateshwara Zoological Park located in the Tirupathy city of Andhra Pradesh state is the largest zoo area wise (2,212 ha). The Indian zoos display 16,616 bird species, 19,203 mammalian species, and 7,665 reptilian species which include 84, 45, and 13 endangered birds, mammals, and reptiles, respectively.

## *Central Zoo Authority (CZA)*

In India, the administrative hierarchy begins with the Ministry of Environment and Forest (MoEF) which is the nodal agency for planning, promotion, and co-ordination pertaining to all environmental and forestry programs. The functioning of zoos in India is regulated by an autonomous statutory body called the Central Zoo Authority (CZA) constituted by the Central Government in 1992 under the provisions of Section-38A of the Wildlife (Protection) Amendment Act, 2006 to exercise the powers conferred on, and to perform the functions assigned to it under the act. The objectives assigned to the authority as spelt out in Section 38(c) of the WPA include among others, laying down standards for housing, upkeep and veterinary care of the animals kept in zoos and to provide technical and other support to the zoos to help them attain these standards with the objective of improving the quality of life of zoo animals, and complement the ongoing national efforts towards the conservation of wildlife. It, therefore, provides technical and financial assistance to such zoos which have the potential to attain the desired standards in animal management. Only such captive facilities which have neither the managerial skills nor the requisite resources are asked to close down. Apart from the primary function of grant of recognition and release of financial assistance, the CZA also regulates the exchange of animals of endangered category listed under Schedule-I and II of the WPA among zoos. Exchange of animals between Indian and foreign zoos is also approved by the authority before the requisite clearances under the Exim Policy and Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and permits are issued by the competent authority. The CZA also coordinates and implements programs on capacity building of zoo personnel, planned breeding programs, and *ex situ* research including biotechnological intervention for conservation of species for complementing *in situ* conservation efforts in the country [39].

## *Present Status of Zoos in Rajasthan*

In the state of Rajasthan, zoos were established to emphasize the significance of wild animals and their conservation, and to promote an understanding of biology, behavior, and distribution of various species. The zoo movement in Rajasthan began with the establishment of the Jaipur Zoo at Ramniwas Bagh in the year 1877 following which other zoos were established in major district headquarters at prime locations [38]. Approximately 1.0–1.5 million national and international tourists visit zoos of Rajasthan [40]. The Jaipur Zoo is well known for successful breeding of animals like Blackbuck, Crocodile, Gharial, Leopard, Sloth Bear, Chinkara, and Lion-tailed Macaque. Unfortunately, the stud book pertaining to tigers is generally not maintained or updated and hence, there is no authentic information about the subspecies these tigers belong to. If in these circumstances, breeding is allowed between two different subspecies, it can result in polluting the genome. The excess population of animals bred in the zoos shall ideally be transferred to animal relocation centers constructed near the PAs to make them acquainted with their natural habitat, but it is not practiced anywhere including Rajasthan. Rajasthan state owns a total of seven zoos recognized by the CZA while four more are yet to be recognized [39]. These zoos are jointly maintained by the state forest department, private sector, NGOs, and trusts.

The major Zoos of Rajasthan namely, Bikaner, Jaipur, Jodhpur, Kota, and Udaipur (Table 1.1) provide shelter to 48 avian species, 29 mammalian species, and 7 reptilian species. The Jaipur Zoo has the maximum number of faunal diversity, followed by Jodhpur, Udaipur, Kota, and Bikaner Zoos. The zoos of Rajasthan also hold animals belonging to the Schedule I and II categories in accordance with the Indian Wildlife Protection Act, 1972 (Boxes 1.1 and 1.2). The Schedule I avians include *Anthracoceros malabaricus*, *Chlamydotis undulata*, and *Ciconia ciconia*; mammals include *Antilope cervicapra*, *Melursus ursinus*, *Panthera leo*, *Panthera tigris tigris*, *Tetraceros quadricornis*, and *Ursus arctos horribilis*; reptiles include *Crocodylus palustris*, *Gavialis gangeticus*, and *Python molurus molurus* (Box 1.1). All the five zoos of the state are presently in the process of being shifted to Biological Parks, i.e., Jaipur Zoo to Nahargarh Biological Park, Udaipur Zoo to Sajjjangarh Biological Park, Jodhpur Zoo to Macheda Biological Park, and Kota Zoo to Abheda Biological Park.

## *Administrative Responsibility of Zoos in Rajasthan*

In Rajasthan, the responsibility of zoos is mainly shouldered by the Department of Forest, Government of Rajasthan, together with a few NGOs and private sector organizations. Zookeepers are largely responsible for the actual care of the animals within these institutions. The training of a zookeeper is very broad and covers many areas of modern animal husbandry and a basic knowledge of veterinary science and behavioral biology. Daily responsibilities of a zookeeper include cleaning and maintenance of animal enclosures (Fig. 1.38) and feeding the animals (Fig. 1.39). Some zookeepers prepare animal diets, report and record animal's health and behavior, or even assist

**Box 1.1** Schedule I Animals Protected in the Zoos of Rajasthan

**Schedule I Animals in the Zoos of Rajasthan:**

**Reptiles**

- *Crocodylus palustris* (Crocodile Marsh, Mugger)
- *Gavialis gangeticus* (Gharial)
- *Python molurus molurus* (Indian Rock Python)

**Aves**

- *Anthracoceros malabaricus* (Indian Pied Hornbill)
- *Chlamydotis undulate* (Houbara Bustard)
- *Ciconia ciconia* (White Stork)

**Mammals**

- *Antilope cervicapra* (Blackbuck or Krishna Mrig)
- *Melursus ursinus* (Sloth Bear)
- *Panthera leo* (Lion)
- *Panthera tigris tigris* (Tiger)
- *Tetraceros quadricornis* (Four-horned Antelope or Chowsingha)
- *Ursus arctos horibilis* (European Brown Bear)

**Box 1.2** Schedule II Animals Protected in the Zoos of Rajasthan

**Scheduled II Animals in Zoos of Rajasthan:**

**Mammals**

*Canis aureus* (Golden Jackal)
*Felis chaus* (Jungle Cat)
*Macaca assamensis assamensis* (Assamese Macaque)
*Macaca mulatta* (Rhesus Monkey)
*Macaca radiate* (Bonnet Macaque)

during treatment. Veterinarians provide medical care for the ill (Fig. 1.40) or injured animals including surgery, vaccinations, and routine physical examination. They also develop and implement preventive health care and help in determining healthy animal diets. Sometimes during patrolling or on the information of villagers, the forest department captures the injured animals and bring them to the nearby zoo for medication and after recovery they are rehabilitated in the wild (Figs. 1.41 and 1.42). Some animals which become handicapped are kept in the zoo for display.

**Fig. 1.38** Spacious cages provide more room to the inmates. *Courtesy: Sonali Singh*

**Fig. 1.39** Motherless Four-horned Antelope fawns are being fed by foster mother (a goat). *Courtesy: Sonali Singh*

**Fig. 1.40** An orphan panther cub rescued from wild is being treated by an experienced caretaker. *Courtesy: Sonali Singh*

**Fig. 1.41** Road accident victim, Hyaena under treatment in intensive care unit. *Courtesy: Sonali Singh*

**Fig. 1.42** Hyaena's broken leg has been given proper orthopedic surgery by covering with plaster. *Courtesy: Sonali Singh*

## Recommendation

1. Zoos should be open about their activities and should welcome close scrutiny of their welfare, breeding, research, and education programs.
2. The major goal of zoos should be to integrate all aspects of their work with conservation-related activities. Animal should be displayed in a near natural setting with a correct and detailed name tag.
3. Zoos and their managing authorities should pursue a strategy of integrated conservation and strive to allocate their financial and human resources carefully and intelligently. They should promote maximum cohesive and strategic thinking and collaboration. This will achieve greatest sustainable conservation benefit for threatened species, their habitats, and human neighbors.
4. Zoos should act as primary centers of expertise in small faunal population management and should be actively involved in regional, national and global cooperative breeding programs. All such programs should be based on sound knowledge using the latest available data on population management, reproductive biology, genetics, behavior, physiology, nutrition, veterinary care, and animal husbandry.
5. The number of animals in each enclosure should be decided by experts for comfortable living and effective management related to their natural-social organization and mean group size.

**Fig. 1.43** Both recreation and education to visitors especially children who are fond of animals is a must. *Courtesy: Sonali Singh*

6. In cases where translocation is recommended, methods to be employed should be strictly based on the guidelines of reintroduction specialist.
7. Interpretation centers should be built in zoos to provide scientific information about animals, their habits and habitat, and special features.
8. Enclosures should have a board displaying picture, name, identifying features, and current status according to the IUCN which should be regularly reviewed and updated. Zoos should ensure that education is a central part of their mission (Fig. 1.43).
9. Rules and regulations should be displayed on a notice board at the very entrance of a zoo to make the visitor aware of their role in maintaining the integrity of such artificial habitat. To this end, audio-visual techniques can be very effective in providing knowledge regarding conservation and good conduct at zoos.
10. Eating and drinking by visitors should not be allowed near animals enclosures. Animal teasing and feeding by visitors should also be strictly prohibited.

## Important Bird Areas (IBAs) in Rajasthan

The Birdlife International, United Kingdom, along with the Bombay Natural History Society (BNHS), Mumbai has identified some areas with rich avifaunal diversity and named them as Important Bird Areas (IBAs) [22, 31]. Three biomes cover the

**Table 1.4** Important Bird Areas (IBAs) of Rajasthan

| S. No. | District | IBA site name |
|---|---|---|
| 1. | Kota | Alniya Dam |
| 2. | Bundi | Bardha Dam |
| 3. | Jaisalmer and Barmer | Desert National Park (DNP) |
| 4. | Bikaner | Diyatra |
| 5. | Ajmer | Gawana Arain, Mangaliyawas, Ramsar, Goyal, Ratakot, Badar |
| 6. | Udaipur | Jaisamand Lake and Wildlife Sanctuary |
| 7. | Bharatpur | Keoladeo National Park |
| 8. | Jodhpur | Khichan Village |
| 9. | Udaipur, Pali, Rajsamand | Kumbhalgarh Wildlife Sanctuary |
| 10. | Sirohi | Mount Abu Wildlife Sanctuary |
| 11. | Kota, Bundi | National Chambal Wildlife Sanctuary |
| 12. | Udaipur | Phulwari Wildlife Sanctuary |
| 13. | Sawai Madhopur | Ranthambhore Tiger Reserve |
| 14. | Udaipur | Sajjangarh Wildlife Sanctuary |
| 15. | Nagour, Jaipur, Ajmer | Sambhar Salt Lake |
| 16. | Bhilwara | Sareri Dam |
| 17. | Alwar | Sariska Tiger Reserve |
| 18. | Udaipur | Sei Dam |
| 19. | Chittourgarh, Udaipur | Sitamata Wildlife Sanctuary |
| 20. | Ajmer | Sonkhliya |
| 21. | Churu | Tal Chhapar Wildlife Sanctuary |
| 22. | Udaipur | Udaipur Lakes Complex |
| 23. | Udaipur | Bagdarrah Area |
| 24. | Bundi | Ramsagar Dam |

*Important Bird Areas of India: Priority Sites for Conservation.*
*Source*: Islam IA and Rahmani AR (2004). Indian Bird Conservation Network (IBCN), Bombay Natural History Society and Birdlife International (UK). P1133

state of Rajasthan namely, Indo-Malayan tropical dry zone, Sahara-Indian Desert, and Indo-Gangetic Plains and hence, the huge diversity of avifauna. Rajasthan at present has 24 IBAs located in various habitats (Table 1.4).

Ranthambhore and Sariska are the two tiger reserves included in the list of IBAs. KNP in Bharatpur district is of international importance for its rich avifauna and migratory birds and meets all the four criteria of an IBA. Pichhola Lake (Fig. 1.44) and Fateh Sagar (Fig. 1.45) of Udaipur and the large reservoir of Alniya at Kota (Fig. 1.46) also own a massive bird population. Sambhar Salt Lake spread in three districts, namely, Jaipur, Nagour, and Ajmer [41] (Fig. 1.47) is yet another IBA.

About 510 species of birds can be seen in Rajasthan [42]. Birds of interest in the IBAs of Rajasthan include, Ashy-crowned Sparrow Lark *Eremopterix grisea*, Syke's Lark *Galerida deva*, Asian Brown Fly-catcher *Muscicapa dauurica*, Bay- backed Shrike *Lanius vittatus*, Long-tailed Shrike *L. schanch*, Black-breasted Weaver *Ploceus benghalensis*, Black-hooded Oriole *Oriolus xanthornus*, Bluethroat *Luscinia svecica*, Booted Warbler *Hippolias caligata*, Crested Bunting male *Melophus lathami*, European Roller *Coraceus garrulous*, Indian Courser *Cursorius*

**Fig. 1.44** Pichhola Lake, Udaipur. *Courtesy: Devendra Bhardwaj*

**Fig. 1.45** Fateh Sagar, Udaipur. *Courtesy: Devendra Bhardwaj*

**Fig. 1.46** Sambhar Salt Lake, Sambhar (Jaipur) is famous for flamingos. *Courtesy: Devendra Bhardwaj*

**Fig. 1.47** The Large Reservoir of Alniya (Kota) is a paradise for both resident and migratory birds. *Courtesy: Rakesh Vyas*

*coramandelicus*, Indian Roller *Coracias benghalensis*, Kentish Plover *Charadrius alexanderinu*, Pied Kingfisher *Ceryle rudis*, Stork-billed Kingfisher, Streak-throated Swallow *Hirundo fluvicola*, Painted Francolin *Francolinus pictus*, and Chestnut-bellied Sandgrouse *Pterocles exustus*. Almost 60% of the geographical area of Rajasthan is desert, yet the grassland patches of eastern Rajasthan hold significant numbers of the Lesser Florican. Although, the threatened species of avians from Rajasthan have been enlisted in the appendices, few are mentioned below for a ready reference.

*Critically Endangered Avians*: White-rumped or White-backed Vulture, Indian Vulture, Red-headed Vulture, Great Indian Bustard and Sociable Lapwing

*Endangered Avians*: Lesser Florican, White-headed Duck (stray record), and Egyptian Vulture.

*Vulnerable Avians*: Lesser Adjutant, Lesser White-fronted Goose, Baer's Pochard, Pallas's Fish-eagle, Grater Spotted Eagle, Eastern Imperial Eagle, Macqueen's or Houbara Bustard, Sarus Crane, Indian Skimmer, Stoliczka's or Whit-browed Bushchat, Pied Tit, and Green Avadavat.

*Near Threatened Avians*: Oriental Darter, Painted Stork, Black-necked Stork, Oriental White Ibis, Lesser Flamingo, Ferruginous Duck, Grey-headed Fish-eagle, Cinereous Vulture, Pallid Harrier, and Black-bellied Tern.

*Birds for which Rajasthan is globally known*: Long-billed and White-backed Vultures, Great Indian Bustard and Sociable Lapwing (CR), Lesser Florican (EN), Houbara Bustard (VU), Stoliczka's or White-browed Bushchat (VU), Pied Tit (VU), Green Avadavat Munia (VU), and Demoiselle Crane (LC) [31]. Please refer to Chaps. 1, 2 and 3 from *Faunal Heritage of Rajasthan: Ecology and General Background of Vertebrates*, Vol. 1; B. K. Sharma et al. (eds.), 2013 and Chap. 8 from this volume for pictures of some of the above-named and other birds from Rajasthan.

## Gaps in Research

The PA network is actually unevenly distributed over various biogeographical regions in the state of Rajasthan and less than 1% of it is under proper legal cover despite being biodiversity rich. There is an immense need to identify new PAs in the state and to comprehensively review the wise use of available natural resources. Many PAs in the state are yet to complete the legal procedures of being converted to conservation reserves, since, the concept of closed areas no more exists. The issues related to the settlement of rights are yet to be resolved. This impedes proper management of these areas. Even, the areas where legal procedures have been completed, consolidation and strengthening of efforts with a system of sharply focused priorities are required together with effective management. As of now, the attention is focused on the conservation of large mammals and almost no attention is usually paid to conserve plants and the smaller animals in general. Consequently, there are gaps in information on several biological and managerial parameters. Unfortunately, the developing countries currently face immense pressure due to the incessantly increasing human population followed by the use, overuse and abuse of such areas

in the name of sustenance of local people [43, 44]. Continuous demands are coming to open such area for the locals if their long-term sustenance is guaranteed. There is an urgent need to create more PAs to preserve our faunal heritage [45, 46]. Please see Chaps. 1, 2 and 3 from *Faunal Heritage of Rajasthan: Ecology and General Background of Vertebrates*, Vol. 1; B. K. Sharma et al. (eds.), 2013 and Chaps. 8, 18 and 20 from this volume for more pictures and relevant details.

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**Epilogue by the editors** At the time when the tiger population is fast dwindling, India has reported an alarming increase in tiger deaths. The country has 41 tiger reserves in 17 states, of which 25 have a notified buffer zone. Nearly 40% of the total deaths have been caused due to poaching. The National Tiger Conservation Authority (NTCA) has stated that the rising demand for tiger parts in various south-east Asian countries and the increasing man–animal conflict are the key reasons for the rise in tiger deaths. The country had witnessed 56 tiger deaths in 2011, when the number of poaching cases was relatively small and only nine out of these deaths were reported to have been caused due to poaching. However, the NTCA has now declared that all deaths will be treated as poaching unless proved otherwise. According to the May 2011 census, India hosts a majority of the world's tiger population at about 1,700. Despite their protected status and creation of special reserves, tigers continue to remain vulnerable due mainly to the huge market for the body parts of this animal. Despite the creation of Special Tiger Protection Force (STPC) in 13 reserves of the country, many STPCs are still to get off the ground except in the state of Karnataka. Interestingly, out of the Rupees 2,000 million annual budget allocated for tiger protection, the bulk goes for anti-poaching operations which now include sophisticated electronic or e-eye surveillance and towers equipped with thermal imaging cameras. With 30% tigers still living outside the protected areas, India is yet to implement some of the important recommendations of the Tiger Task Force (TTF) set up in 2005 (soon after the Sariska debacle) to examine issues involved in tiger conservation.

After the shocking news of January 2005 that no tigers are left in Sariska, the Government of Rajasthan in cooperation with the Government of India and the Wildlife Institute of India (WII) planned re-introduction of tiger which was accomplished in June 2008, February 2009 and July 2010. At present, five tigers—two males and three females—are dwelling in the reserve. The state of affairs at Ranthambhore National Park is also worrying the wildlife lovers and conservationists. Tigers leaving their protected territory to reach faraway places has given a hard time to forest guards with six of them leaving the park during recent years to inhabit other forests far and near whereas, death of tigers following territorial fight owing to shrinking forest cover and human encroachment has now become a serious concern with nine tigers killed during the past four years. It is worthwhile to mention here that, this book is covering in an altogether separate chapter, the firsthand account of the historic tiger re-introduction in Sariska written by the scientists and forest officials who were actually involved in the entire operation. It is a sigh of great relief that, besides 26 adult tigers, 25 cubs born during January 2011 to June 2012, currently inhabit the Ranthambhore Tiger Reserve.

On July 9, 2012, the Government of Rajasthan has cleared the forest department's plans to create buffer zones in the peripheries of Ranthambhore National Park (RNP) where in future the growing population of tigers can move from the park's core area. This will now be looked into and finally approved by the National Tiger Conservation Authority (NTCA). These buffer zones would be developed in the 647 sq km Kailadevi Sanctuary and the 127 sq km Sawai Mansingh Sanctuary adjoining the 392 sq km core area of the RNP. In addition, plans to develop natural corridors or "eco-corridors" connecting the Ranthambhore forest with Kailadevi Sanctuary have also been finalized. For this, 23 villages from the sanctuary will be relocated outside the forest area and the

forest land thus vacated will be used to develop prey base for the tiger. Conservationists, however, are in favor of developing corridors connecting all the tiger reserves in Central India in order to have a natural mix of genes among the entire tiger population thriving at Ranthambhore and Sariska in Rajasthan and that of Palampur Kuno in the adjoining state of Madhya Pradesh.

It is clearly felt that establishment of the Desert National Park (DNP) in Rajasthan as an ace project of the Indian government has positively affected the wildlife, in addition to promoting international tourism. Apart from its strategic importance for Indian defense, the park attracts a large number of investigators from the realms of zoology, botany, agriculture, sociology, geology, geography, non-conventional sources of energy and pedology. Though deficient in water resources, the DNP has rich mineral deposits, in addition to oil and natural gas. Expansion of settlements on account of increase in human population, uncontrolled tourism and over-exploitation of natural resources may prove detrimental to the park. Another major threat is the proposal to build a canal that will bisect the park and bring many ecological changes. The unparalleled floral and faunal diversity of the DNP not only provides a rich feast to the ecologists and historians but also unfolds intricacies of a natural ecosystem. The DNP is perhaps among the most unique parks in the desert region of the world. Proper management plans for the DNP and surrounding PAs are imperative for the conservation management of Rajasthan's wildlife.

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# Chapter 2
# Climate and Other Environmental Factors Influencing Faunal Ecology of Rajasthan

**A.S. Rao and B.K. Sharma**

**Abstract** The chapter throws light on a broad spectrum of the climate in Rajasthan ranging from arid and semiarid to subhumid types with an annual rainfall of less than 100 mm in the western Thar to more than 1,000 mm in eastern Rajasthan and their impacts on the faunal ecology. The pressure of human and livestock population is also one of the causative factors for scarcity of land and water resources. The drought year is often followed by good rainfall years. The impact of industrialization, urbanization, mining of minerals and oil, etc., on the interrelationship of fauna and the fast changing climatic conditions have been also discussed. For arid Rajasthan, global circulation model (GCM) predicts more hot days as well as warmer nights. This chapter concludes that changing climate and environment can lead to faunal migration or habitat loss or may even alter their adaptive capacity to new environments.

## Introduction

The state of Rajasthan occupies the largest geographical area of 342,000 sq km in India with variable climatic conditions for the adaptation of different species in different agroclimatic regions and, hence, presenting the unique faunal diversity. Low and erratic rainfall, extreme temperatures, high wind, and low humidity conditions make it inhospitable to major Indian fauna, particularly in the Thar Desert of the western Rajasthan.

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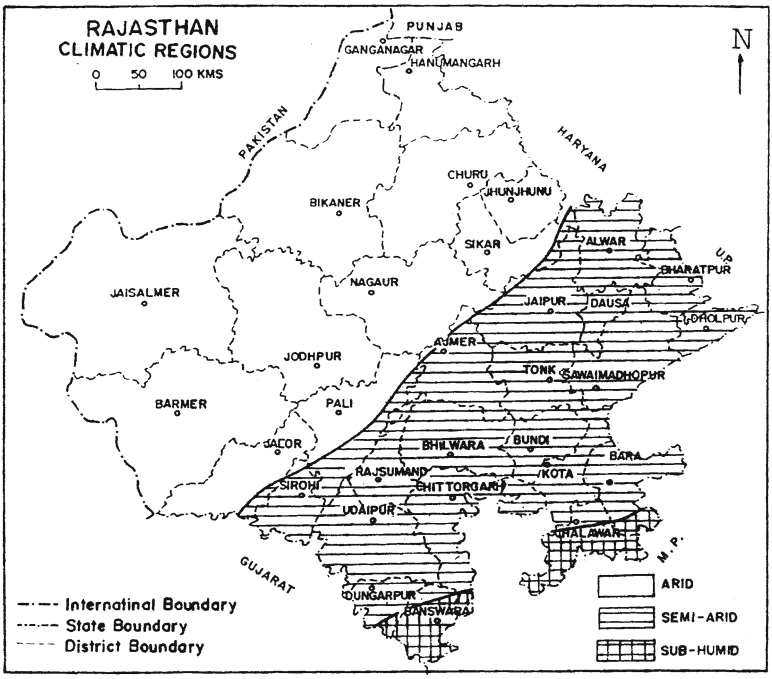


**Fig. 2.1** Climatic regions of Rajasthan

Rajasthan state can be broadly divided into arid, semiarid, and subhumid regions (Fig. 2.1). The western Rajasthan covering an area of 143,842 sq km of the districts Barmer, Bikaner, Churu, Ganganagar, Hanumangarh, Jaisalmer, Jalore, Jhunjhunu, Jodhpur, Nagour, Pali, and Sikar is under the influence of arid climate. In this arid region, rainfall is low and has high annual variations creating inhospitable living conditions to both humans and livestock. Extreme arid conditions with annual rainfall of less than 250 mm prevail in an area of 9,290 sq km in extreme western parts of the state [1]. However, there is an improvement in the rainfall pattern from the west toward the east.

The semiarid area of 66,830 sq km covers the districts of Ajmer, Alwar, Bharatpur, Bhilwara, Bundi, Chittourgarh, Dungarpur, Jaipur, Kota, Sawai Madhopur, Sirohi, Tonk, Udaipur, and parts of Jhalwar, and the subhumid region of 3,200 sq km covers parts of Jhalwar and Banswara districts in the extreme eastern part of the state.

## Climate Characteristics of Rajasthan

Though the southwest monsoon is a regular cyclic process over the region, its behavior is often unpredictable. This erratic nature becomes extreme over arid zone of western Rajasthan. This gives rise to drastic variation in the rainfall pattern resulting in drought in some areas and flood in other areas. Recurring abnormalities

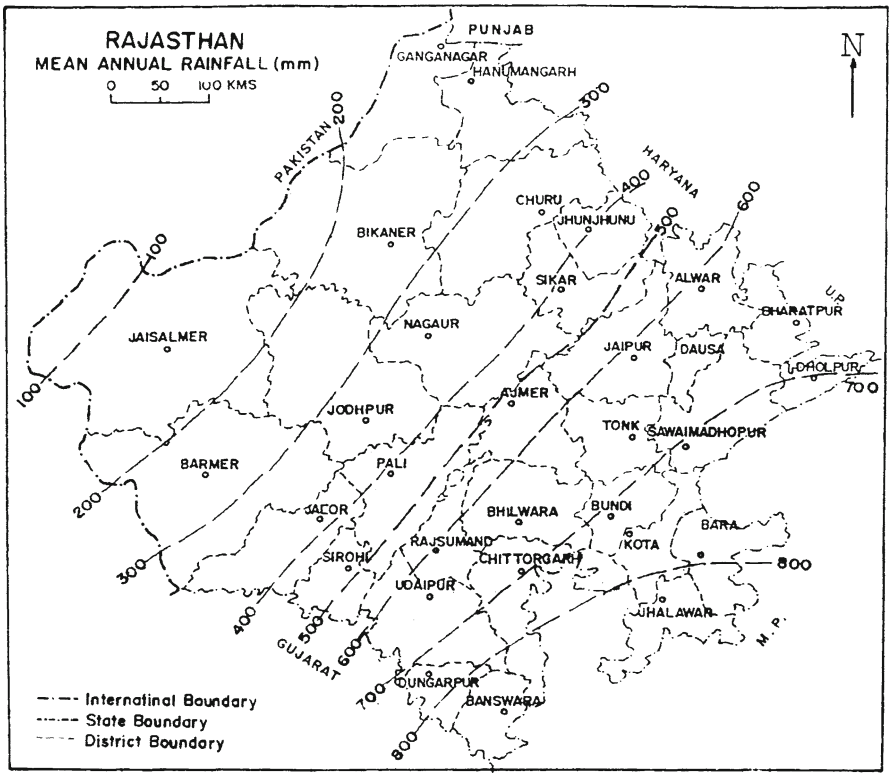


**Fig. 2.2** Mean annual rainfall (mm) distribution over Rajasthan

bring about serious shortfall in food grain and fodder production as well as scarcity of drinking water, leading to the stress on the inhabiting fauna, particularly in the arid regions.

Rajasthan like other parts of India experiences three seasons in a year: summer, monsoon, and winter. During the dry and hot summer, the temperature oscillates from 28 to 46°C, and during the winter, extending from December to March, the temperature remains 8–28°C in most of the parts except the desert. The rainy season falls in the months of July–September.

## *Rainfall Distribution*

The mean annual rainfall over Rajasthan varies from less than 100 mm in the extreme western parts of Jaisalmer district to more than 450–900 mm in the western parts of Jhalwar and Banswara (Fig. 2.2). The isohyets run from south–southwest to north–northeast over Rajasthan with an increasing gradient toward the eastern Rajasthan. These steep gradients in isohyets of the eastern parts of

the state are due to the influence of rainfall toward the west of Aravallis. About 85% of the total rainfall is received during the southwest monsoon period extending from June to September. Remaining portion of rainfall is received in the winter (January–February) in association with western disturbances. According to the Meteorological Department India, the normal date of advancement of monsoon over eastern Rajasthan is 20th June, which gradually extends to the west Rajasthan by 15th July. There can be a deviation of 25 days from normal dates of onset of monsoon, but withdrawal starts in the first week of September and completes within a week.

During past 100 years, the lowest recorded rainfall was 24 mm in the western Rajasthan, whereas it was never below 120 mm in the eastern Rajasthan. The recorded highest rainfall was between 454 and 1,175 mm in western Rajasthan, whereas it was between 123 and 1,698 mm in eastern Rajasthan. Though the quantum of rainfall received is low, high-intensity showers are common in the region. The maximum 24-h recorded rainfall in Rajasthan varied from 129 to 256 mm. The number of days (>2.5 mm) were 8–30 days in arid and 32 in 47 days in semiarid and subhumid regions. The frequency of rainy days normally increases with an increase in annual rainfall in the state.

The coefficient of variation of annual rainfall (CV%) was 30% in eastern Rajasthan and gradually increases to 70% toward western parts of the state. The CV line of 30% almost passes through the line demarcating arid and semiarid regions. High CV values indicate greater variability in the annual rainfall of these regions. A typical example of rainfall variability in arid region can be seen from the records of Jodhpur district which received 1,168 mm in 1917 followed by only 38 mm in 1918 and 53 mm in 2002. Such low and erratic rainfall leads to drought and famine conditions especially in the western Rajasthan. The average frequency of such drought is once in every three years in arid areas, whereas once in every four-five years in semiarid and subhumid regions. In western Rajasthan, the maximum precipitation expected once in two years' return period varies from 160 mm at Jaisalmer to 405 mm at Sikar. It is also expected that once in 100 years, it also shoots up to 720 mm at Jaisalmer and 1,200 mm at Nagour in the arid region.

## *Solar Radiation and Sunshine Availability*

Rajasthan region receives abundant quantities of solar radiation especially in the western parts of the state. The computed mean annual solar radiation in the state varies from 19.3 MJ $m^{-2}$ $day^{-1}$ at Hanumangarh to 20.3 MJ $m^{-2}$ $day^{-1}$ at Kota. The peak solar radiations of the range 24.5–27.1 MJ $m^{-2}$ $day^{-1}$ occur during April and May. The mean duration of bright sunshine hours in the region is 8.3–8.8 h $day^{-1}$, but in the rainy month of August, the bright sunshine is available for only 4.4 to 7.1 h $day^{-1}$, whereas it is for a period of 9.6 to 9.8 h $day^{-1}$ in October and 10.0 to 10.5 h $day^{-1}$ during April and May [2].

## *Air Temperature and Relative Humidity Conditions*

The mean maximum air temperature in Rajasthan varies from 38.6 to 42.6°C in the month of May, and during this period, western part of the state turns into the hottest place in the country. However, due to lack of proper vegetation cover, the sandy soils of this region cannot retain the heat, resulting in the pleasant temperatures during the night even in summer period. Winter is comfortable in the state with mean night temperature of 4.7–10.6°C. The recorded extreme temperatures in the state are –4.4 to 50.0°C in the western Rajasthan and –2.8–47.8°C in the eastern Rajasthan. Relative humidity in the arid region of western Rajasthan is also quite high compared to other semiarid and subhumid regions which indicates that low precipitation occurs in the arid region only because of the unfavorable conditions of the atmosphere.

## *Wind Regime and Associated Phenomena*

Winds are light and variable during winter period, but strong winds prevail during May–July in the most parts of Rajasthan. Jaisalmer region experiences strongest winds with a mean speed of 23.4 km/h during summer period. Wind speed gradually reduces toward the northern and eastern parts of the state. The wind direction is northeast to the north in the winter, while it is south-westerlies or westerlies during the rest of the year.

During severe dust storm period, the wind speed rises up to 60 kmph and causes erosion of the dry soil. It also lifts the soil particles high in the air with the turbulence of the wind. The frequency of dust storms during summer period is highest in the Ganganagar region. Bikaner, Jodhpur, and Jaipur experience moderate number of dust storms, whereas the east and northeastern parts of the state experiences lowest number of dust storms. Jaisalmer region is exposed to high winds but experiences lowest number of dust storms due to its geographic setup and rocky and hard soil conditions prevailing in that area. A quantum of monsoon rainfall received during the subsequent years in the arid region has established a significant relationship with dust storm activity. Also, the dust storms and dust-rising winds deplete the solar radiation, curtail the diurnal temperature range, and increase the mean air temperatures by 2–3°C.

## *Evapotranspiration Requirements*

Potential evapotranspiration is referred to the total water loss through evaporation from soil and water bodies and transpiration from plants. The annual potential evapotranspiration values of Rajasthan computed according to Penman's formula [3] vary from less than 1,300 mm in the districts of Dungarpur and Banswara in

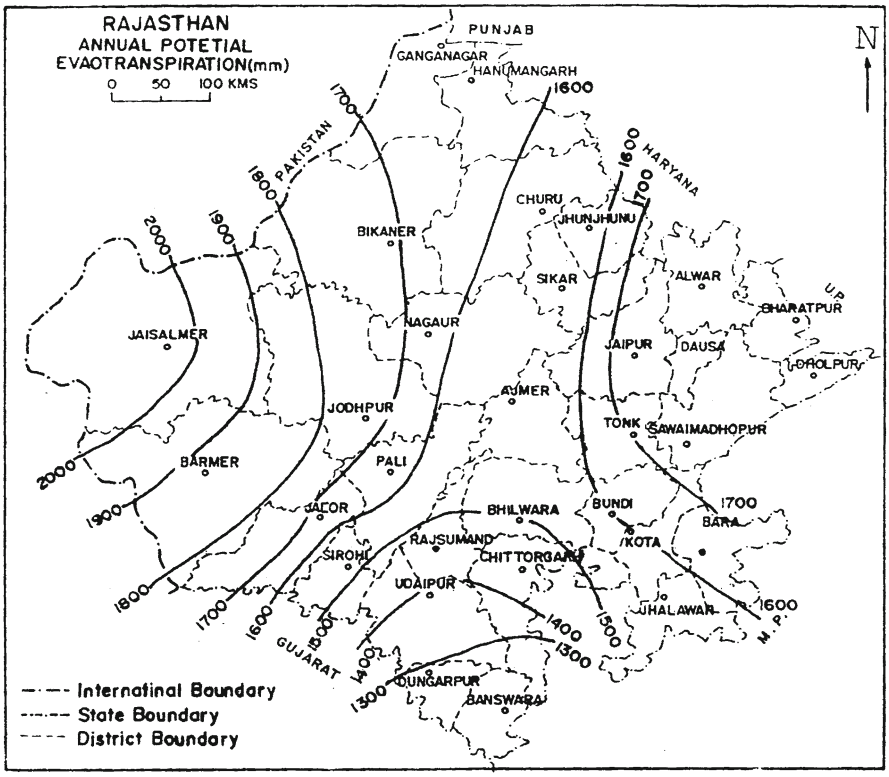


**Fig. 2.3** Mean annual potential evapotranspiration (mm) over Rajasthan

eastern Rajasthan to more than 2,000 mm in Jaisalmer district in the western Rajasthan (Fig. 2.3). Comparison of rainfall with potential evapotranspiration indicates that the evaporation is several times higher than the rainfall received in these areas.

## *Paleoclimatic Changes*

Studies conducted on paleoclimatic changes occurring over northwest India covering Rajasthan and adjoining area indicate that the region experienced alternate wet and dry phases for prolonged periods but is currently experiencing aridity.

Multiple evidences for the past climatic changes in Rajasthan were obtained from the analysis of sediment samples of Mulhar Rann, Gudha, Chamu, and Chirai in and around Jodhpur district [4]. Analysis of Mulhar Rann sediments in the region showed significant fluctuations in the lake levels reflecting climatic changes in the past. Gudlai Nadi, Chamu, and Chirai sediment profiles indicated an alternation of wet and dry phases which can be dated back to 7,000 ± 500, 15,000 ± 2,000, and

>40,000; from the current decade 7,000 years from now, there was a wet place in the northern salt lake of Rajasthan coinciding the wet phase period of Gudlai [5]. Pant and Maliekal [6] reported that the climate of Rajasthan and northwest India was subjected to large-scale fluctuations during the last 10,000 years and the recent arid phase has a history of more than 3,000 years.

Singh [7] studied the rainfall in the Rajasthan region during the past 10,000 years which shows that the civilizations of Harappa and Mahenjodero in the Indus valley flourished 2,500 and 1,700 years back when the mean annual rainfall was between 500 and 800 mm.

## *Climatic Changes During 1900–2008*

The global warming as a result of increased presence of greenhouse gases could lead to a threat to future food security and depletion in natural resources directly or indirectly through anomalies in weather patterns. The main reason for the global warming is heating up of the atmosphere caused by imbalance in incoming and outgoing radiation levels, a phenomenon referred as "greenhouse effect." Among the main greenhouse gases (GHG), viz., water vapors, carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2$), and chlorofluorocarbons (CFC), $CO_2$ is the largest contributor to the total increase in global temperatures. If $CO_2$ emissions continue to increase at near current levels, concentrations will reach to 500 ppmv, twice the preindustrial concentrations by the end of the twenty-first century [8, 9]. The IPCC of the World Meteorological Organization (WMO) projected an increase of 0.1–0.3°C by 2000 in South Asia, and an increase in global mean surface temperature of about 2.5°C by 2100 relative to 1990 mean is expected. It was estimated that the implication of climate change might result in a decrease in annual crop production in the South Asia region [10]. The impact of the climate change by twenty-first century is more likely in arid ecosystem than in semiarid or subhumid regions [9].

In the context of global warming leading to climatic change, several studies made on long-term climatic changes and its variability in different locations of Rajasthan confirm an increase in annual rainfall at some of the stations in the region. Winstanley [11, 12] analyzed the rainfall of Bikaner and Jaisalmer of northwest India and reported that the monsoon in the arid region was favorable during 1900–1930 and has been unfavorable since 1970. Pant and Hingane [13] studied the trends in rainfall and temperature in northwest India covering Punjab, Haryana, west Rajasthan, and west Madhya Pradesh during 1901–1982 which showed an increasing trend in the mean annual rainfall (141.3 mm per 100 years) and a decreasing trend in air temperatures (–0.52°C per 100 years), contradicting the earlier studies made by Winstanley [11, 12].

The studies on the secular changes of arid region show that there is a similar annual rainfall in the arid districts during 1901–2006 (Fig. 2.4). However, climatic changes along the tracts of Indira Gandhi Canal command region showed that

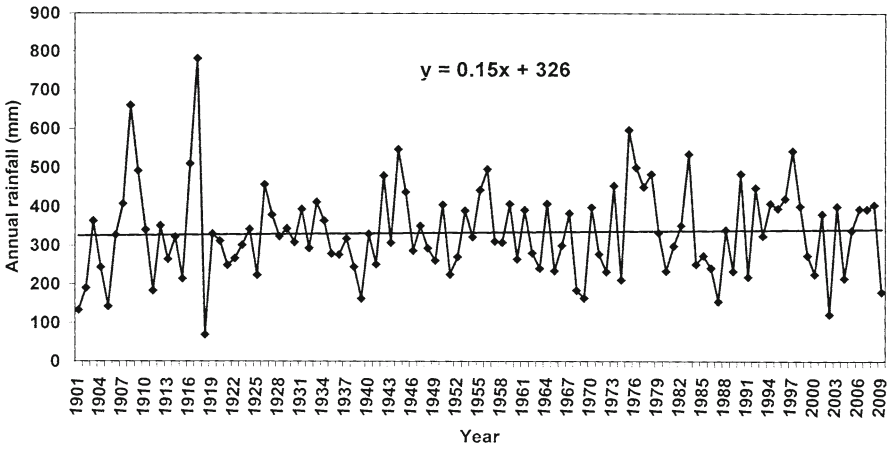


**Fig. 2.4** Long-term rainfall trend of arid Rajasthan

though Ganganagar region has been imposed with canal irrigation during the last six decades, an increase in annual rainfall was apparent only during the last three decades. The long-term rate of increase in the annual rainfall (1926–1993) of Ganganagar was 1.03 mm year$^{-1}$. However, the irrigation effect on rainfall was not observed in Bikaner and Jaisalmer. In general, decrease in the air temperature was observed in the region at a rate of 0.049°C year$^{-1}$ at Ganganagar, 0.02°C year$^{-1}$ at Bikaner, and 0.01°C year$^{-1}$ at Jaisalmer [14]. The annual rainfall at Osian showed an increased trend of 64.2 mm/38 years during 1857–1894 and 55.8 mm/94 years during 1901–1994 at Jodhpur. But there was quite considerable interannual variability in rainfall with periodic trends reversing with a gap of 5–12 years [15].

## Other Environmental Factors

The introduction of canal irrigation in the arid region has brought many changes, not only in vegetation and land use, but also in rainfall patterns, particularly in Sri Ganganagar district which is well irrigated since several decades. Due to this increased water availability, xeric faunal species are being replaced by "mesic" species, and some minor pests of the region are becoming a major problem [16, 17]. The Gang Canal in 1927 and the Indira Gandhi (IGNP) Canal in 1961 were initiated to divert water from the eastern rivers of the Indus system, viz., the Ravi and Beas Rivers, to arid western Rajasthan. The IGNP canal, utilizing 7.59 MAF of Ravi-Beas water, is planned to irrigate 11.43 lakh ha in Sri Ganganagar, Bikaner, and Jaisalmer.

Fauna is also greatly affected by mining activities. The state has 21.7% share of India's total mines. Rajasthan is the major producer of zinc, lead, silver, marble, and gypsum.

These spoilt soils should be properly reclaimed to regenerate vegetation for supporting the ecological balance.

Human population in the state has grown up by 232% from the level of 1901, which includes increase by 28% in rural and 59% in urban population. Besides urbanization, industrialization has rapidly taken place in the districts of Jaipur and Jodhpur, while Kota, Pali, Udaipur, and Ajmer districts are emerging as the industrial centers of the state. The pressure of population, urbanization, and industrialization leads to degradation of natural resources.

In Rajasthan, petroleum exploration and development activities have gained momentum after the largest oil discovery of Mangla 2004 in Barmer-Sanchore Basin in the last two decades of India. A total of 480 million tonnes oil in-place reserves (3.5 billion barrels) have been proved in 22 discovered fields of Barmer-Sanchore Block. Out of these, five fields shall start the commercial production from the year 2009 onwards. Oil exploration leads to *in situ* burning of the waste gases and may spill the oil affecting the environment. Burning the oil generates a large amount of smoke containing particulates and toxic gases. Particulates are of the major concern, as their concentration in the center of the plume remains above the level of tolerance by the human population and fauna for several miles downwind. Countries like Iraq, Russia, Nigeria, and Iran are regarded the highest in rank for burning natural gases and release of millions of tonnes of $CO_2$ to the atmosphere. Iraq alone flares up 600 million feet$^3$/day of natural gas due to lack of utilization facilities. Instead of burning of natural gas, the $CO_2$ emission can be reduced if hydrogen is separated from the natural gases and burnt for power generation in turn producing pure water and reducing $CO_2$ emission up to 90%.

The oil spill releasing a liquid petroleum hydrocarbon into the environment affects birds and mammals. Studies show that birds and mammals are more capable of handling the risk of a local fire and temporary smoke plume than the risk posed by a spreading oil spill. Therefore, reducing the spill size by burning the spilled oil can reduces the overall hazard to mammals. Once coated by oil, neither birds nor mammals have responded well to rehabilitation efforts, and although much has been learned and rehabilitation methods have greatly improved, the success rate of wildlife rehabilitation has been moderate with the best efforts [18, 19].

## Interrelationships Between Microclimates and Fauna

The Thar Desert is considered as the eastern extremity of the northern tropical desert belt, which starts from the Atlantic Coast of Africa through the Sahara on to parts of Arabia, Iran, and Pakistan, and thus the fauna exhibits western affinities The reptilian, avian, and mammalian faunas of the Thar show greater affinity to the west, and most species are of Palearctic origin. Out of 65 mammal species, 35 mammals have Palearctic (refers to eco-regions of north of Himalayas) affinities, 30 are oriental, and three species, viz., *Mus platythrix*, *Mus phillipsi*, and *Cremnomys cutchicus*, are endemic in their distribution [20]. Most of chiropterans, rodents, and all pri-

mates, pholidata and Lagomorpha, are oriental in distribution. Some species of Bats (*Rhinolophidae Triaenops persicus* and *Rhinopomatidae Rhinopoma muscatellum*) and birds (*Parus nuchalis* or White-naped Tit and *Prinia burnesii* or Rufous Prinia) are confined to desert [21].

The vertebrates inhabiting the arid environments have evolved morphological, physiological, and behavior strategies for combating the harsh climatic conditions. Mammals in low rainfall have a lower metabolic rate than closely related species found in mesic habitat [22]. An adaptation reduces the chances of overheating in burrow environment and also reduces the water loss through respiratory passage. To escape from the vagaries of extreme temperatures, most of the small- and medium-sized mammals are nocturnal in habitat. Most of the vertebrates synchronize their breeding activity with the monsoon period due to availability of green food.

Minimal thermal conductance and high normal body temperatures have been considered to be helpful in physiological adjustments to avoid the chances of a lethal heat stroke due to overheating. The low minimal thermal conductance among the nocturnal desert rodents, like *Tatera indica*, may be advantageous in conserving energy during their surface activities in the cool hours of the night [20]. A high body temperature and normal skin temperatures of *Meriones hurricans* reduce the area of heat loss from the body due to small temperature gradient [23]. The Desert Gerbil's tendency to salivate at high ambient temperature is presumably aimed to protect from lethal hyperthermia [23]. More than 80% of reptiles and mammals escape the heat of the day by venturing out from their shelter only during the cooler nights. 95% small- (hedgehogs, shrews, bats, rodents) and medium-sized mammals (most of the carnivores) are nocturnal. The larger-sized mammals like primates, perissodactyls, and artiodactyls are diurnal, but they escape the hottest hours of the days by resting under shade of larger bushes or trees. Even the nocturnal mammals shift their activity pattern to avoid extreme cold temperatures during the night.

Most of the micro- and mesofauna live in the water films surrounding soil particles. Protozoas and nematodes encrust or enter a hydrobiotic state when soil water potential falls below the critical threshold for the species. When soil water potential in desert soil is more than threshold, decomposition and nutrient mineralization result from the complex food web of the soil biota for most of the micro- and macrofauna [24, 25].

Soil termites contribute directly to nutrient cycling processes. Many species of termites have shown to fix atmospheric nitrogen. But termites multiply with high soil temperature and damage many agricultural crops causing up to 60% of wood loss. However, their activity subsides with low soil temperatures during the winter period.

The *tenebrionid* beetles are commonly present in the hot dry desert. Some species like *Adesmia cancellata* L. and *Trachyderma hispida* are diurnal, and others are nocturnal. There is a limited temperature-regulating mechanism in both the species, which seems more effective at lower ambient relative humidity than higher one [26].

The nocturnal gerbil, *Tatera indica*, is not exposed to the day temperature but adjusts its activity pattern to avoid colder period of the nights during winter. During the summer, the Indian Gerbil ventures out of its burrow for about 20 h and the peak activity of *T. indica* was noticed during the evening and started declining after midnight.

When the temperature drops below its tolerance limit, it ceases the outward activity and rests in the burrow [22].

Most of the smaller mammals (about 56%) have adapted a fossorial life. All Microchiropteran bats (25% of the total found in the desert) stay in the caves, mines, and old buildings during the daytime. These habits provide them a comfortable microclimate.

In the Thar Desert, the cyclical change in seasons like an extended summer triggered by global warming makes the reptilian species appear on the ground surface which otherwise would have undergone to hibernate during winter. Thus, the fauna of Rajasthan, though diverse in nature, are adapting well to the changing weather and climatic conditions.

## Conclusion

Rajasthan experiences all types of extreme weathers such as drought, flood, heat, and cold waves, affecting not only the human population but also the fauna, particularly in arid tracts compared to that in semiarid and dry subhumid parts of the state. The climate change in Rajasthan predicts for more warmer days and warmer nights leading to the increased demand for scarce water resources of the region. Various studies on faunal behavior and their strategies show that these species are well adapted for the harsh climatic conditions of Rajasthan. However, the predicted global warming could lead to shift in the climatic zones (and thus ecosystems and agricultural zones) toward poles by 150–550 km in the midlatitude regions. Forests, deserts, rangelands, and other unmanaged ecosystems face decline or frequent extinction of individual species due to shortage of food and water. Besides, challenges are ahead for the faunal habitats which are facing urbanizing, industrialization, mining, and new emerging oil scenario of the state. More area of the state should be brought under reserved area category for preserving natural habitats.

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# Chapter 3
# Impact of Altered Land Use Pattern on Small Mammalian Diversity of Hilly Tracts of Rajasthan, India

**Himmat Singh, Partap Singh, and B.K. Sharma**

**Abstract** This chapter describes the studies made on the small mammalian fauna of the eastern hilly zone of the state, considering the paucity of the information on the subject. Since almost all the patches of land have been converted into crop field, the small mammalian diversity has undergone a series of changes and species replacements. Four study zones viz., crop fields and hilly tracks of Abu Hills, main Aravallis, southern Rajasthan, and southeastern Rajasthan were selected for the present study. The flora of every zone has also been mentioned in the text. Trapping of small mammals in every small field was done for almost seven years at a stretch. Out of the 15 species of small mammalian fauna found in the study areas, the insectivorous House Shrew is the most abundant species. Abu Hills have 12 species of rodents, while the southern part has eight species. Absence of Cutch Rock-rat in southeastern Rajasthan is surprising. The diversity of Aravalli has been greatly altered during the last decade possibly due to the impact of irrigation by Indira Gandhi irrigation canal. In search of shelter in upland bushes, small mammals have started moving toward the Thar which has resulted in increased diversity of destructive rodent species in the area. Other pressures faced by these animals have also been discussed.

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## Introduction

The state of Rajasthan is an extremely interesting region of the Indian subcontinent. The Thar Desert, situated on its western side, is the eastern extension of the vast Persio-Arabian Sahara Desert. The eastern hilly zone of the state is constituted by the old Archean and Precambrian Aravalli and Vindhyan System [1]. The Aravallis, one of the oldest rock systems of the world, diagonally bisects the state from Palanpur (Gujarat) to Delhi. The Thar, situated on the western side of the Aravallis, is the only hot desert of India, while the eastern side is semiarid and subhumid. In the latter part of the state, the Aravallis merge with exposure of the Vindhyas and in the extreme southeast, with the Deccan basalt [2]. The southern part of western Rajasthan is formed of the Malani rock system. Though the Thar Desert received the attention of biologists, it remained neglected, and only two worthwhile studies on mammals [3, 4] were carried out. Considering the paucity of information, the survey of small mammals was carried out from 1992 to 1999. Because of ever-increasing human and livestock population in these hilly tracts, every patch of flat land has been converted into crop field. Because of altered land use pattern, the small mammalian diversity has undergone series of changes and species replacement [5]. To study the effect of anthropogenic factors, trapping of small mammals was carried out in the crop field habitat of the four study zones viz., Abu Hill, main Aravallis, southeastern Rajasthan, and southern Rajasthan (Fig. 3.1).

In this communication, an effort has been made to analyze diversity of small mammals in the crop field and the possible impact of human activities on biodiversity of these hilly tracts.

## The Study Area

### *Abu Hill*

Trapping in the crop field habitat was carried out at four altitudes (foothills, 500–600 m, 1,000–1,100 m, and 1,500–1,600 m) on the Abu Hill. Due to high altitude and good precipitation, Abu Hill has a rich vegetation cover. The vegetation at the foothills consists of *Acacia leucophloea*, *Salvadora persica*, and *Bauhinia variegata*. At 500 m, the vegetation is replaced by *Anogeissus pendula*, *Butea monosperma*, *Acacia* sp., *Dichrostachys cinerea*, and *Securinega leucopyrus*. Here, the canopy is relatively dense but allows sufficient light for the development of shrubby and herbaceous flora consisting of *Grewia tiliaefolia*, *Ziziphus rugosa*, *Cassia absus*, *Cyperus metzei*, and *Eragrostis gangetica*. Near 1,000-m altitude, a conspicuous change in floristic composition from xerophytic to mesophytic type is observed. A large proportion of evergreen species mainly consisting of *Erythrina suberosa*,

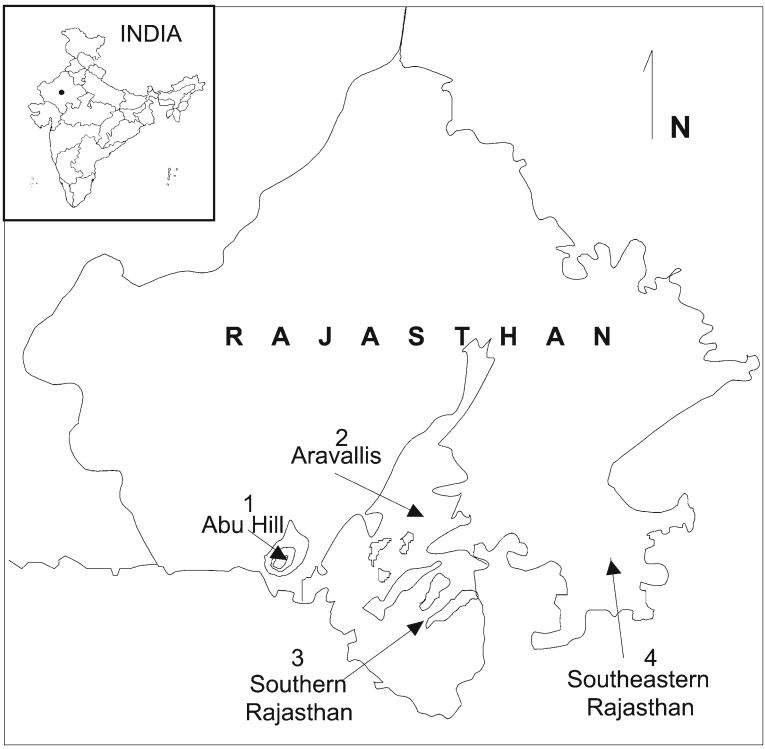


**Fig. 3.1** Map of Rajasthan showing the four study areas

*Bauhinia purpurea*, *B. variegata*, *Syzygium cumini*, and *Ficus* sp. make their appearance. Ground cover is commonly matted with annuals, which are dominant during monsoon. Shrubs like *Caesalpinia decapetala*, *Carissa spinarum*, *C. congesta*, and *Flacourtia indica* are common at slopes in rocky areas. At highest elevation (1,500–1,600 m), *Mangifera indica* and *Syzygium cumini* are conspicuous. Other predominant tree species of the elevation are *Grevillea robusta*, *Ficus palmata*, *F. benghalensis*, *F. racemosa*, *F. virens*, and *Phoenix sylvestris*. Many grasses like *Cymbopogon martinii*, *Andropogon annulatus*, *Chloris virgata*, and *Eleusine verticillata* frequently occur in the region.

## *Main Aravallis*

As compared to the Abu Hills, the main Aravallis receive less rainfall and thus are not so vegetated. Moreover, various anthropogenic activities like grazing, falling of trees, and collection of fruits for consumption further deplete the vegetation cover. Trapping on the main Aravallis was carried out at Pindwara, Ranakpur, and

Kumbhalgarh. Ranakpur is situated at the foothills, and the common plant species are *Anogeissus pendula*, *Boswellia serrata*, *Melia indica*, *Acacia arabica*, *Prosopis spicigera*, *Cassia auriculata*, and *Euphorbia ligularia*. The terrain is undulating with number of runnels and rivulets draining the hillock. Pindwara (400 m) has mixed type (xeric and mesic) of vegetation. *Prosopis spicigera*, *Albizia lebbeck*, *Cassia siamea*, *Cynodon dactylon*, and *Euphorbia caducifolia* are among major vegetation of Pindwara. Kumbhalgarh, situated at 900–1,000-m altitude, has quite a different terrain. The area of hills occupied by tribals is sparsely vegetated, and only *Euphorbia caducifolia* with intermittent *Anogeissus* and *Annona squamosa* trees could be observed. Remote areas of the region are, however, dominantly occupied by *Mangifera indica*, *Cassia fistula*, *Emblica officinalis*, *Aegle marmelos*, *Anogeissus latifolia*, *Bauhinia variegata*, *Acacia senegal*, *Annona squamosa* and *Boswellia serrata*, *Cynodon dactylon*, *Sorghum halepense*, *Grewia tenax*, *Cassia auriculata*, and *Euphorbia* sp.

## *Southern Rajasthan (Udaipur–Banswara Zone)*

Neemach Mata Hill near Udaipur is well forested, and common flora of the hill is composed of *Butea monosperma*, *Syzygium hyrianium*, *Ziziphus nummularia*, *Pongamia pinnata*, *Wrightia tinctoria*, and *Euphorbia caducifolia*. The Sajjangarh Hills are severely denuded, and only a few thickets *Prosopis juliflora*, *Acacia leucophloea*, *Ziziphus nummularia*, and *Grewia flavescens* are present here and there. The chain of low hills of Jhadol–Dungarpur region are treeless, but the protected areas are vegetated with trees of *Boswellia serrata*, *Cassia fistula*, *Madhuca indica*, *Stercularia urens*, *Dendrocalamus strictus*, and *Diospyros melanoxylon* and shrubs of *Dichrostachys cinerea*, *Grewia flavescens*, *Virtex negendo*, and *Jetropha curcus*. The common grass species of the region are *Heteropogon contortus*, *Sehima nervosum*, and *Echinochloa colonum.*

## *Southeastern Rajasthan (Kota–Jhalawar Zone)*

The trappings were carried out from Ranthambhore to Pidawa (23°75′ to 26°52′ N) in north-south axis and from Rawatbhata to Shahbad (75°56′ to 76°45′ E) in the east-west axis. The northern part of this zone is bounded by the Aravallis which are composed of foliated schists, quartzites, and limestone. The central zone is covered by rocks of the Vindhyan system. This scarpland is well wooded, though the foothills are denuded. The south part of this zone is composed of the Deccan Trap region; a wide belt of black cotton soil is overladen on bedrocks of Vindhyanchal Mountain system. Rainfall in this zone varies from 650 to 950 mm per annum. The

vegetation is characterized by *Anogeissus pendula* and *Boswellia serrata* mixed forest. Other trees like *Sterculia urens*, *Acacia catechu*, *Aegle marmelos*, *Cassia fistula*, and *Terminalia arjuna* are also in fair numbers. The understory is composed of shrubs, *Ziziphus nummularia*, *Lantana camara*, and *Capparis decidua*, and grasses, *Aristida depressa*, *Apluda mutica*, and *Hereropogon controtus*.

## Material and Methods

Trapping of small mammals was carried out from 1992 to 1999 in all the four zones of Rajasthan state. In crop-field habitats, two trap lines of 30 snap traps each were fixed at an interval of 10 m. The distance between two trap lines was 15 m. The traps were kept laid for 72 h. Peanut butter was used as bait. The traps were checked every 6 h, and the captured small mammals were retrieved. Peanut butter was replenished every time small mammals were taken from snap traps. Captured small mammals were numbered by toe clipping and weighed, and various morphometric measurements were taken on printed forms. Before preserving the females in formalin, status of pregnancy, number of embryos and corpora lutea, and condition of uterus and mammae were taken into account.

The vegetation cover was determined by the line transect method [6]. Trap index for each habitat and locality was calculated by using the following formula [7]:

$$\text{Trap Index} = \frac{\text{Total no. of small mammals}}{\text{No. of trapping days} \times \text{No. of small mammal traps}} \times 100$$

Many indices of alpha diversity ($\alpha$) such as Simpson's index, alpha of log series, and Margalef's richness index (MRI) are used for analysis. For present work, only (MRI) was calculated [8] using formula:

$$\text{Margalef's Richness Index}\left(\text{MRI}\right) = \frac{S - I}{N}$$

where $S$ is the number of species and $N$ is the total number of individuals in a sample.

The beta diversity is the measurement of the replacement of species between compared habitats/sites.

For calculating beta diversity ($\beta$) among the sites, the following formula was used:

$$\text{Beta diversity}\left(\hat{a}\right) = \frac{N}{\eta}$$

where $N$ is the number of species common in both the samples compared and $\eta$ is the average number of species in the samples compared.

Dendrograms were prepared by using the formula:

$$\text{Distance} = 1 - \beta$$

where $\beta$ is beta diversity.

## Results

A total of 613 small mammals, belonging to 15 species, were captured in 7,154 trap days (Table 3.1) from the crop field habitat.

From Abu Hill 257 specimens of 12 species were captured in 2,394 trap days. The trap index of the locality was found to be 10.74. The alpha ($\alpha$) diversity of Abu Hill was calculated to be 2.37. The insectivorous House Shrew *Suncus murinus*, was the most abundant (29.1% of the total catch) small mammal in the region. However, the most abundant rodent of the region was Cutch Rock-rat, *Cremnomys cutchicus* (17.1%), followed by the Golund, *Golunda ellioti* (14.4%). Out of the six *Mus* species collected from all the four zones, only three species viz., *Mus saxicola*, *Mus phillipsi*, and *Mus terricolor*, were present at the Abu Hill. Some other field rodents *Tatera indica* (10.8%), *Millardia meltada* (8.5%), and *Bandicota bengalensis* (3.8%) were less preponderant in the region.

From the main Aravallis, small mammals were collected from crop fields of foothills. In 1,797 trap days, 128 small mammals belonging to ten different species were collected (Table 3.1). Trap index of the zone was found to be 7.12, and $\alpha$ diversity of the zone was calculated to be 2.11 (Table 3.2). Here too, *S. murinus* was the most abundant (37.5%) small mammal followed by *C. cutchicus* (14.8%) and *M. meltada* (14%). The Bandicoot *B. bengalensis* was also quite common (11.7%) in the region. It was surprising that only one species of mouse *M. saxicola* was collected from the zone and that too, in small numbers (1.5%).

In 1,950 trap days, 184 specimens of 13 species of small mammals (one insectivore and 12 rodent species) were collected in the southeastern Rajasthan zone (Table 3.1). The trap index and diversity of the zone were 9.44 and 2.64, respectively (Table 3.2). The Shrew, *S. murinus*, was the most abundant (44%) small mammalian species. The zone was the most species-rich (total 13 species) region, and *G. ellioti* (13%) and *R. rattus* (11.9%) were common rodents of the region. The zone was quite rich in *Mus* species population, and a total of five species (*Mus musculus*, *M. booduga*, *M. saxicola*, *M. phillipsi*, and *M. platythrix*) were found in the region.

In southern Rajasthan, only 44 specimens, belonging to eight species, were caught in 1,013 trap days. Here too, *S. murinus* was the most abundant (29.5%) small mammal followed closely by *C. cutchicus* (25%). Only one *Mus* species, *Mus musculus*, was entrapped in the zone.

**Table 3.1** Occurrence of small mammals in four hilly tracts of Rajasthan

| Species | Common names | Abu Hill | Aravallis | Southeastern Rajasthan | Southern Rajasthan | Total |
|---|---|---|---|---|---|---|
| *S. murinus* | House Shrew | 75 | 48 | 81 | 13 | 35.4 |
| *F. pennanti* | Five-stripped Palm Squirrel | 3 | 4 | 12 | 6 | 4.08 |
| *T. indica* | Indian Gerbil | 28 | 5 | 5 | 2 | 6.53 |
| *Vandeleuria oleracea* | Asiatic Long-tailed Climbing Mouse | 1 | 1 | 2 | 0 | 0.65 |
| *Rattus rattus* | House Rat | 28 | 10 | 22 | 4 | 10.44 |
| *C. cutchicus* | Cutch Rock-rat | 44 | 19 | 0 | 11 | 12.07 |
| *M. meltada* | Indian Metad | 22 | 18 | 11 | 0 | 8.32 |
| *Mus musculus* | House Mouse | 0 | 0 | 2 | 2 | 0.65 |
| *M. booduga* | Little Indian Field Mouse | 0 | 0 | 1 | 0 | 0.16 |
| *M. terricolor* | Tiny Spiny Mouse | 1 | 0 | 0 | 0 | 0.16 |
| *M. saxicola* | Saxi Mouse | 4 | 2 | 2 | 0 | 1.31 |
| *M. phillipsi* | Fawn Spiny Mouse | 0 | 0 | 8 | 0 | 1.31 |
| *M. platythrix* | Spiny Mouse | 4 | 0 | 5 | 0 | 1.46 |
| *G. ellioti* | Indian Bush Rat | 37 | 6 | 24 | 4 | 11.58 |
| *B. bengalensis* | Bandicoot Rat | 10 | 15 | 9 | 2 | 5.87 |
| Total | | 257 | 128 | 184 | 44 | |

## *Species Distribution*

The Shrew, *S. murinus sindensis* was the most abundant small mammal of the Crop field habitat in all the four zones. However, its relative percentage was maximum in the southeastern zone (44% of total small mammal population), followed by main Aravallis (37.5%), southern zone (29.5%), and Abu Hill (29.2%). The Cutch Rock-rat, *Cremnomys cutchicus*, was the second most abundant small mammal in the three zones. In southern Rajasthan, the Cutch Rock-rat constituted 25% of the small mammalian fauna, followed by Abu Hill (17.1%) and main Aravallis (14.8%). However, its absence from the southeastern region was surprising. The Bush Rat *Golunda ellioti* was the second most preponderant species in southern Rajasthan and the third most abundant on the Abu Hills. Though, common in southern and the main Aravallis, this species was relatively fewer in number. The field rodents *Bandicota bengalensis* and *Millardia meltada* were common in Abu Hill, main Aravallis, and the southeastern zone but were poorly represented in southern Rajasthan. *Mus* species were preponderant in the southeastern zone, common in the Abu Hill zone, but poorly represented in the other two zones.

*Alpha Diversity (a)*: To compute the diversity of all the four study zones, Margalef's richness index [8] was used. The southeastern zone was not only the most species-rich zone but also the most diverse (MRI = 2.64) among four study zones (Table 3.2). Abu hill supported 12 small mammalian species and had MRI = 2.37. Main Aravallis

**Table 3.2** Trap index and Margalef's index in four study zones

| Zone | Trap index | No. of species | No. of individuals | MRI |
|---|---|---|---|---|
| Abu Hill | 10.74 | 12 | 257 | 2.37 |
| Aravalli | 7.12 | 10 | 128 | 2.11 |
| Southeastern Rajasthan | 9.44 | 13 | 184 | 2.64 |
| Southern Rajasthan | 4.34 | 8 | 44 | 1.84 |

**Table 3.3** $\beta$ Diversity between various study zones

| Zones | Aravalli | Southeastern Rajasthan | Southern Rajasthan |
|---|---|---|---|
| Abu Hill | 0.909 | 0.72 | 0.70 |
| Aravalli | – | 0.78 | 0.77 |
| Southeastern Rajasthan | – | – | 0.76 |

were third in order of diversity (MRI = 2.11), and the southern zone was found to be least diversified (MRI = 1.84).

*Beta Diversity (b)*: Crop fields are artificially created ecosystems. To satiate hunger of the ever-increasing human population, every patch of flat land in the hilly tract of Rajasthan is being converted into croplands. Being a similar habitat, crop fields support different small mammalian fauna because of varied ecological conditions. To compare the four study zones, $\beta$ diversity (Tables 3.3 and 3.4) was calculated. Using a single linkage dendrogram (Fig. 3.2), it became evident that Abu Hill and the main Aravallis were found to be the most similar ($\beta = 0.909$) zones. These study zones shared a maximum number of common species (10). The southern zone showed the least similarity to all the three zones.

## Discussion

The crop fields are unique habitat created and maintained for human benefit. While creating such habitats in hilly tracts of Rajasthan, the natural ecosystem gets fragmented, natural growing flora is removed and crops of human interest are grown (Fig. 3.3). This changed flora greatly influences fauna of the region. The water used for irrigation further brings changes in the soil regime. The artificial fencing, whether it is bio-fencing or stone wall fencing, created for protecting crops from wild and feral animals provides another microhabitat to small mammals. [5].

As many as 15 species of small mammals were collected from the crop fields of the hilly tracts of Rajasthan. Earlier studies also reveal that the Aravallis support a

**Table 3.4** List of nonflying small mammals of Rajasthan

| Order/common name | Scientific names | Habitats | IUCN (2012) Status[a] |
|---|---|---|---|
| **Order: Carnivora** | | | |
| **Family Herpestidae** | | | |
| Indian Grey Mongoose | *Herpestes edwardsii* | SC/R/F | LC |
| Rudy Mongoose | *Herpestes smithii* | SC/R/F | LC |
| **Order: Insectivora** | | | |
| **Family Erinaceidae** | | | |
| Indian Hedgehog | *Paraechinus micropus* | SC | LC |
| Indian Long-eared Hedgehog | *Paraechinus collaris* | SC/R/F | LC |
| **Family Soricidae** | | | |
| House Shrew | *Suncus murinus* | SC/CF/F/R | LC |
| Anderson's Shrew | *Suncus stolizkcanus* | SC/F/R | LC |
| **Order: Lagomorpha** | | | |
| Indian Hare | *Lepus nigricollis* | SC/F | LC |
| **Order: Pholidota** | | | |
| **Family Manidae** | | | |
| Thick-tailed Pangolin | *Manis crassicaudata* | F/ SC | NT |
| **Order: Rodentia** | | | |
| **Family Hystricidae** | | | |
| Crested Porcupine | *Hystrix indica* | R | LC |
| **Family Muridae** | | | |
| Soft-furred Metad | *Millardia meltada* | CF/F/R | LC |
| Indian Field Mouse | *Mus booduga* | SC/CF | LC |
| Fawn-colored Mouse | *Mus cervicolor* | SC /R | LC |
| House Mouse | *Mus musculus* | SC/CF | LC |
| Tiny Spiny Mouse | *Mus terricolor* | SC/R | LC |
| Spiny Mouse | *Mus phillipsi* | SC/CF/R | LC |
| Spiny Field Mouse | *Mus platythrix* | SC/CF/ | LC |
| Gray Spiny Mouse | *Mus saxicola* | SC/CF/ | LC |
| Short-tailed Mole | *Nesokia indica* | SC/F/R | LC |
| House Rat | *Rattus rattus* | SC/CF/R | LC |
| Indian Gerbil | *Tatera indica* | SC/CF | LC |
| Asiatic Long-tailed Mouse | *Vandeleuria oleracea* | F/R | LC |
| Little Hairy-footed Gerbil | *Gerbillus gleadowi* | SC | LC |
| Indian Desert Gerbil | *Meriones hurrianae* | SC/CF | LC |
| Dwarf Gerbil | *Gerbillus nanus* | SC | LC |
| Indian Bush Rat | *Golunda ellioti* | SC/CF | LC |
| Cutch Rock-rat | *Cremnomys cutchicus* | R | LC |
| Lesser Bandicoot Rat | *Bandicota bengalensis* | SC/CF | LC |
| **Family Pteromalidae** | | | |
| Large Brown Flying Squirrel | *Petaurista philippensis* | F | LC |
| **Family Sciuridae** | | | |
| Five-stripped Palm Squirrel | *Funambulus pennantii* | SC/CF/F | LC |

SC Scrublands; CF Crop fields; F Forest; R Rocky

[a]Status according to IUCN Red List of Threatened Species(2012)

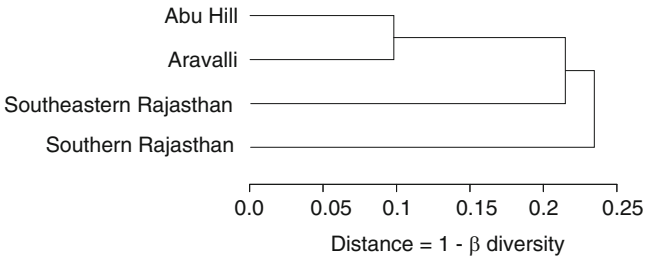


**Fig. 3.2** Dendrogram showing similarity between four study zones

**Fig. 3.3** Fragmentation of continuous forest with the introduction of cropland (yellow patch in the middle) has been detrimental to the survival of inhabiting fauna

larger number of small mammals as compared to the adjacent Thar Desert [9]. While comparing present data with that of earlier studies [3], it becomes evident that the small mammal fauna of the Aravallis has greatly been altered during the last nine decades, primarily because of irrigated agriculture [5]. Other factors which influence the abundance of rodents are mining (Fig. 3.4), altitude, season, and the habitat's structural characteristics [10]. In the crop field habitat of the Aravallis, preponderance of small mammals was the maximum as compared to other habitats [11]. Similar results were obtained in crop fields of southeastern Rajasthan [12]. This greater diversity of small mammals in crop fields is because of immigration of peninsular small mammals [13]. It has been conjectured that

**Fig. 3.4** Surface mining has posed serious threat to the Aravallis by causing massive land degradation

some "humid elements" like *M. meltada*, *G. ellioti*, and *B. bengalensis* have invaded the Thar Desert recently through gaps in the Aravallis. The irrigated croplands provide a conducive environment for these mesic elements to survive and thrive. The other factor, because of which maximum number of small mammalian species was found in the crop field habitat, was fencing. The farmers of the region generally fence the crop fields by planting *Euphorbia*, *Acacia*, *Ziziphus*, and *Cassia* bushes. Dried branches of *Phoenix* and other thorny bushes were also used to fence the crop fields (Fig. 3.5).These bio-fences provide an ideal habitat to Bush Rat *G. ellioti*, *B. bengalensis*, *S. murinus*, *M. meltada*, and *F. pennanti*. Where stones were easily available, the farmers erected a fence by loosely piling these stones. This loosely piled stone wall fences provided an ideal habitat to the crevice dwelling Rock-rat *Cremnomys cutchicus* and the Brown Spiny Mouse *Mus platythrix* (Fig. 3.6). Because of availability of nutritive food all year round in crop fields, *C. cutchicus* has altered its natural niche, i.e., cracks and crevices of hills [5], and prefers to live in the crevices of the stone-wall fencing of crop fields. While comparing the two types of fencing (bio-fence and stone wall fence), it was found that *S. murinus* significantly preferred bio-fences ($\chi^2 = 9.77$, d$f = 1$, $P < 0.005$). Likewise, *F. pennanti* ($\chi^2 = 11.56$, d$f = 1$, $P < 0.001$) and *B. bengalensis* ($\chi^2 = 10.2$, d$f = 1$, $P < 0.005$) also preferred the bio-fenced microhabitat. *R. rattus* and *M. meltada*, too, were preponderant in bio-fenced crop fields. In the stone wall-fenced habitats, the Rock-rat, *C. cutchicus* was significantly more abundant ($\chi^2 = 5.26$, d$f = 1$,

**Fig. 3.5** Bio-fencing of crop fields attracts many rodent species

**Fig. 3.6** Stone-wall fencing of crop fields attracts rock-dwelling rodent species

$P < 0.005$). Likewise, *Mus terricolor*, *M. phillipsi*, and *M. booduga* also preferred stone wall-fenced crop field [13].

*Suncus murinus* is the most abundant small mammal (Table 3.1) in all the four study zones. Its abundance was not surprising because this insectivorous small mammal has few predators and is an opportunist omnivore. Though, an insectivore, this small mammal feeds on leaves of a shrub, *Mimosa hamata* (90.66% of annual food), in the Thar Desert. However, in the hills of Rajasthan, there is no dearth of insect fauna, and the shrew primarily feeds on insects and other animals (91.4%) of total food material [13]. Low predator pressure and quite abundant natural food are two factors which make it the most successful small mammal in hilly tracts. The second most preponderant small mammal species (most abundant rodent species) was *C. cutchicus*. Its abundance can be attributed to the presence of stone-wall fence. Next in order of abundance was *G. ellioti*. This Bush Rat preferred bio-fenced crop fields, and the scrublands present in the vicinity of croplands. The commensal rodent *Rattus rattus* was next in order of abundance. This behavioral atavism in *R. rattus* has also been observed in other parts of India. *M. meltada*, *B. bengalensis*, *T. indica*, and *F. pennanti* were other common rodents of the region. *Mus saxicola*, *M. phillipsi*, and *M. platythrix* were sparse, while *M. booduga* and *M. musculus* are rare in the region. Less abundance of smaller *Mus* species can be attributed to preponderance of more aggressive, larger rodents.

Most diverse among all the four study zones was the southeastern Rajasthan zone (Kota–Jhalawar zone). The region was not only the most diverse (MRI = 2.64) but also the most species-rich zone, because the maximum numbers of 13 species were collected from this area. The agriculture in the region is not rain-dependent, and the tube wells are a perpetual source of water for irrigation. Due to availability of water, the crops are sown all year round. Because of it, there is no dearth of food, and small mammals thrive well in the region, making it the most species-rich and diverse region.

Abu Hill crop fields were the second most diverse (MRI = 2.37) among the four study zones. Mount Abu WLS is situated on this hill. The only hill station of Rajasthan, Mt. Abu, faces intense tourist pressure. Owing to the presence of the wildlife sanctuary, the hill is well protected by the state forest department. This protection is due to the greater diversity of small mammals on the hill.

The third most diversified zone was the main Aravallis (MRI = 2.11). As human intervention is comparatively more, the zone is less diverse. Being unprotected, the hills were harvested for grass, fodder, and fuel wood. Least diverse among the four study zones was the southern zone (MRI = 1.84). In this zone, agriculture is mainly monsoon dependent, and farmers could harvest only one crop in a year, that too when the monsoon does not fail. For 7–8 months, the crop fields do not support any vegetation and hence the poor diversity of small mammals.

The result of small mammal trapping, thus, suggests that the fragmentation of the natural ecosystem results in an increased diversity of destructive rodents species. These crop fields in the hilly tracts provide a conducive environment to mesic peninsular rodents. These mesic species are invading the xeric region of western Rajasthan because of changes brought about by the changed land use patterns through irrigated agriculture.

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# Chapter 4
# Threats to Faunal Diversity of the Aravalli Hills with Special Reference to Kumbhalgarh Wildlife Sanctuary

**A.K. Chhangani, Paul Robbins, S.M. Mohnot, and B.K. Sharma**

**Abstract** This chapter describes the Aravallis as a reserve for threatened and endangered faunal species. Most of the protected areas in the state, namely, Sariska Tiger Reserve and wildlife sanctuaries like Kumbhalgarh, Mount Abu, Sitamata, Sundhamata, Sajjangarh, Raoli-Tatgarh, Jaisamand, and Phulwari Ki Nal, lie adjacent to the Aravalli Ranges. The wildlife of the Aravallis includes Leopard *Panthera pardus*, Striped Hyaena *Hyaena hyaena*, Indian Wolf *Canis lupus*, Golden Jackal *Canis aureus*, Hanuman Langur S*emnopithecus entellus*, Four-horned Antelope *Tetracerus quadricornis*, Chinkara *Gazella bennettii*, Indian Crested Porcupine *Hystrix indica*, Sambar *Cervus unicolor*, Nilgai *Boselaphus tragocamelus*, Sloth Bear *Melursus ursinus*, Toddy Cat or Common Palm Civet *Paradoxurus hermaphroditus*, Jungle Cat *Felis chaus*, Bengal Fox *Vulpes bengalensis*, Crocodile *Crocodylus palustris*, and Indian Rock Python *Python molurus*. An intensive research of many years by the authors has revealed several unacknowledged key issues central to the future of faunal biodiversity in the region. This chapter presents the habitat condition of the study area, population trends, and the major threats to the fauna while pointing out toward the importance and emergence of new adaptations in the faunal populations and harmonious human–animal interaction.

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## Introduction

The Aravalli Hills of Rajasthan are a significant habitat for a variety of flora and fauna. The Aravalli Ranges are the heavily eroded, relict span of Precambrian uplift, forming steep and rocky terrain in some areas, deep drainages, and undulating forested hills. Running from the northeast to the southwest, the range consists of a series of detached hills and ridges, which rise to heights varying from 274 to 1,722 m with the highest altitude at Guru Shikhar, rising to a height of 1,722 m above the mean sea level. The Aravalli forms a greenbelt across the edge of the Thar Desert, acts as a corridor connecting diverse ecosystems, and serves as a reserve for threatened species. As a result, most of the protected areas in the state are situated in the Aravalli Ranges, including the Sariska Tiger Reserve and sanctuaries such as Sitamata, Kumbhalgarh, Sajjangarh, Raoli-Tatgarh, Jaisamand, Mount Abu, Sundhamata, and Phulwari Ki Nal.

This chapter describes threats to the faunal diversity of the Aravalli Hills, drawing heavily on several years of intensive research with special reference to the Kumbhalgarh Wildlife Sanctuary. This chapter describes the condition of the case study area, summarizes population trends and habitat conditions in the region, and catalogues the major threats to fauna. It then focuses attention on three key issues, largely overlooked in the existing literature, including the role of climate in determining the condition, prospects of wildlife survival, and the role of human activity for not only threatening wildlife but, in some cases, actually enabling and supporting wildlife populations. We conclude that it is important to address the issue of the traditionally emphasized threats to the wildlife and harmonize the human–animal interaction.

## The Kumbhalgarh Wildlife Sanctuary

The Kumbhalgarh Wildlife Sanctuary is located in three districts of Rajasthan, namely, Pali, Udaipur, and Rajsamand in the southwest of Aravalli Hills (Fig. 4.1), between 73°2′ and 73°30′ east and 25°0′ and 25°40′ north. The sanctuary is situated across the slopes of the Aravalli and includes several flatter forested lands adjoining it. These hills form watershed between the low-lying plains of *Marwar* in the west and the high tableland of *Mewar* in the east. The slopes are gentle at the outer boundary and gentle to steep at the *Mewar* boundary, sometimes, becoming precipitous near the top. The dominant vegetation is *Anogeissus pendula* dry deciduous forest [1].

The climate of this habitat is subtropical, characterized by distinct winter, summer, and monsoon seasons, with summer temperatures of more than 30°C, which may rise up to 45°C or higher (the maximum temperature observed in the sanctuary during the study period was 48°C). Conversely, mean winter temperature is 5°C, with a minimum of 2°C recorded during the study period. The strong winds blow from the west and are generally moderate, but severe sandstorms may occur


**Fig. 4.1** Location of Kumbhalgarh Wildlife Sanctuary in the Aravalli Hills

occasionally before the arrival of rains. The monsoons may break in the middle of the June but are more often delayed and commence in mid-July, with an average rainfall of 725 mm, given to high interannual variability and periodic monsoon failure.

Kumbhalgarh is a remarkably successful sanctuary, though, somewhat understudied. Covering an area of about 610 km$^2$, the sanctuary has long been rich in wildlife. Historical records emphasize large numbers of Bengal Tiger, panther Sloth Bear, wolf, hyena, Sambar, Chinkara and Four-horned Antelope in the nineteenth century. Decline in the population of wild animals has since occurred. Tigers were present until 1960 but now are extinct from the sanctuary area.

The rulers of this area and their keen interest in wildlife helped the flora and fauna flourish considerably, though long periods of state economic exploitation have played a detrimental role. The erstwhile Jodhpur state maintained a

"*shikarkhana*" until 1949 when the forest was transferred to the state forest department in 1950. The following period saw a contracting system for exploitation of key timber and nontimber forest products, with detrimental effects on wildlife habitat. The reserved forest was declared a wildlife sanctuary in 1971 and placed within the framework of the 1972 Wildlife Protection Act. While significant resources have been brought to the sanctuary through plantation and bans on mining and agricultural encroachment, fauna in the sanctuary remained under various types of threats which require better research and more carefully targeted conservation management strategies.

## Faunal Population and Demographic Trends

The main wildlife of Kumbhalgarh Wildlife Sanctuary includes Leopard (*Panthera pardus*), Striped Hyaena (*Hyaena hyaena*), Gray Wolf (*Canis lupus*), Golden Jackal (*Canis aureus*), Hanuman Langur or Northern Plains Gray Langur (*Semnopithecus entellus*), Four-horned Antelope (*Tetracerus quadricornis*), Chinkara (*Gazella bennetti*), Indian Crested Porcupine (*Hystrix indica*), Sambar (*Cervus unicolor*), Nilgai (*Boselaphus tragocamelus*), Sloth Bear (*Melursus ursinus*), Toddy Cat (*Paradoxurus hermaphroditus*), Jungle Cat (*Felis chaus*), Bengal Fox (*Vulpes bengalensis*), Mugger (*Crocodylus palustris*), and Indian Rock Python (*Python molurus*). The status of major wildlife of the sanctuary is provided in Tables 4.1 and 4.2.

Herbivore populations at Kumbhalgarh show species-specific trends in growth and decline. The populations of Nilgai, Wild Boar and Hanuman or Nothern Plains Grey Langur, most prominently, have increased in recent years. Simultaneously, the populations of Chousingha or Four-horned Antelope and Chinkara have declined to the point that their viability in the study area is questionable (Figs. 4.2–4.4).

Increase in the numbers of Nilgai and Wild Boar is largely due to their successful adaptation to feeding in crop fields around the sanctuary [2]. Sloth Bear and Hanuman Langur feed not only on traditional arboreal species (including *Ziziphus nummularia* and *Ficus racemosa*) which remain in relative abundance in the forest but have further adapted to browsing on invasive species especially *Lantana camera* and *Prosopis juliflora*. Sambar, Chousingha and Chinkara, conversely, are poorly equipped to make use of invasive and crop species being predominant grazers depending on ground forage competing with domestic livestock in the reserve (Fig. 4.4) [3].

Predator species such as Panther, Striped Hyaena, Gray Wolf, Golden Jackal, Jungle Cat and Bengal Fox also show growth and decline in their number [4]. The number of panther, Striped Hyaena and Golden Jackal has increased regularly, whereas Gray Wolf, Jungle Cat and Bengal Fox have shown marginal growth in their population with a decline in 1994–1995 (Fig. 4.5).

Additionally, a total of 201 species of birds have been recorded in the Kumbhalgarh Wildlife Sanctuary, of which three species are enlisted as Critically Endangered by the BirdLife International and IUCN-2012. Of these, three vulture species *Gyps*

**Table 4.1** Status of the mammalian wildlife in the Kumbhalgarh Wildlife Sanctuary

| Order | Family | Name and scientific name | Status |
|---|---|---|---|
| Carnivora | Canidae | Golden jackal (*Canis aureus*) | C |
| | | Gray Wolf (*Canis lupus*) | R |
| | | Bengal Fox (*Vulpes bengalensis*) | VC |
| | Ursidae | Sloth Bear (*Melursus ursinus*) | C |
| | Viverridae | Common Palm Civet (*Paradoxurus hermaphroditus*) | VC |
| | | Small Indian Civet (*Viverricula indica*) | C |
| | Hesperiidae | Indian Grey mongoose (*Herpestes edwardsi*) | VC |
| | | Small Asian Mongoose *Herpestes javanicus auropunctatus* | VC |
| | Hyaenidae | Striped Hyaena (*Hyaena hyaena*) | UC |
| | Felidae | Jungle Cat (*Felis chaus*) | UC |
| | | Desert Cat (*Felis libyca*) | R |
| | | Leopard (*Panthera pardus*) | C |
| Rodentia | Hystricidae | Porcupine (*Hystrix indica*) | C |
| Lagomorpha | Leporidae | Indian Hare (*Lepus nigricollis*) | C |
| Artiodactyla | Suidae | Wild Boar (*Sus scrofa cristatus*) | VC |
| | Cervidae | Chital (*Axis axis*) | R[a] |
| | | Sambar (*Cervus unicolor*) | R |
| | Bovidae | Chowsingha (*Tetracerus quadricornis*) | R |
| | | Nilgai (*Boselaphus tragocamelus*) | VC |
| | | Chinkara (*Gazella bennettii*) | UC |
| *Chiroptera* | *Pteropodidae* | Large Brown Flying Fox (*Pteropus giganteus*) | C |
| *Primate* | *Cercopithecidae* | Hanuman Langur (*Semnopithecus entellus*) | VC |

*C* common, *R* rare, *UC* uncommon, *VC* very common
[a]Introduced

**Table 4.2** Reptiles of the Kumbhalgarh Wildlife Sanctuary

| Common name | Scientific name | Status |
|---|---|---|
| Common Garden Lizard | *Calotes versicolor* | *C* |
| Northern House Gecko | *Hemidactylus flaviviridis* | C |
| Rock Gecko | *Hemidactylus maculatus* | C |
| Common Skink | *Mabuya carinata* | C |
| Common Indian Monitor | *Varanus bengalensis* | C |
| The Indian Chameleon | *Chamaeleo zeylanicus* | R |
| Soft-Shelled Turtle | *Trionyx gangeticus* | C |
| Indian Python | *Python molurus* | U |
| Indian Cobra | *Python molurus* | C |
| Saw-scaled Viper | *Echis carinatus* | C |
| Russell's Viper | *Vipera russelli* | C |
| Rat Snake | *Ptyas mucosus* | C |
| Checkered Keelback Snake | *Xenochrophis piscator* | C |
| Common Krait | *Bungarus caeruleus* | C |
| Mugger | *Crocodylus palustris* | R[a] |

C common, R rare, UC uncommon, VC very common
[a]Introduced

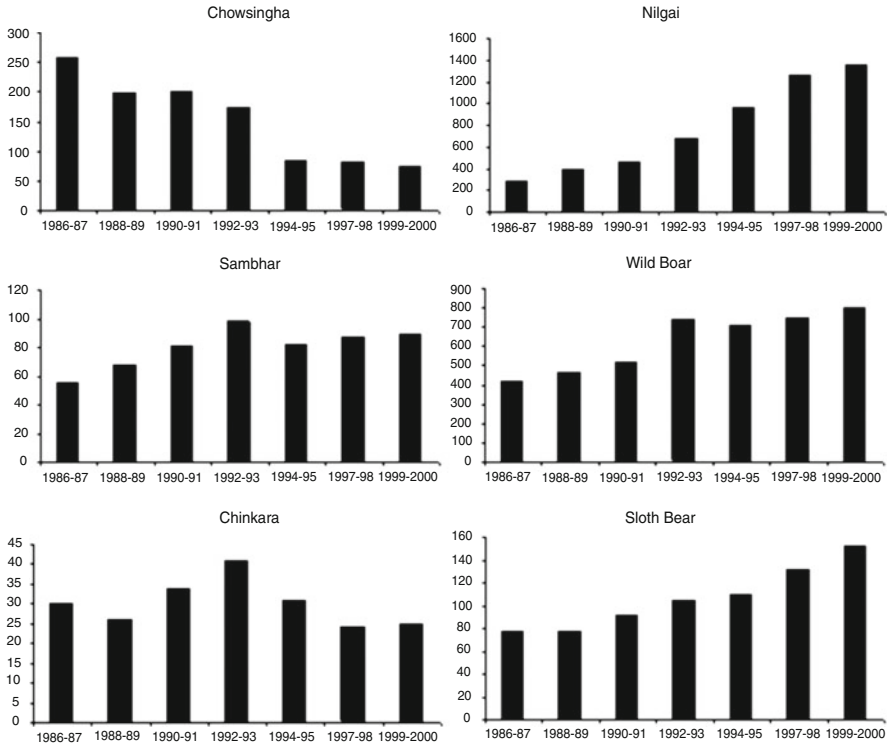


**Fig. 4.2** Population of herbivores at Kumbhalgarh Wildlife Sanctuary (1996–2000)

*bengalensis*, *G. indicus*, and *Sarcogyps calvus* are categorized as Critically Endangered, one species as Near Threatened (*Mycteria leucocephala*), and four species, *Grus antigone*, *Rynchops albicollis*, *Parus nuchalis*, and *Estrilda formosa*, as Vulnerable. *Parus nuchalis* is confined to India.

During normal rainfall years, when dams and water bodies in and around the sanctuary are full, there is an abundance of food materials for both resident and migratory avifauna. The number of large trees, rocks, cliffs, and small islands in the reservoirs further provides sufficient roosting sites. These two factors have sustained the notably large abundance of species.

Finally, a variety of reptiles were observed during the study period, especially snake species, including *Naja naja naja*, *Naja naja oxiana*, *Vipera russelli*, *Boiga trigonata*, *Trimeresurus gramineus*, *Python molurus*, *Eryx conicus*, *Typhlops acutus*, *Eryx xjohni*, *Ptyas mucosus*, *Argyrogena ventromaculatus*, *Argyrogena fasciolatus*, *Spalerosophis arenarius*, *Echis carinatus*, and *Xenochrophis piscator*. Ecologically, Kumbhalgarh Wildlife Sanctuary is clearly a significant and suitable habitat for snakes. The Aravalli region more generally provides an important habitat, sustaining and influencing the neighboring Palaearctic–Oriental snake faunal element. Snakes are crucial component of Aravalli ecosystem, more so, being important predators on

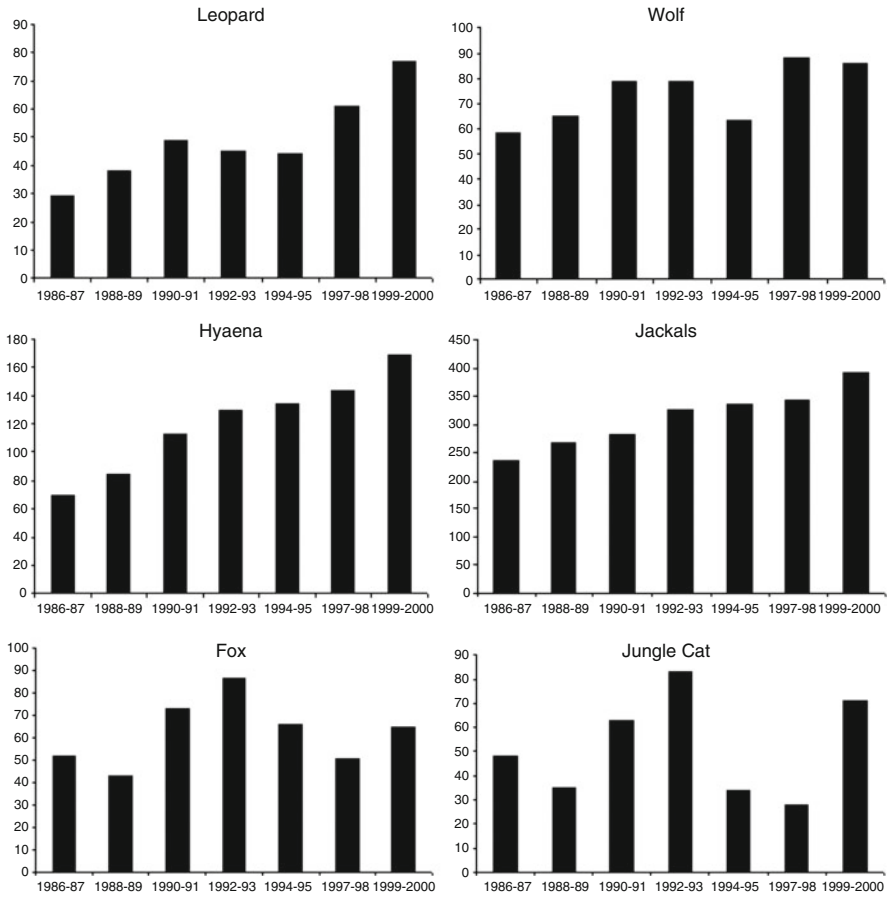


**Fig. 4.3** Population of carnivorous at Kumbhalgarh Wildlife Sanctuary (1996–2000)

a variety of insects, small mammals, and small birds. Among the reptiles, Rock Python (*Python molurus*) is the largest followed by the Mugger (*Crocodylus palustris*), an introduced species, living in the isolated "Thandi Bari" area of the reserve. Two species of turtles were observed throughout KWLS: Soft-shelled Turtle (*Trionyx gangeticus*) and Flapshell Turtle (*Lissemys punctata punctata*). The sanctuary exhibits a remarkable diversity of lizards and snakes living close to the numerous streams. Common lizards include the Indian House Gecko (*Hemidactylus brookii*), Yellow-billed Mole-skink (*Eumeces taeniolatus*), Bronze Grass-skink (*Mabuya macularia*), Common Garden Lizard (*Calotes versicolor*), Common Indian Monitor (*Varanus bengalensis*), and Indian Chameleon (*Chamaeleo zeylanicus*). Among the snakes Indian Cobra (*Naja naja naja*), Checkered Keelback (*Xenochrophis piscator*), Indian Krait (*Bungarus caeruleus*), Russell's Viper (*Vipera russelli*), Bamboo Pit-viper (*Trimeresurus gramineus*), Indian Rat-snake (*Ptyas mucosus*), and Indian Python (*Python molurus*) are common throughout the Aravalli Hills.

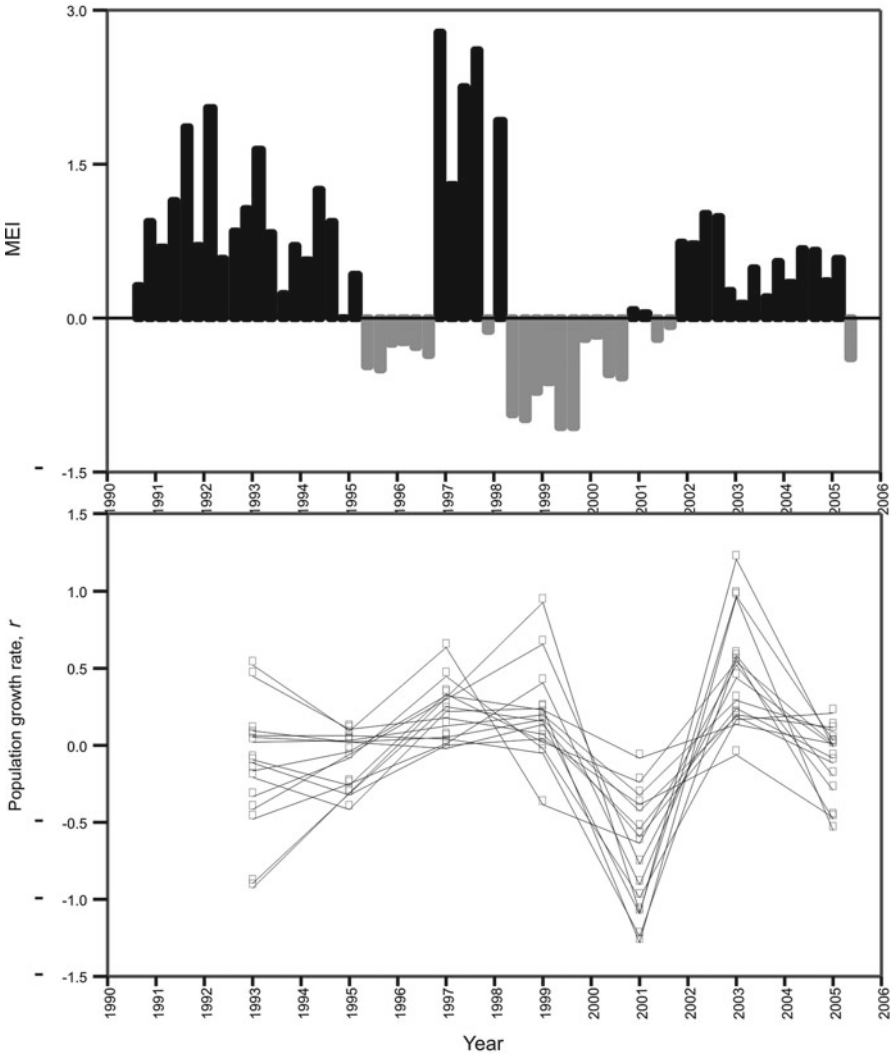


**Fig. 4.4** Multivariate ENSO Index (MEI) during the monsoon season, 1991–2005. Population growth rates (r) across biennial counts for 15 large mammal species in the Kumbhalgarh Wildlife Sanctuary [13]

## Threats to Faunal Diversity

The Aravalli Hills remain a crucial habitat for a large number of fauna making it an essential site for biodiversity maintenance. However, changes in land cover, habitat, and other conditions have led to decrease in the populations of several species with some species (e.g., Chinkara) at the brink of local extinction. There are myriad drivers of this change, and the threat to species includes road accidents, overgrazing, diseases, tree

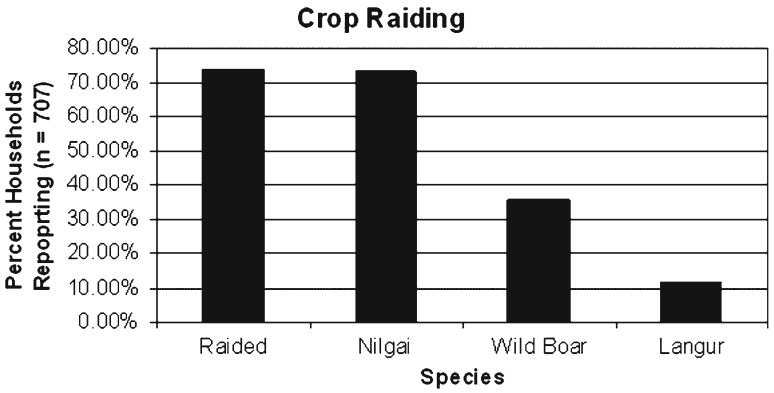


**Fig. 4.5** Crop raiding at villages adjacent to Kumbhalgarh Wildlife Sanctuary (2006)

cutting, weedy species invasion, fire, encounters with humans, monoculture plantation, and the size and configuration of sanctuaries which have been described below.

## *Road Accidents*

All the national parks and wildlife sanctuaries in the Aravallis are facing a serious threat of roads, highways, and mega highway projects [4–7]. For example, Kumbhalgarh alone faces road accident threat round the clock on its five-six roads and highway crossing the sanctuary which include the Jodhpur–Udaipur highway between Sadari and Bokhada villages, Desuri-Charbhuja road through Desuri-Ki-Nal, Kot-Diver road through Divar-Ki-Nal, Sadari-Parshuram temple road and Ghanerao-Muchhala Mahaveer temple road passes through the sanctuary. These busy roads and the major highways include heavy truck and bus traffic. The Ranakpur temple, Parshuram temple, and Muchhala Mahaveer temple are major tourist attractions brining cars, jeeps, and buses from several directions.

A total of 374 road kills were recorded in and around Kumbhalgarh Wildlife Sanctuary during December 1995–August 1998, out of which 80% occurred on highways. They were common along sharp turns, slopes, near water holes, and on small tracks preferred by animals to cross roads. Altogether 42 species of animals were found killed in road accidents (Table 4.3). Of these, 49% were birds, 39.5% mammals, 11.5% reptiles, and 12.4% domestic animals. The most common victim was Hanuman Langur, followed by Common Palm Civet (*Paradoxurus hermaphroditus*) and Five-striped Squirrel (*Funambulus pennantii*). Other mammalian taxa include Panther, Striped Hyaena, Gray Wolf, Golden Jackal, Sloth Bear, Jungle Cat, Indian Fox, Wild Boar and Nilgai.

Additionally, many animals, though not killed in accidents, are seriously injured and had minimum possibilities for survival and reproduction. It is quite likely that several deaths of wild animals due to road accidents might have escaped our attention,

**Table 4.3** Road accident fatalities for fauna at Kumbhalgarh Wildlife Sanctuary

| Species name | Scientific name | # killed |
|---|---|---|
| *Mammals* | | |
| Leopard | *Panthera pardus* | 2 |
| Striped Hyaena | *Hyaena hyaena* | 1 |
| Golden Jackal | *Canis aureus* | 12 |
| Nilgai | *Boselaphus tragocamelus* | 6 |
| Wild Boar | *Sus scrofa* | 3 |
| Wolf | *Canis lupus* | 1 |
| Bengal Fox | *Vulpes bengalensis* | 5 |
| Civet | *Paradoxurus hermaphroditus* | 24 |
| Jungle Cat | *Felis chaus* | 6 |
| Hanuman Langur | *Semnopithecus entellus* | 29 |
| Common Mongoose | *Herpestes edwardsii* | 4 |
| Small Asian Mongoose | *Herpestes javanicus auropunctatus* | 5 |
| Five-Striped Squirrel | *Funambulus pennantii* | 20 |
| Indian Gerbil | *Tatera indica* | 10 |
| Field Mouse | *Mus platythrix* | 14 |
| Indian Hare | *Lepus n. nigricollis* | 5 |
| House Mouse | *Mus musculus linn* | 8 |
| *Total* | | 155 |
| *Birds* | | |
| Indian Long-billed Vulture | *Gyps indicus* | 4 |
| Indian White-backed Vulture | *Gyps bengalensis* | 7 |
| Gray Partridge | *Francolinus pondicerianus* | 9 |
| Gray Quail | *Coturnix coturnix* | 6 |
| Rock Bush Quail | *Perdicula argoondah* | 2 |
| Gray Junglefowl | *Gallus sonneratii* | 5 |
| Indian Peafowl | *Pavo cristatus* | 6 |
| Rock Pigeon | *Columba livia* | 5 |
| Indian Ring Dove | *Streptopelia decaocto* | 16 |
| Red Turtle Dove | *S. tranquebarica* | 8 |
| Little Brown Dove | *S. senegalensis* | 12 |
| Crow Pheasant | *Centropus sinensis* | 6 |
| Common Indian Nightjar | *Caprimulgus asiaticus* | 2 |
| Common Myna | *Acridotheres tristis* | 3 |
| House Crow | *Corvus splendens* | 9 |
| Jungle Crow | *C. macrorhynchus* | 2 |
| Common Babbler | *Turdoides caudatus* | 14 |
| Jungle Babbler | *T. striatus* | 6 |
| Pied Bushchat | *Saxicola caprata* | 8 |
| Indian Robin | *Saxicoloides fulicata* | 2 |
| Indian House Sparrow | *Passer domesticus indicus* | 12 |
| *Total* | | 144 |
| *Reptiles* | | |
| Varanus | *Varanus bengalensis* | 25 |
| Varanus | *Varanus griseus* | 4 |

(continued)

**Table 4.3** (continued)

| Species name | Scientific name | # killed |
|---|---|---|
| *Mammals* | | |
| Cobra | *Naja naja* | 5 |
| Cat Snake | *Boiga trigonata* | 12 |
| Checkered Keelback | *Xenochrophis piscator* | 29 |
| *Total* | | 75 |
| *Domestic Animals* | | |
| Dog | spp. | 13 |
| Cat | *Felis* spp. | 5 |
| Goat | *Capra hircus* | 12 |
| Sheep | *Ovis aries* | 23 |
| Total | | 53 |

in the absence of observation. If strict measures are not taken, the number of deaths of wild animals will continue to increase in the Aravallis. Proper signboards noting the presence of wild animals, especially on sharp turns and slopes along roads in conservation areas, may save at least a few. Water holes should be prepared in areas far from roads (which is surprisingly not the common practice). Speed of the vehicles must be controlled while crossing the sanctuary area.

## *Overgrazing*

Like several national parks and sanctuaries, Kumbhalgarh faces a constant threat of livestock grazing. While grazing is considered officially restricted in most areas of the sanctuary, livestock accesses the reserve daily. This grazing has degraded ground cover within the forest. There is a decline in ground foliage, bush, and herb density due to overgrazing by sheep and goat and trimming off tree canopy as a result of browsing by camels. This situation is most common on the periphery of the sanctuary but, quite often, large herds of goat, sheep, cow, and camel enter into core areas as well. Overgrazing may become most problematic during drought [8] and can be considered as a major factor of biomass decline in KWS [2, 9, 10].

As noted above, this land cover impact has the largest effect on the wild species competing with livestock for ground cover including Sambar, Four-horned Antelope and Chinkara. Notably, there was no such competition observed with arboreal species like langurs or other grazers. Livestock is likely to provide a significant food resource for the sanctuary's carnivores, whose populations are stable. Livestock herders report a 1–2% of monthly herd loss due to predation in the sanctuary [9]. In this way, grazing has species-specific and inadvertent ameliorating influences on biodiversity loss.

## *Disease*

Wildlife species are exposed to a variety of diseases including foot and mouth (FMD), mange, serra, brucellosis, and several viral, bacterial, protozoan, and helminthes diseases. These are the result of interaction with domestic livestock [10]. Grazing grounds and drinking water holes shared with livestock results in further exposure and mutual infection. This threat has become more acute since inoculation of livestock entering into wildlife conservation areas is unenforced. As noted previously, at Kumbhalgarh WLS about 200,000 domestic animals depending partially or wholly on the sanctuary for fodder made the serious risk for the spread of the disease. Domestic cattle from villages surrounding conservation areas in the Aravalli require vaccination, especially against mange, serra, brucellosis, anthrax, and FMD.

## *Tree Cutting*

A survey of 709 households between 1998 and 2006 and a formal survey of 709 households in these 12 villages adjacent to the Kumbhalgarh Sanctuary show that each household makes an average number of ten trips for collecting fuelwood into the forest per month, extracting a self-reported average 20 kg per trip making a total of 200 kg per household per month. Considering the size and condition of the sanctuary, dry and fallen wood is unlikely to provide a bulk of this wood supply, and observations at high-traffic paths in the forest reveal that green wood is cut from a number of forest species, including *Anogeissus pendula*, *Acacia senegal*, *Ziziphus nummularia*, *Cassia auriculata*, *Prosopis juliflora*, and *Acacia nilotica*. With the exception of the invasive *P. juliflora* tree (which tends to dominate in tree falling), all of these species are important for many wild fauna.

A total of 450 trees belonging to 45 species and 30 families were noted and marked. Of these, 68 trees (or 15% of the total trees) belonging to 16 species were cut for firewood, construction, fodder, etc. Wood-cutters preferred species such as *Acacia senegal*, *Anogeissus pendula*, *A. latifolia*, *Albizia lebbeck*, *Acacia catechu*, *Lannea coromandelica*, and *Azadirachta indica*. The sanctuary is deprived of trees and its products, which are important for the endemic fauna of sanctuary. These trees provide food, fodder, and shelter to a large number of species. Control of tree cutting is difficult, only by expanding staff for monitoring and improving staff salaries to discourage illicit extraction can wood-cutting be controlled. Introduction of fuelwood-saving devices like subsidized LPG and *gobar* gas plant in the villages near conservation areas may also reduce the demand of fuelwood.

## *Exotic Weed Species*

Invasion of exotic weed species has also resulted in the degradation of forest habitat. The two species in particular, *Lantana camara* and *Prosopis juliflora*, invading

the forest area have replaced native species including *Anogeissus latifolia*, *A. pendula*, *Bauhinia racemosa*, *Boswellia serrata*, *Ficus bengalensis*, *F. racemosa*, *Ziziphus mauritiana*, and *Z. nummularia* and shrub species like *Grewia flavescens*, *G. tenax*, *Helicteres isora*, and *Annona squamosa*. In Kumbhalgarh Sanctuary near Ranakpur, more than 600 ha of area are heavily covered by *Lantana camara* in the drainages and hillsides and *Prosopis juliflora* along the roadsides. *Lantana* is currently only on watershed area in Kumbhalgarh, but has expanded fast during last 5–8 years. Significantly, langurs eat all parts of the species regularly without any ill effect, while all other wild animals and livestock avoid this bush. This suggests that langurs may be a key vector for the dispersal of invasive seeds [10]. Given the menace the plant represents for both competing indigenous flora and for faunal habitat, it is essential that the *Lantana camara* and *Prosopis juliflora* be controlled so that native species of grasses, shrubs, and trees can be re-established. Eradication efforts must be followed by the fallow of the seeding of indigenous species.

## *Forest Fire*

Fires are, often, caused due to negligence of right holders living inside the sanctuary. The heavy traffic between Sadri-Sayra and Desuri-Charbhuja within the sanctuary area is also the cause of forest fires. Half-burnt cigarettes and *bidis* are thrown along the roadside, which often fall on the dry leaves and catch fire. In tribal areas, fire may sometimes be caused during festivities of *bolma* (worship) in which locals offer *Magra Puja* (worship of the hill) by burning forest area. Conversely, forest fire is also essential for the regeneration of trees, as it thinned out the litter layer and creates favorable conditions for regeneration. Forest fires also promote the growth of young shoots, which are favorite food of herbivores and langurs. The influence of fire in KWS must, therefore, be considered as complex since uncontrolled fire events damage habitat; periodic fire is essential for forest regeneration. Fire events damage flora and fauna of KWS with particular influence on microflora and microfauna on the topsoil and in little layers, which reduces soil fertility. Fire causes serious damage to the younger generation of tender plants, which dies off while resistant plants like *Butea monosperma*, *Acacia senegal*, *Anogeissus pendula*, and *Anogeissus latifolia* may survive. It causes tremendous damage to the ground cover and to shrubs which form ideal habitat and feeding ground for wild animals particularly herbivores. Due to fire, many species of insects, reptiles, and birds are killed and their eggs are destroyed.

Maintenance of existing fire lines and extra patrolling during fire season (again requiring an improved commitment of forest department staff at the lower levels) can reduce the risk of forest fire. Education awareness among peoples around the sanctuary may be important. Man-made fires can perhaps also be controlled through Village Forest Protection Committees (VFPC), though their condition, autonomy, and power are anemic at present.

## *Encounters with Humans*

Crop raiding by different wild animals, particularly mammals, has been widely reported from all across the Aravalli Hills, including raids by Nilgai, Sloth Bear, Wild Boar, Hanuman Langur and Porcupine. As in other parts of India [11], farmers use many methods to protect their crop fields and orchards from wildlife, some of which represent a threat to invading wildlife. These methods include patrolling the fields with gun, throwing stone with *gophan,* keeping dogs, and fencing by thorny twigs, open electric wire, and potash bombs. In a separate survey from the region, some farmers (about 15%) use dogs for crop protection and to chase the wild animals. Many times, these dogs kill the wild animals, in particular, juveniles and infants. While the remaining 5% use dangerous methods like single shotgun, potash bomb, and high-voltage electric current by which wild animals are usually killed or seriously injured.

Most typically proffered remedies for such conflicts seem unrealistic (e.g., power fencing around sanctuaries, replacement of traditional crops with only those inedible to wild animals, etc.). Improved fencing and walls are expensive but, if of sufficient height, might dissuade crop raiders. More radically, crop raids should be considered an inevitable cost of conservation, and compensation systems might be devised to alleviate their potentially devastating effects.

## *Monoculture Plantation*

The Aravalli Range has lost some of its biodiversity due to large-scale monocultural plantation blocks, which have come to cover grasslands over the last 25 years. Such monoculture plantation areas are common in the buffer zone of all the sanctuaries in the Aravalli Ranges and plantation near roadside. Common species in such plantations include *Acacia senegal*, *Eucalyptus camaldulensis*, and *Ziziphus mauritiana*, even in some areas *Prosopis juliflora*. Such areas are not attractive to wild animals, but have some commercial value. Monoculture plantation should be avoided completely in future plantation projects. New plantation projects must have equal ratios of native trees, shrubs, herbs, and grasses with species selection designed for the needs of wild fauna.

## *Size and Configuration of Sanctuaries and Parks*

The history of conservation area development has meant the carving of sanctuaries and parks out of preexisting reserved forest areas, usually surrounded by dense populations which often produces awkward shapes and sizes incompatible with conservation objectives [2]. The size of the Kumbhalgarh Wildlife Sanctuary, as an

obvious example, is about 60 km in length but just 5 to 12 km in width. These are adjoining revenue lands available, which should be included in the sanctuary area and declare this as a national park. While this is advantageous as a corridor, it allows easy access and proximity to core areas from the edges. The home range of many animals is also constrained by this width [10]. The panther's average home range is about 25 $km^2$. A similar problem is faced in the Raoli-Tatgarh Wildlife Sanctuary, Jaisamand Wildlife Sanctuary, Mount Abu Wildlife Sanctuary, and Phulwari Ki Nal Wildlife Sanctuary. Many animals have been forced to move out of the sanctuary area, where they face acute threats from road accident, poaching, hunting, etc.

## *Unacknowledged Key Issues*

All above described threats to wildlife in the Aravalli region are reasonably well known and increasingly well understood (excluding the effects of grazing). Recent research has revealed, however, several generally unacknowledged issues that are central to the future of faunal biodiversity in the region, including problems related to erratic climate (potentially exacerbated by global warming), and role of different human subsidies.

## *Climate*

Given the dramatic changes that people have caused to animal habitat over the last century, it is tempting to conclude that the problems faced by faunal biodiversity are entirely anthropogenic in nature. There is increasing evidence, however, that large-scale climatic drivers such as El Niño–Southern Oscillation (ENSO) can strongly influence the population of large mammals [12]. Our preliminary research indicates that this may be the case at Kumbhalgarh Sanctuary and likely, therefore, throughout the Aravallis. An ENSO index explained much of the variability in population size, apparently reflecting the mass mortality left by the major 1998–2000 La Niña event. Monsoon failure apparently overwhelmed endogenous factors that ordinarily regulate population dynamics. Numerous reports of declining vertebrate population in Asia during the same time frame suggest that our findings may be symptomatic of a geographically broad impact of the 1998–2000 La Niña. We interpret our findings in the context of local political conflict and ecological effects of the global climate cycle. Specifically, forest department census figures suggest a massive die-out coinciding with the drought of 2000, which followed two consecutive monsoon failures. Time series of biennial counts (1991–2005) suggest that the population of 15 species under study declined from 1999 to 2001, with 14 out of 15 experienced a die-off exceeding 20% (minimum = 4%; median = 53% ; maximum = 72%) (Fig. 4.6).

Our findings reveal a parallel impact of drought on the mammal species in the Kumbhalgarh Wildlife Sanctuary (KWS), in Rajasthan, India. All 15 species

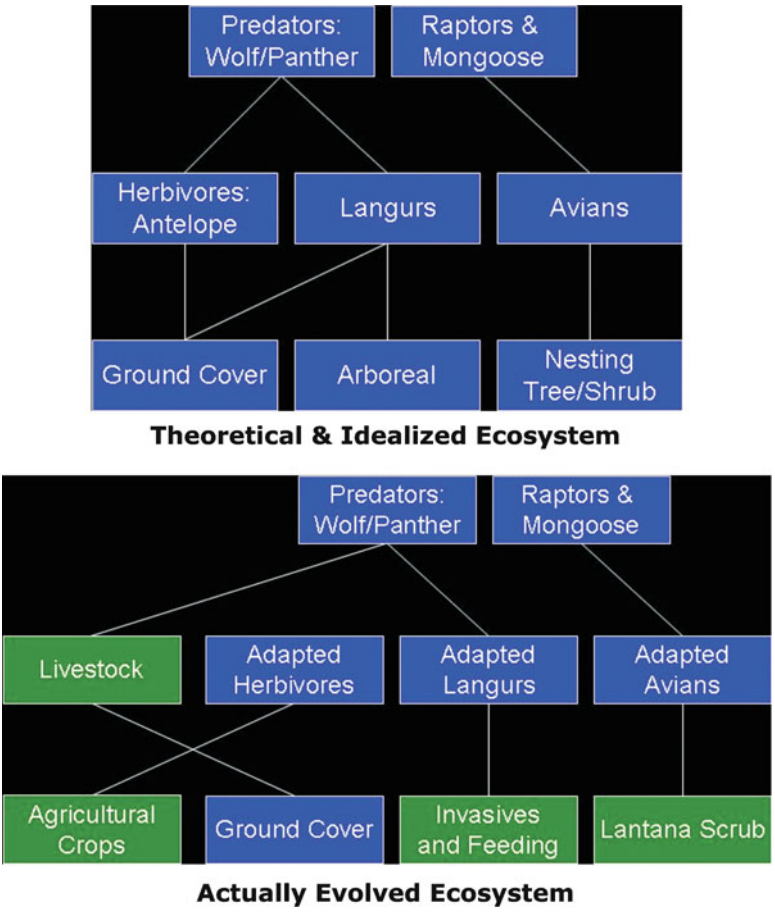


**Fig. 4.6** Idealized Aravalli ecosystem versus reality

declined in abundance between 1999 and 2001 [12]. This universal downturn coincided with the major 1998–2000 La Niña event, which led to vegetative drought in the Aravalli region of Rajasthan. An ENSO index accounted for much of the observed variability in population size. ENSO apparently impacted mammalian population dynamics in this semiarid region. Major La Niña events are anomalies, so it seems that this kind of impact on population dynamics is too infrequent to be important. However, events of similar magnitude to the 1998–2000 event have occurred in every five years on an average, over the past few decades. Thus, monsoon failure and drought may have a strong, semiregular impact on the population dynamics of mammals in many semiarid and dry deciduous ecosystems [8]. Further analysis of the data suggests that the Multivariate ENSO Index explained on an average, almost half of the variance in population growth rate, underlining the mass mortality in wild fauna in the wake of the La Niña spanning 1999 [12].

## *Adaptation*

Growth in the numbers of Hanuman Langurs, Nilgai and Wild Boar is due in part to their adaptation to feeding in crop fields around the sanctuary [13]. Animals like Sambar, Four-horned Antelope and Chinkara, on the other hand, cannot adapt themselves to crop field and are mainly grazers depending on ground food within the sanctuary area. This resource has degenerated in recent years due to overgrazing and heavy resource pressure in and around KWS [3]. Sloth bear and langurs depend more heavily on arboreal food (flowers and fruits) and also eat the exotic plants still available in good variety and quantity. The forest produces enough reproductive parts like flower and fruits even in the difficult conditions (like drought) to support such species, maintaining some of the faunal diversity of the KWS despite heavy human pressure [9].

Table 4.4 shows the overall trends in several species of concern for Kumbhalgarh, all of which appear on the IUCN Red List but only a few of which are considered globally threatened. Notably, at least one species of truly global concern such as Sloth Bear (*Melursus ursinus*) and Four-horned Antelope (*T. c. qudtricormis*) appears in each of the successful and unsuccessful categories.

## *Role of Human Subsidies*

It is increasingly clear that human beings and village resources are important parts of the ecosystem of wild fauna in the Aravalli, as elsewhere in India [14, 15]. Specifically, crop raiding and predation of wildlife on domestic livestock is difficult and expensive for local producers [9, 16]. A survey of 707 households in villages suggests the extent of this problem, 73% of all households surveyed reported raids during the growing season, with nilgai raids predominating (Fig. 4.7). These households further report the frequency of raids to be 25 nights per month per household on an average, making this essentially threat to crops during the growing season in the nights. Interviews suggest that unchecked raids by larger mammals, especially Nilgai, can result in total crop loss in a single evening. Foragers like Nilgai, whose populations are on the incline as noted previously, increasingly depend on these resources. This survey also reveals 265 (37%) predation of one or more livestock by wild animals in a year. Of these, only 15 cases were described as occurring in the village or field, with the remainder occurring in the forest. A total of 1,088 (7%) animals were reported to be predators. All but fifteen of these reports claim that the animals were taken from inside the forest. For the most part, respondents do not complain about these losses, in so far as they represent an expected fixed cost to be paid to obtain the benefits of forest grazing, especially during the rainy season.

Extrapolating these figures to the regional herd of 96,000 goats and sheep, it suggests that roughly 6,700 animals are taken annually (or 18 per day) from herders across the park. This represents a heavy toll for the survival of predatory species,

**Table 4.4** Overall faunal population trends at Kumbhalgarh Wildlife Sanctuary between 1991 and 2005

| Species | Latin | 1991 population | 2005 population | Δ | IUCN declared "Red List" category |
|---|---|---|---|---|---|
| Langur | *Semnopithecus entellus* | 3,071 | 4,894 | 59% | Lower risk, Near Threatened |
| Sloth bear | *Melursus ursinus* | 105 | 162 | 54% | Vulnerable: A2cd, C1 + 2a |
| Nilgai | *Boselaphus tragocamelus* | 604 | 931 | 54% | Lower risk, Least Concerned |
| Leopard | *Panthera pardus* | 54 | 82 | 52% | Lower risk, Least Concerned |
| Sambar | *Cervus unicolor* | 88 | 122 | 39% | Lower risk, Least Concerned |
| Jackal | *Canis aureus* | 312 | 300 | −4% | Lower risk, Least Concerned |
| Hyaena | *Hyaena hyaena* | 125 | 119 | −5% | Lower risk, Near Threatened |
| Wild cat | *Felis chaus* | 76 | 65 | −14% | Lower risk, Least Concerned |
| Wolf | *Canis lupus* | 85 | 47 | −45% | Lower risk, Least Concerned |
| Four-horned antelope | *T. c. qudtricormis* | 211 | 106 | −50% | Vulnerable: VU C2a(i) |
| Wild boar | *Sus scrofa* | 631 | 223 | −65% | Lower risk, Least Concerned |
| Chinkara | *Gazella bennetti* | 37 | 10 | −73% | Lower risk, Least Concerned |

**Fig. 4.7** Kumbhalgarh Aravalli Ranges

especially where a decline of smaller herbivores is prevailing. Absence of these prey species would mean the pursuit of new prey including higher predation on the remaining smaller ungulates as well as pursuit of livestock by panthers and wolves outside the forest, where they currently may create a nuisance. The socioeconomic costs and disruption of such a shift could be significant. Clearly, humans are also the victims in the Aravalli, often coming from poor rural producers whose stakes in conservation planning are low. Consideration of this increasingly evident fact is prerequisite to form any meaningful conservation schemes.

## Conclusions

The Kumbhalgarh Wildlife Sanctuary system that has emerged from this configuration is the one, in which wild predators (e.g., panther and wolves) have come to rely on domesticated grazers (e.g., goats and sheep) who, in turn, depend on wild herbaceous resources. Similarly, wild browsers (e.g., Nilgai and Wild Boar) depend increasingly on domesticated crops. Indigenous species (e.g., langurs and Sloth Bear) have adapted to exogenous species.

This, by no means, is an ideal one for the conservation of biodiversity. It, however, has supported, for the time being, several keystone species of the Aravalli, for which conservation reserves (e.g., Ravli Todgarh, Kumbhalgarh) were originally designed. The successful species suggest that we need to be as adaptive in our

management as the wild fauna in their survival if the future of Aravalli biodiversity is to be achieved. It also entails a continued effort against mining in the Aravalli and against agricultural encroachment into forested lands, where these activities have been successfully halted in the sanctuaries and parks of the Aravalli region; however, a more subtle and systematic approach is essential. Each park and species presents its own puzzle, and more research will be absolutely necessary before further programs are initiated. The future belongs to conservation planners and experts who can adapt and not reach instead to the shelf for "one-size-fits-all" solutions. Please see Chaps. 2 and 3 from *Faunal Heritage of Rajasthan: Ecology and General Background of Vertebrates*, Vol. 1; B. K. Sharma et al. (eds.), 2013 and Chaps. 18 and 20 from this volume for more pictures and conservation issues.

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# Chapter 5
# Faunal Ecology and Conservation of the Great Indian Desert

**C. Sivaperuman and Q.H. Baqri**

**Abstract** The Great Indian Desert is biogeographically the easternmost edge of the Saharan-Arabian Desert zone, with an extent of 280,000 km$^2$ area, comprising 61% of the total geographical area of the state. The Great Indian Desert is one of the smallest deserts in the world, but it exhibits a wide variety of habitats and biodiversity. It is the most thickly populated deserts in the world with an average density of 83 persons per km$^2$, whereas, in other deserts, the average is only seven persons per km$^2$. The vegetation of this region consists mainly of xerophytes like *Prosopis cineraria*, *Capparis deciduas*, *Calotropis procera*, *Salvadora oleoides* and *Lasiurus scindicus*. The Great Indian Desert is quite rich in animal life, and the fauna of this desert is mainly of Palaearctic-Oriental origin, exhibiting a remarkable diversity in habitat. This chapter based on field surveys conducted from 2000 to 2004 under the project sponsored by the Ministry of Environment and Forests, Government of India, is also consulted with existing literature on the various fauna of the Great Indian Desert. The surveys were carried out in different habitats like sandy area, stable and shifting type of sand dunes, rocky area, gravel, *sewan* grass, lakes and tanks of saline and fresh water, canal area and agricultural fields which provide excellent shelter to the fauna of this region. The species richness, abundance and diversity of different faunal groups, namely, insects, beetles, ants, amphibians, reptiles, birds and mammals, have been described in details. The arrival of canal water has increased the diversity of fauna in the Great Indian Desert.

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## Introduction

The Great Indian Desert or Thar Desert is biogeographically the easternmost edge of the Saharan-Arabian Desert zone, with an extent of 280,000 km$^2$ consisting of 61% of the total geographical area of the state. This hot desert in the north-western region of India is unique and the only habitat type in the Indian subcontinent. The principal geomorphologic formations are dunes (highly mobile sands), *magras* (local uplands constituting important watersheds) and *bhakars* (hillocks suddenly rising in the midst of plains). The Great Indian Desert is considered to be a unique desert because of its location at the crossing of the Palaearctic, Oriental and Saharan elements of biodiversity, both at the species level and at the level of ecological communities. The number of species of plants and animals may be low, but their xerophytic characteristics make some of them a special taxonomic significance. Animals and plants have developed to adapt to the difficult climatic conditions with extreme temperature and lack of moisture.

The climate is characterised by low rainfall with erratic distribution, extremes of diurnal and annual temperatures, low humidity and a high wind velocity. The arid climate has marked variations in its diurnal and seasonal range of temperature, exhibiting the most characteristic phenomenon of the warm-dry continental climate. During summer (March to June), the maximum temperature can go up to 48°C and occasionally rises to 51°C. The night temperature drops down considerably and remains between 20°C and 29°C. January is observed as the coldest month. During winter (December to February), the minimum temperature may fall to 2°C in the night. Occasional secondary western disturbances mostly cross western, northern and eastern Rajasthan during the winter months, causing light rainfall, and the increased wind speed creates a wind-chill effect. The average annual rainfall ranges from less than 100 to 400 mm.

## Vegetation

The natural vegetation is classified as Northern Desert Thorn [10]. These occur in small clumps scattered in more or less open forms. Density and size of patches increase from west to east following the increase in rainfall. Natural vegetation in the Thar Desert is composed of the following tree, shrub and herb species. The major tree species are *Acacia leucophloea*, *Acacia senegal*, *Anogeissus rotundifolia*, *Prosopis cineraria*, *Salvadora oleoides* and *Tecomella undulata.*

Small trees and shrubs: *Calligonum polygonoides*, *Acacia jacquemontii*, *Balanites roxburghii*, *Ziziphus nummularia*, *Calotropis procera*, *Suaeda fruticosa*, *Crotalaria burhia*, *Aerva tomentosa*, *Clerodendrum multiflorum*, *Leptadenia pyrotechnica*, *Lycium barbarum*, *Grewia populifolia*, *Commiphora mukul*, *Euphorbia neriifolia*, *Cordia rothii* and *Maytenus emarginata*

Herbs: *Eleusine compressa*, *Dactyloctenium scindicum*, *Cenchrus biflorus*, *Cenchrus setigerus*, *Lasiurus hirsutus*, *Cynodon dactylon*, *Panicum turgidum*, *Panicum anti-*

*dotale*, *Dichanthium annulatum*, *Sporobolus marginatus*, *Saccharum spontaneum*, *Cenchrus ciliaris*, *Desmostachya bipinnata*, *Cyperus arenarius*, *Eragrostis* sp., *Ergamopagan* sp., *Phragmites* sp. and *Typha* sp.

## Scientific Studies in the Thar Desert

Scientific studies on the fauna of the Great Indian Desert have been reported by many authors [1, 2]. In recent years, various workers have been contributing in different fields of faunal ecology of the Great Indian Desert [3–14].

Studies on the avifauna of the Great Indian Desert were carried out by different researchers and these studies mainly listing the species from different parts of the Thar Desert [14–36].

Detailed studies on population ecology of vultures have been made by various workers in the Great Indian Desert [37–49].

Among mammals, rodents are one of the well-studied groups in the Great Indian Desert; Prakash published more than 300 research papers in the field of rodent ecology, and also a large number of scientific studies have been carried out by various workers on systematic and ecological studies of desert rodents [50–59]. Primates are another well-studied group in the Great Indian Desert [60–72].

Even though many reports and publications were available in the past, no efforts have been made to present the overall fauna of the Great Indian Desert in a single place. An attempt is made here to present the fauna of the Great Indian Desert based on the field surveys and published work.

## Materials and Methods

The Great Indian Desert was studied from May 2000 to May 2004 in different habitats like sandy area, stable and shifting type of sand dunes, rocky areas, gravel, sewan grass, lakes and tanks of saline and fresh water, canal areas and agricultural fields. The surveys were conducted using previously recognised scientific sampling methods:

*Insects*: Net sweeping, aspirator/pooter, mechanical knockdown/beating, light trap and soil sampling.

*Spider*: Pitfall trapping, sweep netting and hand searching for cryptic fauna [73] were used to collect the spiders. The spiders were identified with the help of a standard key of systematic references [74–80] and with a hand lens and a microscope.

*Avifauna*: Bird species were assessed in the representative plots using line transect method for arable sandy, farming, forest hills, gardens, groves, plantations, protected

areas and sand dune habitats and total count method for wetland habitat [81, 82]. During the period of study (November 2000 to May 2003), a total of 148 localities were surveyed in almost all the habitats throughout the year (except in August), by different members of the research team of the project (Refer map: [36]).

*Mammals*: All the habitats in the Thar Desert were surveyed for the study on mammalian diversity.

*Species richness and abundance*: Species richness (number of species) and abundance (number of individuals) of birds in the Thar Desert in every month were calculated from the census data and field observations. Species richness indices like Margalef index (R1) and Menhinick index (R2) were calculated using the formula given by Magurran (1988).

*Species diversity indices*: Diversity measures the variation in richness and abundance. Diversity index combines the information on multiple species into a single number. These indices provide easily understandable measures of diversity. Shannon-Weiner (H′), Simpson's (λ) and Hill's diversity numbers N1 and N2 were calculated using the computer programme SPDIVERS.BAS [83].

*Evenness measures*: A number of indices have been used to quantify the evenness of diversity. Two evenness measures, namely, Shannon Evenness and Sheldon Evenness, were calculated using the computer programme SPDIVERS.BAS [83].

## Results

### *Insect*

The species richness and abundance were highest in the order Lepidoptera followed by Coleoptera and Hemiptera (Fig. 5.1). The Shannon index of diversity was highest in the order Lepidoptera and lowest in Odonata (Table 5.1). The members of the family Noctuidae, which constitute an important group of agricultural pests, are dominant in our collection from the Thar of Rajasthan. In this group, *Utetheisa pulchella* has been found as most abundant species in the Great Indian Desert.

Odonata are generally found at or near freshwater bodies. However, some species may be found far from their breeding sites. Odonata are beneficial to us because they are predators and help in control of insect pests. In our study, odonates have been collected from paddy fields of Sri Ganganagar and Hanumangarh districts, where generally knee-deep waters are maintained throughout the cultivation period.

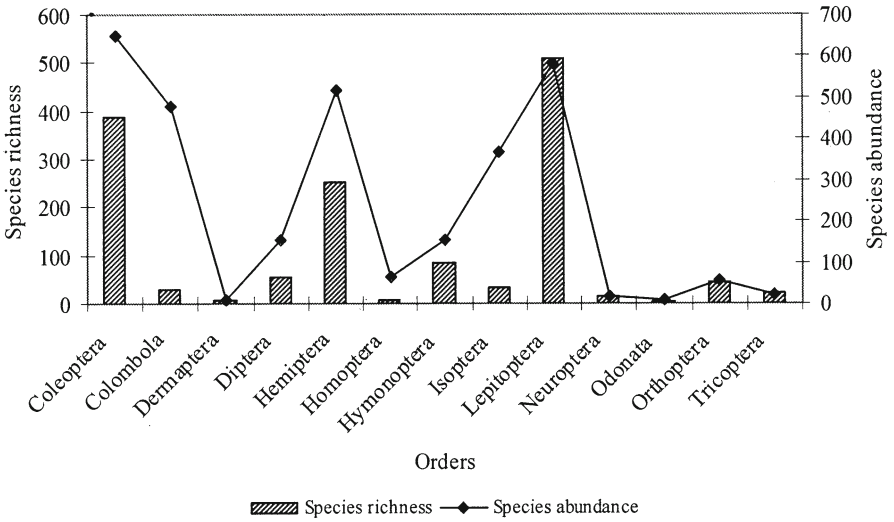


**Fig. 5.1** Species richness and abundance of insect in different orders in the Great Indian Desert

**Table 5.1** Diversity indices of different orders of insects in the Great Indian Desert

| | Richness | | | | Hill's number | | Evenness | |
|---|---|---|---|---|---|---|---|---|
| Order | R1 | R2 | Simpson's | Shannon | N1 | N2 | E1 | E2 |
| Coleoptera | 59.93 | 15.28 | 0.01 | 5.57 | 262.82 | 169.19 | 0.93 | 0.67 |
| Collembola | 4.38 | 1.28 | 0.09 | 2.74 | 15.55 | 11.39 | 0.82 | 0.56 |
| Dermaptera | 2.92 | 2.42 | 0.05 | 2.02 | 7.54 | 18.33 | 0.92 | 0.94 |
| Diptera | 10.91 | 5.51 | 0.03 | 3.69 | 39.93 | 38.38 | 0.92 | 0.71 |
| Hemiptera | 40.02 | 11.05 | 0.01 | 4.89 | 132.40 | 71.55 | 0.88 | 0.53 |
| Homoptera | 1.45 | 0.88 | 0.19 | 1.70 | 5.49 | 5.09 | 0.87 | 0.78 |
| Hymenoptera | 16.49 | 6.79 | 0.02 | 4.11 | 61.13 | 53.34 | 0.93 | 0.73 |
| Isoptera | 5.59 | 1.77 | 0.03 | 3.39 | 29.78 | 29.16 | 0.96 | 0.88 |
| Lepidoptera | 79.79 | 21.09 | 0.01 | 5.98 | 396.27 | 182.58 | 0.96 | 0.78 |
| Neuroptera | 4.29 | 3.33 | 0.01 | 2.46 | 11.68 | 78.00 | 0.99 | 0.97 |
| Odonata | 0.51 | 0.76 | 0.71 | 0.41 | 1.51 | 1.40 | 0.59 | 0.75 |
| Orthoptera | 10.98 | 6.07 | 0.01 | 3.70 | 40.64 | 92.81 | 0.97 | 0.90 |
| Trichoptera | 7.02 | 4.80 | 0.00 | 3.13 | 23.00 | 17.01 | 1.00 | 1.00 |

## *Termite*

A total of 44 species belonging to four families were recorded from here, namely, Kalotermitidae (two species), Hodotermitidae (six species) and Termitidae (36) [84].

### *Beetle*

A total of 85 species belong to 12 genera have been recorded in the Great Indian Desert (Sewak, 2008): seven species, *Scarabaeus* Linnaeus; five species, *Gymnopleurus* Illiger; three species, *Heliocopris* Burmeister; five species, *Catharsius* Hope; seven species, *Copris* Geoffroy; three species, *Phalops* Erichson; 10 species, *Caccobius* Thomson; 28 species, *Onthophagus* Latreille; four species, *Oniticellus* Serville; three species, *Drepanocerus* Kirby; nine species, *Onitis* Fabricius; and one species, *Chironitis* Lansberge.

### *Ant*

Thirty-six species of ants distributed under 16 genera were recorded [86]. The family Formicidae comprises six subfamilies, namely, Dorylinae (one genus and two species), Ponerinae (two genera and three species), Pseudomyrmecinae (one genus and two species), Dolichoderinae (one genus and one species), Myrmicinae (six genera and 18 species) and Formicinae (five genera and 10 species).

### *Spider*

A total of 28 species of spiders belonging to 13 families and 21 genera were recorded from Desert National Park [87]. Among these, five species—*Lycosa madani*, *Uroctea indica*, *Drassodes parvidens*, *Zelotes desioi* and *Drassodes luridus*—were new records for this area. Most of the spiders were non-weavers. *Neoscona* sp., *Herennia ornatissima* and *Stegodyphus sarasinorum* were the only weavers. Highest number of genera and species were recorded in Lycosidae and Gnaphosidae followed by Thomisidae and Clubionidae. An analysis of the result of the present study shows that great variety of spiders exists in DNP. Among the recorded species, *Stegodyphus sarasinorum*, *Heteropoda fabrei*, *Herennia ornatissima* and *Zelotes desioi* were recorded only from Jaisalmer district. Other species were observed in both the districts.

### *Fishes*

A total of 12 species of fishes were recorded from Kailana Lake in the Thar Desert during the study period (Table 5.2); these belong to seven orders and eight families.

**Table 5.2** Fish fauna in the Kailana Lake, Great Indian Desert

| S. No. | Order | Family | Species name | Common name |
|---|---|---|---|---|
| 1 | Atheriniformes | Belonidae | *Xenentodon cancila* | Freshwater Garfish |
| 2 | Channiformes | Charinidae | *Chanda* baculis | Himalayan Glassy Perchlet |
| 3 | Clupeiformes | Clupeidae | *Gudusia chapra* | Indian River Shad |
| 4 | Cypriniformes | Cyprinidae | *Catla catla* | Catla |
| 5 | | | *Cirrhinus mrigala* | Mrigal |
| 6 | | | *Cyprinus carpio* | Common Carp |
| 7 | | | *Labeo calbasu* | Kalbasu or Black Rohu |
| 8 | Osteoglossiformes | Notopteridae | *Notopterus* notopterus | Grey Featherback |
| 9 | Perciformes | Cichlidae | *Tilapia mossambica* | Tilapia, Mozambique Cichlid |
| 10 | | Nandidae | *Nandus nandus* | Mottled Nandus |
| 11 | Siluriformes | Bagridae | *Mystus* vittatus | Striped Dwarf Cat Fish |
| 12 | | | *Mystus* cavasius | Gangetic Mystus |

**Table 5.3** Order and status of bird species recorded from the Great Indian Desert[a]

| | | Status | | | |
|---|---|---|---|---|---|
| S. No. | Order | R | M | Total number of species | % |
| 1 | Podicipediformes | 01 | – | 01 | 0.37 |
| 2 | Pelecaniformes | 06 | 02 | 08 | 2.94 |
| 3 | Ciconiiformes | 18 | 01 | 19 | 6.99 |
| 4 | Phoenicopteriformes | 02 | – | 02 | 0.74 |
| 5 | Anseriformes | 11 | 10 | 21 | 7.72 |
| 6 | Falconiformes | 23 | 04 | 27 | 9.93 |
| 7 | Galliformes | 04 | – | 04 | 1.47 |
| 8 | Gruiformes | 09 | – | 09 | 3.31 |
| 9 | Charadriiformes | 14 | 29 | 43 | 15.81 |
| 10 | Columbiformes | 04 | – | 04 | 1.47 |
| 11 | Psittaciformes | 02 | – | 02 | 0.74 |
| 12 | Cuculiformes | 03 | – | 03 | 1.10 |
| 13 | Strigiformes | 01 | – | 01 | 0.37 |
| 14 | Apodiformes | 02 | – | 02 | 0.74 |
| 15 | Coraciiformes | 12 | – | 12 | 4.41 |
| 16 | Piciformes | 04 | – | 04 | 1.47 |
| 17 | Passeriformes | 107 | 03 | 110 | 40.44 |
| Total | | 223 | 49 | 272 | 100.00 |

[a]Sivaperuman *et al*. (2008)

## *Birds*

During the present study, a total of 272 species of birds belonging to 55 families under 17 orders were recorded from the Thar desert of Rajasthan. Out of these, 223 species are resident and 49 are migrants (Table 5.3) [14].

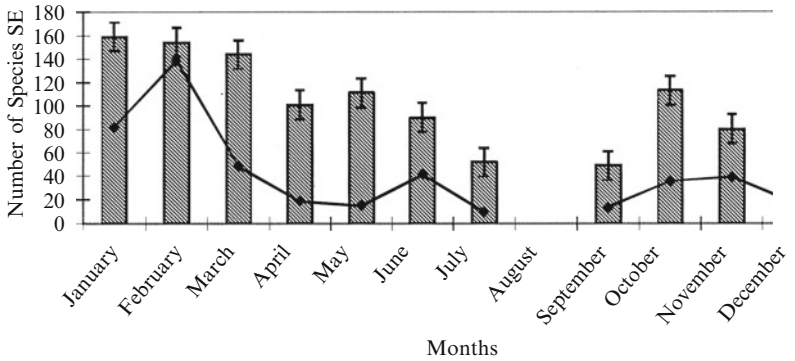


**Fig. 5.2** Species richness and abundance of birds in different months in the Great Indian Desert (May 2000–May 2003)

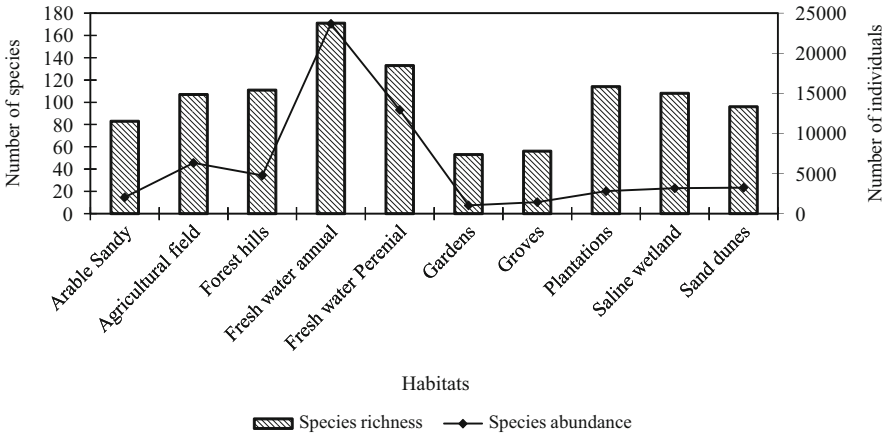


**Fig. 5.3** Species richness and abundance of birds in different habitats in the Great Indian desert (May 2000–May 2003)

## *Species Richness and Abundance*

Species richness was highest in the month of January (159), followed by February (154), during the study period of four years in the Thar Desert. Abundance of birds was highest in the month of February (19,283) and lowest in July (1,342) (Fig. 5.2). During the month of August, survey was not conducted in any year.

Eleven microhabitats were recorded in the study area, namely, arable sandy, farming, forest hills, freshwater annual, freshwater perennial, gardens, groves, plantations, protected areas, saline wetlands and sand-dunes. Species richness and abundance were highest in the freshwater annual and freshwater perennial habitats (Fig. 5.3).

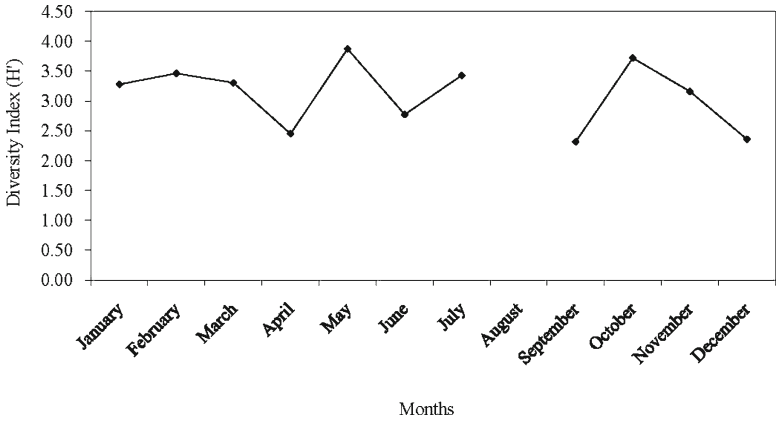


**Fig. 5.4** Diversity index of birds in different months in the Great Indian Desert (May 2000–May 2003)

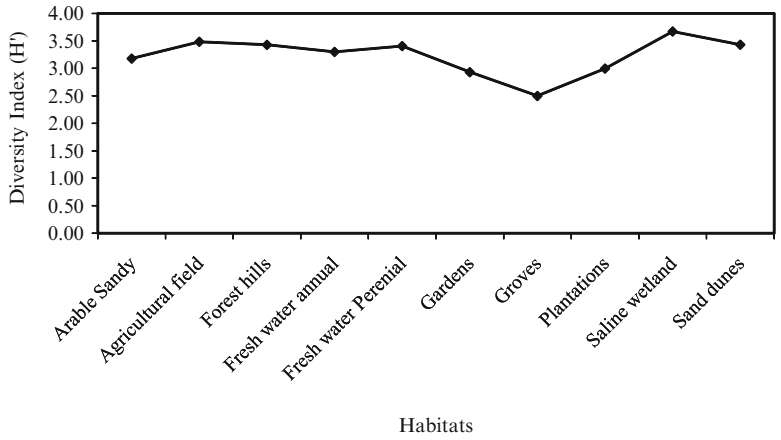


**Fig. 5.5** Diversity index of birds in different habitats in Great Indian Desert (May 2000–May 2003)

## *Diversity Indices*

Most widely used diversity indices like Shannon-Weiner index, Simpson's index and Hill's numbers were estimated for the birds of the Thar Desert. The diversity indices for overall bird community (H') were 3.94 and (λ) 0.05. The species richness index R1 was 24.22 and R2 was 1.01. Similarly, high values were obtained for Hill's numbers N1 and N2. Hill's number N1 was 51.36 and Hill's number N2 was 19.24. The highest diversity was in the month of May followed by October (Fig. 5.4).

Among the habitats, wetland habitat showed the highest diversity (Fig. 5.5).

**Table 5.4** Relative abundance and dominance of threatened bird species in the Thar Desert of Rajasthan

| S. No. | Species name | Estimated no. of individual | Dominance |
|---|---|---|---|
| 1 | Painted Stork | 297 | 35.83 |
| 2 | Beach Stone Plover | 89 | 10.74 |
| 3 | Marbled Teal | 83 | 10.01 |
| 4 | Sarus Crane | 74 | 8.93 |
| 5 | Spot-billed Pelican | 73 | 8.81 |
| 6 | Ferruginous Pochard | 56 | 6.76 |
| 7 | Cinereous Vulture | 56 | 6.76 |
| 8 | Darter | 44 | 5.31 |
| 9 | Indian White-backed Vulture | 21 | 2.53 |
| 10 | Great Indian Bustard | 15 | 1.81 |
| 11 | Pallid Harrier | 10 | 1.21 |
| 12 | Red-headed Vulture | 6 | 0.72 |
| 13 | Eastern Imperial Eagle | 4 | 0.48 |
| 14 | Black Stork | 1 | 0.12 |
| Total | | 829 | 100.00 |

## *Threatened Birds Recorded from the Thar Desert*

During the study period, 14 species of threatened birds were recorded from the Thar Desert in Rajasthan. Among these, the Painted Stork was the most dominant species followed by the Beach Stone Plover. Relative abundance and dominance of the threatened species are given in the Table 5.4.

## *Mammals*

A total of 66 species of mammals belonging to 13 orders and 23 families were recorded from the Great Indian Desert (Table 5.5). Of these, the highest number of species was recorded from the order Rodentia followed by Chiroptera.

The relative abundance of selected species of mammals is presented in Table 5.6. Of the recorded species, *Antilope cervicapra* was the most dominant, followed by *Gazella bennetti* and *Boselaphus tragocamelus*.

The diversity indices of mammals are presented in Table 5.7. Highest diversity with respect to the Shannon index was observed in *Gazella bennetti*, followed by *Lepus nigricollis*, *Boselaphus tragocamelus* and *Hemiechinus collaris*. Similarly, the richness indices of R1 and R2 are also higher in the following species *Gazella bennetti*, followed by *Lepus nigricollis*, *Boselaphus tragocamelus* and *Hemiechinus collaris*.

**Table 5.5** Orders and families of the mammals recorded from the Great Indian Desert

| | | Family | | Species | |
|---|---|---|---|---|---|
| S. No. | Order | India | Thar Desert | India | Thar Desert |
| 1 | Insectivora | 3 | 2 | 28 | 4 |
| 2 | Chiroptera | 6 | 7 | 110 | 18 |
| 3 | Primates | 3 | 1 | 15 | 2 |
| 4 | Pholidota | 1 | 1 | 2 | 1 |
| 5 | Carnivora | 7 | 6 | 55 | 14 |
| 6 | Artiodactyla | 5 | 2 | 32 | 4 |
| 7 | Lagomorpha | 2 | 1 | 10 | 1 |
| 8 | Rodentia | 4 | 3 | 101 | 22 |
| 9 | Proboscidea | 1 | 0 | 1 | 0 |
| 10 | Sirenia | 1 | 0 | 1 | 0 |
| 11 | Perissodactyla | 2 | 0 | 3 | 0 |
| 12 | Cetacea | 6 | 0 | 29 | 0 |
| | Scandentia | 1 | 0 | 3 | 0 |
| Total | | 42 | 23 | 390 | 66 |

**Table 5.6** Relative abundance and dominance of selected mammals of Great Indian Desert

| S. No. | Species name | Relative abundance | Dominance |
|---|---|---|---|
| 1 | *Antilope cervicapra* | 1,760 | 37.38 |
| 2 | *Gazella bennetti* | 1,354 | 28.75 |
| 3 | *Boselaphus tragocamelus* | 760 | 16.14 |
| 4 | *Semnopithecus entellus* | 330 | 7.01 |
| 5 | *Lepus nigricollis* | 155 | 3.29 |
| 6 | *Vulpes vulpes pusilla* | 58 | 1.23 |
| 7 | *Hemiechinus auritus* | 44 | 0.93 |
| 8 | *Hemiechinus collaris* | 40 | 0.85 |
| 9 | *Canis aureus* | 28 | 0.59 |
| 10 | *Vulpes bengalensis* | 26 | 0.55 |
| 11 | *Felis chaus* | 25 | 0.53 |
| 12 | *Sus scrofa* | 21 | 0.45 |
| 13 | *Funambulus pennantii* | 20 | 0.42 |
| 14 | *Canis lupus* | 16 | 0.34 |
| 15 | *Vulpes vulpes* | 12 | 0.25 |
| 16 | *Tatera indica* | 10 | 0.21 |
| 17 | *Meriones hurrianae* | 9 | 0.19 |
| 18 | *Herpestes auropunctatus* | 7 | 0.15 |
| 19 | *Felis silvestris* | 6 | 0.13 |
| 20 | *Gerbillus gleadowi* | 6 | 0.13 |
| 21 | *Herpestes edwardsi* | 6 | 0.13 |
| 22 | *Paraechinus micropus* | 5 | 0.11 |
| 23 | *Gerbillus* sp. | 3 | 0.06 |
| 24 | *Mus booduga* | 3 | 0.06 |
| 25 | *Hystrix indica* | 2 | 0.04 |
| 26 | *Viverricula indica* | 2 | 0.04 |
| 27 | *Panthera pardus* | 1 | 0.02 |

**Table 5.7** Diversity index of mammals in the Great Indian Desert

| S. No. | Species name | R1 | R2 | Simpson's index | Shannon index | N1 | N2 | E1 | E2 | E3 | E4 | E5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | *Antilope cervicapra* | 3.76 | 0.69 | 0.25 | 1.72 | 5.57 | 4.00 | 0.51 | 0.19 | 0.16 | 0.72 | 0.66 |
| 2 | *Boselaphus tragocamelus* | 14.74 | 3.56 | 0.06 | 3.64 | 37.95 | 16.65 | 0.79 | 0.38 | 0.37 | 0.43 | 0.42 |
| 3 | *Canis aureus* | 5.70 | 3.78 | 0.03 | 2.86 | 17.49 | 31.50 | 0.95 | 0.87 | 0.86 | 1.80 | 1.85 |
| 4 | *Canis lupus* | 3.24 | 2.50 | 0.06 | 2.19 | 8.91 | 15.00 | 0.95 | 0.89 | 0.88 | 1.68 | 1.77 |
| 5 | *Felis chaus* | 6.47 | 6.06 | 0.09 | 2.76 | 15.83 | 10.63 | 0.87 | 0.66 | 0.64 | 0.67 | 0.65 |
| 6 | *Felis silvestris* | 2.79 | 2.45 | 0.00 | 1.79 | 6.00 | 0.00 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 |
| 7 | *Funambulus pennantii* | 3.34 | 2.46 | 0.06 | 2.29 | 0.91 | 15.83 | 0.96 | 0.90 | 0.89 | 1.59 | 1.66 |
| 8 | *Gazella bennetti* | 47.16 | 9.27 | 0.01 | 5.41 | 224.69 | 153.46 | 0.92 | 0.65 | 0.65 | 0.68 | 0.68 |
| 9 | *Gerbillus gleadowi* | 0.56 | 0.82 | 0.66 | 0.45 | 1.56 | 1.50 | 0.65 | 0.78 | 0.56 | 0.95 | 0.87 |
| 10 | *Gerbillus* sp. | 0.91 | 1.15 | 0.33 | 0.63 | 1.88 | 3.00 | 0.91 | 0.94 | 0.88 | 1.58 | 2.24 |
| 11 | *Hemiechinus auritus* | 4.49 | 2.71 | 0.37 | 1.76 | 5.82 | 2.69 | 0.61 | 0.32 | 0.28 | 0.46 | 0.35 |
| 12 | *Hemiechinus collaris* | 9.48 | 5.69 | 0.01 | 3.55 | 34.82 | 0.95 | 0.99 | 0.98 | 0.97 | 5.59 | 5.74 |
| 13 | *Herpestes auropunctatus* | 1.02 | 1.13 | 0.48 | 0.77 | 2.22 | 2.10 | 0.73 | 0.73 | 0.61 | 0.94 | 0.90 |
| 14 | *Herpestes edwardsi* | 6.00 | 3.97 | 0.02 | 2.96 | 18.84 | 37.80 | 0.96 | 0.89 | 0.89 | 2.00 | 2.06 |
| 15 | *Lepus nigricollis* | 17.45 | 7.15 | 2.24 | 4.08 | 59.51 | 44.70 | 0.91 | 0.66 | 0.66 | 0.75 | 0.74 |
| 16 | *Meriones hurrianae* | 3.19 | 2.66 | 0.02 | 2.04 | 7.72 | 76.00 | 0.98 | 0.96 | 0.95 | 4.66 | 5.21 |
| 17 | *Mus booduga* | 1.82 | 1.73 | 0.00 | 1.09 | 3.00 | 0.00 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 |
| 18 | *Paraechinus micropus* | 2.48 | 2.24 | 0.00 | 1.61 | 4.99 | 0.00 | 0.99 | 0.99 | 0.99 | 0.00 | 0.00 |
| 19 | *Semnopithecus entellus* | 1.21 | 0.44 | 0.27 | 1.50 | 4.50 | 3.58 | 0.72 | 0.56 | 0.50 | 0.79 | 0.73 |
| 20 | *Sus scrofa* | 1.31 | 1.09 | 0.21 | 1.48 | 4.43 | 4.66 | 0.93 | 0.88 | 0.88 | 1.05 | 1.06 |
| 21 | *Tatera indica* | 1.30 | 1.26 | 0.36 | 1.08 | 2.97 | 2.81 | 0.78 | 0.74 | 0.65 | 0.94 | 0.92 |
| 22 | *Vulpes bengalensis* | 6.68 | 4.43 | 0.01 | 3.09 | 21.98 | 87.75 | 0.98 | 0.95 | 0.95 | 3.99 | 4.13 |
| 23 | *Vulpes vulpes* | 2.41 | 2.02 | 0.02 | 1.86 | 6.44 | 11.00 | 0.95 | 0.92 | 0.91 | 1.71 | 1.84 |
| 24 | *Vulpes vulpes pusilla* | 12.31 | 6.69 | 0.04 | 3.88 | 48.62 | 206.63 | 0.98 | 0.95 | 0.95 | 4.24 | 4.31 |

## Discussion

The Great Indian Desert is an ecologically diverse area. This is emphasised by the considerable variation in the community patterns of the regional fauna. The organisms of the desert possess a suite of adaptations that enable them to survive fluctuating cycles of drought and rain. Within the area of the Great Indian Desert, in the time since proclamation, biological data collection has been undertaken by a variety of individuals and organisations. Most of this data, collected over a decade ago, is relevant background information.

The highest number of species recorded in the Great Indian Desert, namely, insect (1,449), termite (44), beetle (85), ant (36), spider (28), amphibians (8), reptiles (44), birds (272) and mammals (66), is not surprising, because of the intensive and extensive field surveys that have been conducted by various workers. Of the recorded species, 22 species of insects, 12 species of fishes and 23 species of birds were reported for the first time in the Great Indian Desert (Table 5.8).

Among the different habitats, wetlands showed the highest species richness and abundance of birds. Wetland species like Common Coot, Lesser Flamingo, Bar-headed Goose, Black-winged Stilt, Common Redshank, Little Cormorant and Northern Shoveller showed high dominance [14]. Other than the wetlands, the plantations in

**Table 5.8** Species recorded for the first time from the Great Indian Desert *insects*

| S. No. | Order | Family | Species name |
|---|---|---|---|
| 1 | Collembola | Entomobryidae | *Cyphoderus javanus* |
| 2 | | | *Entomobrya* sp. |
| 3 | | Hypogastruridae | *Hypogastrura indovaria* |
| 4 | | | *Xenylla obscura* |
| 5 | | Isotomidae | *Cryptopygus thermophilus* |
| 6 | | | *Isotomodes dagamae* |
| 7 | Trichoptera | Hydropsychidae | *Aethaloptera sexpunctata* |
| 8 | Cryptostigmata | Austrachipteridae | *Lamellobates palustris* |
| 9 | | Ceratozetidae | *Ceratozetes* sp. |
| 10 | | Epilohmanniidae | *Epilohmannia pallida indica* |
| 11 | | | *Rhysotritia peruensis* |
| 12 | | Galumnidae | *Galumna* sp. |
| 13 | | Haplozetidae | *Rostrozetes foveolatus* |
| 14 | | Lohmaniidae | *Heptacarus hirsutus* |
| 15 | | Oppiidae | *Brachioppa* sp. |
| 16 | | | *Oppia kuhnelti* |
| 17 | | Phthiracaridae | *Atropacarus (Hoplophorella) scapellatus* |
| 18 | | Scheloribatidae | *Scheloribates albialatus* |
| 19 | | | *Scheloribates indicus* |
| 20 | | | *Scheloribates thermophilus* |
| 21 | | Xylobatidae | *Paraxylobates imitans* |
| 22 | | | *Xylobates capucinus* |

the vicinity of the Indira Gandhi Nahar Project (IGNP canal) and gardens showed high abundance of birds [89].

Among the *Francolinus* species, the Grey Francolin (*Francolinus pondicerianus*) was the only species which preferred to live in the hottest desert, mainly because of its low dependence on water. Indian Peafowl (*Pavo cristatus*) and Rosy-ringed Parakeet (*Psittacula krameri*) were recorded near human settlements where water availability is adequate. Eurasian Collared-dove (*Streptopelia decaocto*) and Little Brown Dove (*Streptopelia senegalensis*) were recorded in large numbers near the village ponds. Sand dunes and sandy plains are commonly found in the Barmer and Jaisalmer districts. Though these areas are characterised by strong winds and high temperatures during the summer months, and cold in the winter season, many species of birds were found in these habitats, namely, Common Crested Lark (*Galerida cristata*), Rufous-fronted Prinia (*Prinia buchanani*) and Desert Wheatear (*Oenanthe deserti*).

Crops such as millet, wheat, sorghum, green vegetables and oil seeds are widely cultivated in plains where water is available for irrigation. Underground water is generally used for irrigation purposes in the Thar Desert, except in the IGNP command area. As a result, the soil surface generally remains moist for some period in these areas. The standing crops provide shelter to a variety of resident birds and also attract migratory species. Insectivorous species like bee-eater (*Merops orientalis* and *Merops persicus*) were recorded abundantly in the vicinity of the electric lines and agricultural crops. Though orchards are rare, they are one of the important habitats in the Thar Desert. They provide shelter for many species during the summer months, i.e. *Psittacula krameri*, *Megalaima haemacephala*, *Dendrocitta vagabunda* and *Pycnonotus leucotis*.

The sand dunes, sandy plains and inter dunes have good natural grasslands, specially the sewan grass (*Lasiurus indicus*) in Jaisalmer district. However, this natural grassland is now threatened because they have been converted into croplands in the command areas. As a result, the invertebrate fauna, which always becomes the first victim whenever any ecosystem is distributed, is fast changing. But, the soil moisture favours the population of earthworm, nematodes, insect and several species of bugs, snails, etc. Due to the mismanagement of canal water, new water bodies have developed, which provide an ideal breeding place for mosquitoes. If the availability of water has attracted many species of passerine birds, the conservation of grasslands into croplands is reducing the suitable habitat of native birds. One of the endemic species in the desert, the Stoliczka's Bushchat (*Saxicola macrorhyncha*), is under severe threat, as also the Great Indian Bustard (*Ardeotis nigriceps*).

Some wildlife species which are fast vanishing in other parts of India are found in the desert in large numbers, such as the Great Indian Bustard *(Ardeotis nigriceps)*, the Blackbuck *(Antilope cervicapra)*, the Chinkara *(Gazella bennettii)* and the Indian Wild Ass *(Equus hemionus khur)* in the Rann of Kutch. How these animals and insects survive in these harsh conditions, in such high temperatures, without potable water or green vegetation is amazing. They have evolved excellent survival strategies: Their size is smaller than other similar animals living in different

conditions, and they are mainly nocturnal. There are certain other factors responsible for the survival of these animals in the desert. Due to the lack of water in this region, transformation of grasslands into cropland has been very slow. The protection provided to them by a local community, the *Bishnois*, is also a factor.

The Desert National Park, Jaisalmer, spread over an area of 3,162 km$^2$, is an excellent example of the ecosystem of the Thar Desert and its diverse fauna. The Great Indian Bustard, Blackbuck, Chinkara, Desert Fox, Bengal Fox, wolf, Desert Cat, etc., can be easily seen here. Seashells and massive fossilised tree trunks in this park record the geological history of the desert. The region is a haven for migratory and resident birds of the desert. One can see many eagles, harriers, falcons, buzzards, kestrels and vultures. Short-toed Eagle *(Circaetus gallicus)*, Tawny Eagle *(Aquila rapax)*, Spotted Eagle *(Aquila clanga)*, Laggar Falcon *(Falco jugger)* and Kestrel are the commonest of these.

Tal Chhapar Sanctuary is a very small sanctuary in district Churu, 210 km from Jaipur. This sanctuary is home to a large population of graceful Blackbuck. Desert Fox and Desert Cat can also be spotted along with typical avifauna such as partridge Grey Francolin. The Great Indian Desert is only 6% of the total land area of the country. However, with this relatively small area in a hostile environmental situation, it supports nearly 7% of the mammalian fauna of India.

## *Impact of Indira Gandhi Nahar Project*

The major portion of the Thar Desert came under the princely states of Jaisalmer, Jodhpur and Bikaner (now in Rajasthan) before Independence. It was the desire of every ruler to bring water to the thirsty landscapes, so as to provide water for drinking as well as irrigation purposes. One of the first attempts to green the desert was made by Maharaja Ganga Singh, the ruler of Bikaner, bringing water from Sutlej through a canal which was later named Gang Canal. The construction of Gang Canal was started in 1920 and was commissioned on October 26, 1927, while the entire work was completed in 1928. Its total length was initially 130 km, which could irrigate about 1.4 lakh ha in Bikaner state. After Independence, a separate plan was chalked out by the Government of India to bring water to the adjacent areas for cultivation, so that the increased demand of water and food may be met for the growing human population. The work on this project was initiated in 1958, and the canal was named as Rajasthan Canal. The excavation could commence only in 1960 after the signing of an agreement with the Government of Pakistan, the "Indus Waters Treaty". Initially, the area covered four districts of Rajasthan, namely, Ganganagar, Bikaner, Hanumangarh and Jaisalmer. Later, this canal was renamed as Indira Gandhi Nahar Project (IGNP) after the (late) Prime Minister of India, Smt. Indira Gandhi. In addition to optimising agriculture production, the project also envisages the regional development and ecological improvement by arresting desertification. The IGNP is one of the largest and most expensive irrigation systems of the dry land in the world. Many urban and rural villages of Bikaner, Churu, Ganganagar and Jodhpur districts get drinking water through the IGNP canal.

The IGNP is now considered a grand endeavour to bring water from the Himalayas to the vast stretches of arid western Rajasthan. The water is diverted from Harike Barrage in Punjab through the 204 km IGNP feeder canal and into the 445 km main canal in Masitawali. The project was to be completed in three stages. Stage I was completed in 1973 and stage II in 1985. Work is still under progress for the final stage. After the completion of the III and final stage, the main canal and feeder channels will spread over about 8,000 km in length. As per planning, about 11% of the Thar Desert of Rajasthan will be irrigated after completion of this project.

Greater part of the main IGNP canal suffers from the effects of wind and shifting sand-dunes, which block the flow of water in canals. In order to counteract the effects of wind and shifting sand dunes, the Government of Rajasthan started afforestation on both sides of the IGNP canal up to 100 m width. A large number of nurseries have been established along the canal at various places, e.g. Hanumangarh, Chhatargarh, Bajiv, Bhikampur, Phalodi and Mohangarh. The afforestation has been completed in two stages. Stage I was initiated in 1962, sponsored by the International Development Agency (IDA), and was completed in the year 1989. In stage one, 102,769-ha land was brought under afforestation on the canal banks and roads, under the sand dune stabilisation and pasture development schemes. Afforestation stage II was started in 1985 and continued up to 1996. This project was funded by World Food Programme (WFP), Command Area Development (CAD) and Desert Development Programme (DDP). A total of 21,101 ha area was planted up to 1990. Main species of planted trees are *Acacia nilotica*, *Dalbergia sissoo*, *Eucalyptus camaldulensis*, *Prosopis cineraria*, *Tecomella undulata* and *Ziziphus mauritiana*. Some of the afforested area provides shelter to mammals, namely, Wild Boar, Nilgai, jackal and fox. Many species of resident birds use the area as a corridor for movement, e.g. Common Babbler, Paradise Flycatcher and Green Pigeon.

Availability of canal water for irrigation has completely changed the pattern of *kharif* cropping in the IGNP command area. Groundnut *Arachis hypogaea*, cotton *Gossypium* sp., paddy *Oryza sativa* and sugarcane *Saccharum officinarum* have replaced traditional crops like *Moong*, *Phaseolus radiatus*, *Monthh Vigna aconitifolia*, *guar Cyamopsis tetragonoloba* and *bajra Pennisetum typhoides*. Single-cropping areas are being converted into double- and triple-crop areas. Sandy soil fields have been brought under regular two-crop cultivation like *bajra* and *guar* in *kharif*; mustard, gram, wheat, barley in *rabi*; and vegetable. In spite of all these plus points, the IGNP has become the subject of debate because the new cropping pattern has recently attracted many species of agricultural pests (insects and nematodes) which had never been recorded earlier. Minor pests have now assumed the status of major pests. Human diseases like falciparum malaria have become prevalent in the areas where it was unheard of [90].

Due to mismanagement of canal water, new water bodies have developed, which provide an ideal breeding place for the mosquitoes. If the availability of water has attracted many species of passerines birds, then on the other hand the conversion of grasslands into croplands is responsible for the reduction of suitable habitat for native birds.

In the canal area, the underground water table is rising due to seepage from the canal. As a result of substandard construction and poor maintenance of the canal in many places, inter-dunal reservoirs have formed, where the vegetation cover has changed from xerophytic and psammophytic species to hydrophytic and mesophytic plants. These inter-dunal wetlands attract large number of waterfowls. This arid system has been supporting many species of waterfowls, waders and passerines. The habitat alteration, mainly under the impact of the massive Indira Gandhi Nahar Project (IGNP), is also paving the way for various life forms from mesic areas, replacing the indigenous desert biodiversity. Overall, the canal water in this area has increased the diversity of fauna in the Thar Desert.

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# Chapter 6
# Planning Conservation for Chambal River Basin Taking Gharial *Gavialis gangeticus* and Ganges River Dolphin *Platanista gangetica* as Umbrella Species

**Syed Ainul Hussain, Ruchi Badola, Rishikesh Sharma, and R. Jagannath Rao**

**Abstract** This chapter describes the Chambal River basin and its conservation significance and discusses major issues affecting the conservation status. It also includes important aquatic fauna having Gharial (*Gavialis gangeticus*) as the flagship species followed by the Gangetic Dolphin *Platanista gangetica*, Indian Marsh Crocodile or Mugger (*Crocodylus palustris*) and Smooth-coated Otter (*Lutrogale perspicillata*). The Chambal River was identified as an important Gharial habitat in 1974 and was declared the "National Chambal Sanctuary" in 1978, followed by the "captive breeding programme" in 1979. Though the Gharial population showed an increasing trend initially, since 2000, the population in the National Chambal Sanctuary has shown a dramatic decline. Between 1992 and 2000, 40% decline in the population was observed. The population of Ganges River Dolphin in the National Chambal Sanctuary was monitored during 1985–2007. The major issues affecting the integrity of the basin such as increasing human population, extraction of river water by the

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adjoining states of Madhya Pradesh, Rajasthan and Uttar Pradesh, discharge of industrial and domestic effluent into the river and control of soil erosion and ravine formation have been discussed. The prerequisites such as development and strengthening of the policy and legislation support for integrated river basin management, involvement of stakeholders and minimising the impacts of land use and water abstraction have been emphasised. As a conservation strategy, involvement of local communities through ecotourism, existing network of forest protection and village eco-development committees located in the basin have also been suggested.

## Introduction

Rivers are complex wetlands which not only include the bed, banks and watercourses but also the associated groundwater and the floodplain-related wetlands. From their source to their mouth and up to a considerable distance to the sea, the river encompasses a sequence of different types of ecosystem. The conservation or restoration of biodiversity along a river depends on the maintenance of essential ecological processes, such as periodic floods, minimum water flows and specific rates of sediment transport. These processes are often modified by activities upstream that can have far reaching consequences on the state of downstream ecosystems [1].

Strong interrelations exist between groundwater and surface water in the basin, between water quantity and quality and between land and water, upstream and downstream which turn river basins from a geographical area into a coherent system [2]. Rapid and unsustainable development in the river basin leads to disruption of the natural hydrological cycle and loss of biodiversity. In many cases, this has resulted in greater frequency and severity of flood and drought imposing major economic and social losses and a heavy cost to the human population. The convention on wetlands (Ramsar Convention) identified the need to integrate wetlands for river basin management. This resolution recognised the important hydrological functions of wetlands, including groundwater recharge, water quality improvement and flood alleviation and the inextricable link between water resource and wetland [3].

Rational management of watercourse and associated wetland units can only be carried out through an ecosystem-based approach [1]. Since the waters in the same hydrographic basin are interdependent, they should be managed in a unitary way regardless of administrative and jurisdictional boundaries. However, while the concept of integrated river basin management has been endorsed by many different institutions over the last decade, the legal and institutional frameworks necessary for this purpose are totally lacking or are in infancy [1].

This chapter outlines the Chambal River basin, identifies its conservation significance, discusses major issues and suggests measures for integrated management taking the Gharial (*Gavialis gangeticus*) and the Gangetic Dolphin (*Platanista gangetica*) as umbrella species.

## The Chambal River

The Chambal River originates from the summit of Janapav Hill of the Vindhyan Range at an altitude of 854 m above the msl at 22°27′N and 75°37′E in Mhow, Indore district, Madhya Pradesh. The river has a course of 965 km up to its confluence with the Yamuna River in the Etawah district of (UP) [4]. From the place of its origin, the Chambal River flows for 320 km in northerly direction before entering the deep gorge in Rajasthan at Chaurasigarh, about 96 km upstream of Kota. The deep gorge extends up to Kota, and the river then flows for about 226 km in Rajasthan in a north-easterly direction and then forms the boundary between Madhya Pradesh (MP) and Rajasthan for about 252 km. Thereafter, the river forms the boundary between MP and UP for about 117 km, enters UP near Chakar Nagar village and flows for about 40 km before joining the Yamuna River. The main tributaries of the Chambal are Siwana, Retam, Shipra, Choti Kalisindh, Kuno and Kuwari in Madhya Pradesh and Kalisindh, Parvati, Parwan and Banas in Rajasthan.

The Chambal River is on an average 400 m in width while its depth ranges from 1 to 26 m [5]. During monsoon the water level rises up to 10–15 m and often spreads to 500 m from either bank. The maximum discharge of the river is 54,500 $m^3/s$ and the minimum is 27,000 $m^3/s$ [6]. Between 1960 and 1972, four multipurpose dams, namely, Gandhi Sagar, Jawahar Sagar, Rana Pratap Sagar and Kota Barrage, were built on the Chambal River which affected its flow considerably [5].

The Chambal is one of the last remnant rivers in the Greater Ganges River system, having significant conservation values. It harbours the largest Gharial (*G. gangeticus*) population in the world [6] and highest density of the Gangetic Dolphin (*P. gangetica*) [7], and besides being a staging ground for migratory waterfowls, it is also one of the last remnant nesting grounds for Indian Skimmer (*Rynchops albicollis*) and Small Indian Pratincole (*Glareola lactea*). Since 1979, a 600 km stretch of the Chambal River between Kota Barrage and the Chambal-Yamuna confluence has been protected as the National Chambal Sanctuary for the conservation and management of Gharial. The boundaries of the sanctuary extend one kilometer from either bank. This sanctuary area falls in Rajasthan, Madhya Pradesh and Uttar Pradesh and is managed by the concerned state forest departments from Kota, Morena and Agra, respectively [6]. The National Chambal Sanctuary has been recognised as an Important Bird Area [8].

Unlike other rivers of the Ganges River system, the Chambal River is relatively unpolluted [9]. The water quality exhibits very low suspended solids and low biological oxygen demand (BOD) and high dissolved oxygen (DO). There is no indication of organic matter discharge or eutrophication in the river, as the value of chemical oxygen demand (COD), ammonia ($NH_4$) and phosphate ($PO_4$) are below the detection limits. The essential cations (Ca, Mg, Na and K) are also within the ranges that support aquatic organism. On the basis of standards set by the Central Pollution Control Board (CPCB), Government of India, the Chambal River water can be considered as the category “A”. Also by comparing the water quality parameter with ranges given by Allen [10], the Chambal River is considered clean [11].

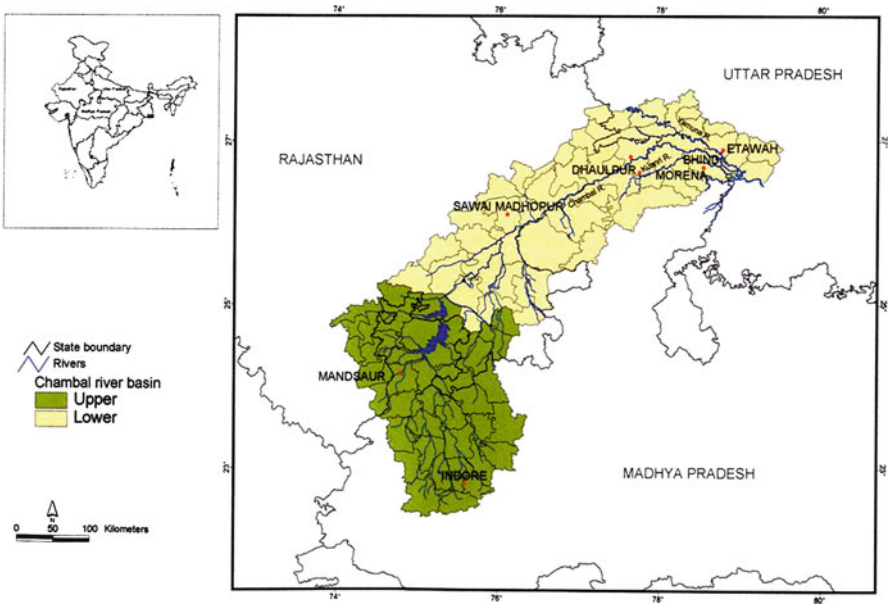


**Fig. 6.1** The extent of Chambal River showing upper and lower basin

## *The Chambal River Basin*

The entire Chambal basin extends across Madhya Pradesh, Rajasthan and Uttar Pradesh covering around 93 *tehsils* and 24 districts. Of these, nine districts comprise of the upper Chambal basin, and 15 districts comprise of the lower Chambal basin (Fig. 6.1). The total area of the basin is around 120,000 km$^2$. The location of the Gandhi Sagar Dam (24°44′N and 75°33′E) has provided a sound basis for dividing the Chambal basin into upper and lower basins. The upper Chambal basin consists of 320 km of river stretch and the adjacent land area of around 35,750 km$^2$. This land area falls in 21 *tehsils* of seven districts of Madhya Pradesh and three *tehsils* of two districts of Rajasthan. The lower Chambal basin consists of 645 km of river stretch and the adjacent land area of around 84,250 km$^2$. This land area (Fig. 6.2) falls in the four districts of Madhya Pradesh, three districts of Rajasthan and two districts of Uttar Pradesh.

## *Geology of the Area*

The upper Chambal basin is marked by sloping hilly terrain of the Vindhyan chain along the Chambal and its tributaries in Dhar, Indore and Dewas districts of Madhya Pradesh and the Rampura-Bhanpura Plateau in the Mandsaur district. The

**Fig. 6.2** The Chambal landscape

basin also covers the western highlands in the northeast of Ratlam comprising Neemuch, Sailana and Dilipganj highlands, the eastern highlands comprising Choti Kalisindh basin covering Tarana, Agar, Gangadhar, Sitamau and Garoth *tehsils* in Mandsaur district [4].

Gentle slope of alluvial plains in the north towards the Yamuna River in UP makes the lower Chambal basin. These alluvial plains have developed into 10–15 km wide extensive ravines. The eastern part of the river in Rajasthan is marked by Bundi-Ranthambhore line of hills extending up to Dhaulpur. The eastern part of the river in Madhya Pradesh has extensive ravines in the Harawati Plains, extending up to Bhind district [12].

## *Climate*

The climate of the basin is influenced by its location with respect to the Tropic of Cancer and the presence of lofty Vindhyan Ranges in the upper reaches. The area is semi-arid. The extreme temperature in the region varies from 2°C to 48°C during winter and summer, respectively. The southwest monsoon is the major source of rainfall. The mean annual rainfall of the Chambal basin was computed as 797 mm, of which about 93% occurs during monsoon months [6].

## *Soil*

The predominant soil type in the area is black soil which is distributed throughout the upper reaches of MP; mixed red and black soil occurs in Mandsaur and Chittourgarh districts; laterite soil is found in the pockets, particularly in Romper Plateau. Alluvial soils dominate the entire basin particularly in the lower basin, which is often 60-m thick [12].

## *Flora*

Most of the basin falls under biogeographical province 4B (semi-arid Gujarat-*Rajputana*) [13]. The vegetation in the area is largely tropical dry deciduous forest (group 5) and tropical thorn forest (group 6) [14]. This can be broadly divided into:

1. Southern tropical dry deciduous forests having dry teak forests, very dry teak forests, southern dry mixed deciduous forests and *Anogeissus pendula* forests
2. Northern tropical dry deciduous forests having dry mixed deciduous forests and dry mixed deciduous dense forests
3. Northern tropical thorn forests in ravine areas

## *Fauna*

The basin is predominantly home to animals of scrublands such as the Leopard (*Panthera pardus*), Grey Wolf (*Canis lupus*), Caracal (*Caracal caracal*), Jungle Cat (*Felis chaus*), Ratel (*Mellivora capensis*), Smooth-coated Otter (*Viverricula indica*), Sloth Bear (*Melursus ursinus*) and Nilgai (*Boselaphus tragocamelus*). However, the basin has a sizeable population of Bengal Tiger (*Panthera tigris*) and its associated prey such as the Chital (*Axis axis*) and Sambar (*Rusa unicolor*). As far as the aquatic wildlife is concerned, Gharial is the flagship species followed by Ganges River Dolphin, Indian Marsh Crocodile or Mugger (*Crocodylus palustris*) and Smooth-coated Otter (*Lutrogale perspicillata*) [15, 16]. The Great Indian Bustard (*Ardeotis nigriceps*) and Lesser Florican (*Sypheotides indicus*) extensively use the grasslands in Sailana, Ralamandal and Ghatigaon WLS in the basin. Wetlands such as Keoladeo NP are important wintering ground for migratory ducks and geese, including the globally threatened *Leucogeranus leucogeranus*, which was last sighted here in 2002. The Indian Sarus Crane (*Grus antigone*), Demoiselle Crane (*Anthropoides virgo*) and Common Crane (*Grus grus*) widely use the floodplains and agricultural lands in the basin.

## Status of Species of Conservation Significance in the Chambal River

### *Gharial*

During a countrywide survey of crocodiles in 1974, the Chambal River was identified as one of the important Gharial habitats (Fig. 6.3). In a 60 km stretch of Chambal between Jawahar Sagar Dam in Rajasthan and Panchhnada in Uttar Pradesh, the initial Gharial population was reported to be 107 individuals of different age and sex, of which 29 were adults [17]. In 1978, this stretch of Chambal River was declared as the National Chambal Sanctuary under the Wildlife (Protection) Amendment Act, 2006. In the year 1979, a captive-reared restocking programme was initiated, and by the year 2007, 2,010 captive-bred Gharials were restocked in the sanctuary (Fig. 6.4). By the year 1992, the Gharial population in the Chambal was 1,065, of which 62 were breeding females [18]. As many as 1,242 Gharials have been reported in the 400-km stretch of the river between Pali and Bhare [19]. As many as 91 nests have been observed in 2009 nesting season in 425-km stretch of the sanctuary between Pali and Panchhnada.

Since 2000, the Gharial population in the National Chambal Sanctuary is showing a dramatic decline. Between 1992 and 2007, 40% decline in their population was observed [11]. The decline was prominent in the recruitment class <120 cm. This decline has been attributed to incidental mortalities due to fishing nets, change in river morphology, disturbances on nesting beaches and reduction in water availability [11].

**Fig. 6.3** Gharial (*Gavialis gangeticus*) in Chambal River

**Fig. 6.4** The baby Gharials in Chambal—world's largest breeding population of Gharial (*G. gangeticus*)

Of the 865 Gharials seen in 2007, 225 were released individuals [11]. Mass mortality of Gharial has been reported from the tail end of the sanctuary, in Uttar Pradesh, during 2007–2008 when 112 Gharials had died because of unknown reason. Such decline could wipe out the Gharial population in the basin if appropriate conservation measures are not taken.

As many as 301 Muggers have also been reported form the National Chambal Sanctuary. The sightings of Mugger are more or less restricted to rocky stretches and rocky outcrops in the sanctuary. The Mugger being a generalist largely competes with the gharial for space and prey. The Mugger has also been reported from the other wetlands and rivers of Rajasthan within the Chambal basin. However, their population status is relatively unknown.

## *Gangetic Dolphin*

The Gangetic Dolphin (Fig. 6.5) is at the top of the aquatic food chain. The great abundance of this species in a river system indicates a healthy ecosystem and plays an essential role in maintaining the balance in the ecosystem. The population of the Gangetic Dolphin in the National Chambal Sanctuary was monitored between 1985 [17] and 2007. No Gangetic Dolphin was recorded in a 120-km stretch of the sanctuary between Pali and Rahu Ka Gaon. The estimated population during 1988–2007 ranges between 55 and 85 individuals of different age and sex. The Gangetic Dolphin

**Fig. 6.5** A Gangetic river Dolphin (*Platanista gangetica*) from Chambal River

population is subjected to frequent mortalities in passive fishing. Though the physical environment of the Chambal River is stable, there is increasing evidence of infrastructural development along the river, causing concern for the Gangetic Dolphins.

## *Smooth-Coated Otter*

Along the rocky stretches of the Chambal, a small population of Smooth-coated Otter occurs. It is reported that this species show a greater preference for rocky stretches in all seasons [15, 16]. Stretches with bank-side vegetation and marsh were used in proportion to their availability, especially in summer. Open clayey and sandy banks were largely avoided. During 1988, 29 otters were sighted in five different groups, each consisting of 2–9 individuals. During the 1992 survey, only 14 otters were recorded, all from the same sites [16]. The mean group size of otter recorded from the entire sanctuary was 4.3 (±0.72) [20]. However, a recent report suggested that otters are getting increasingly rare in the sanctuary, attributed to loss of habitat due to mining, human disturbance and also poaching.

### *Status of Forests in the Basin*

Data on the extent of forests for the 94 *tehsils* are not available to us. However, the total forest area of the 24 districts is around 26,406 km$^2$. The district wise forest area in the basin ranges between 0.016 and 45.3%. This includes areas with >40% canopy cover, <40% canopy cover and scrubs. In Madhya Pradesh, districts having good forests areas are Dewas, Gwalior, Morena and Shivpuri and in Rajasthan are Baran, Bundi, Chittourgarh and Kota, while Sawai Madhopur district has very little forested areas.

## Socio-economic Status of the Local People

The mean human density of the basin is 256/km$^2$ (minimum 110/km$^2$ for Shivpuri, maximum 680/km$^2$ for Agra), which is lower than the national average (273/km$^2$). The literacy rate varies from 32% (Bhilwara) to 66% (Gwalior) (Table 6.1). The relative CMIE index of development [21] (Box 6.1) of the area is 82.7 (minimum of 54 for Shivpuri and maximum of 186 for Indore). The relative CMIE (Centre for Monitoring Indian Economy) index of development (Box 6.1) are 73, 69 and 72 for MP, Rajasthan and UP, respectively. There are seven major irrigation projects (Gandhi Sagar, Rana Pratap Sagar, Jawahar Sagar, Kota Barrage, Parwati Pick-up Weir, Harish Chander Sagar and Gudha Dam), 12 medium and 134 minor irrigation projects in the Chambal River basin, as well as some small irrigation systems (covering <20 ha) constructed and operated by *panchayat samitis*.

**Box 6.1** CMIE Index of Development

The relative CMIE (Centre for Monitoring Indian Economy) index of development is an indicator used widely among the development economists and sociologists to assess the relative degree of development of an area. It is expressed in percentage (with 100% as national average) and computed as follows:

| | |
|---|---|
| 1. Per capita value of output of 18 major crops | 25% |
| 2. Per capita bank credit for agriculture | 25% |
| 3. Number of mining and factory workers per lakh population | 08% |
| 4. Number of household manufacturing workers per lakh population | 04% |
| 5. Per capita bank credit for manufacturing workers per lakh population | 08% |
| 6. Per capita bank deposit | 10% |
| 7. Per capita bank credit to service sector | 10% |
| 8. Literacy rate in percentage | 05% |
| 9. Number of hospital beds per lakh of population | 05% |

*Source*: Verma, 1987

**Table 6.1** District profiles of the Chambal River basin, India

| | States/district | Area (km²) | Human density (km²) | Forest (km²) | Scrub (km²) | Total forest area (km²) | % Forest area | CMIE Index | Literacy rate |
|---|---|---|---|---|---|---|---|---|---|
| *Madhya Pradesh* | | | | | | | | | |
| 1 | Bhind | 4,459 | 272 | 81 | 55 | 136 | 3.0 | 55 | 49.23 |
| 2 | Dewas | 7,020 | 147 | 1,644 | 6 | 1,650 | 23.5 | 94 | 44.08 |
| 3 | Dhar | 8,153 | 168 | 636 | 45 | 681 | 8.4 | 69 | 34.54 |
| 4 | Gwalior | 5,214 | 271 | 1,302 | 116 | 1,418 | 27.2 | 114 | 57.7 |
| 5 | Indore | 3,898 | 470 | 453 | 8 | 461 | 12.0 | 186 | 66.32 |
| 6 | Mandsaur | 9,791 | 159 | 779 | 92 | 871 | 8.9 | 63 | 48.67 |
| 7 | Morena | 11,594 | 147 | 4,542 | 695 | 5,247 | 45.3 | 74 | 41.33 |
| 8 | Ratlam | 4,861 | 200 | 185 | 76 | 261 | 5.4 | 79 | 44.15 |
| 9 | Shajapur | 6,196 | 167 | 0 | 5 | 5 | 0.08 | 77 | 39.23 |
| 10 | Shivpuri | 10,278 | 110 | 2,410 | 364 | 2,774 | 27.0 | 54 | 33.03 |
| 11 | Ujjain | 6,091 | 228 | 1 | 0 | 1 | 0.016 | 119 | 49.08 |
| *Rajasthan* | | | | | | | | | |
| 1 | Baran | 6,955.4 | 117 | – | – | 2,187 | 31.4 | 94 | 32.75 |
| 2 | Bharatpur | 5,066 | 325 | 620 | 251 | 871 | 17.2 | 89 | 42.96 |
| 3 | Bhilwara | 10,455 | 152 | 170 | 213 | 383 | 3.67 | 72 | 31.65 |
| 4 | Bundi | 5,550 | 138 | 418 | 212 | 630 | 11.4 | 94 | 32.75 |
| 5 | Chittourgarh | 10,856 | 137 | 1,597 | 454 | 2,051 | 19.0 | 67 | 34.28 |
| 6 | Dhoulpur | 3,034 | 247 | – | – | 115.76 | 3.48 | 55 | 35.09 |
| 7 | Jhalawar | 6,219 | 154 | 301 | 222 | 523 | 8.4 | 61 | 32.94 |
| 8 | Kota | 5,480.6 | 163 | – | – | 3,278.78 | 15.0 | 119 | 47.88 |
| 9 | Sawai Madhopur | 10,527 | 186 | 1,270 | 740 | 2,010 | 19.0 | 62 | 36.27 |
| 10 | Tonk | 7,194 | 135 | 118 | 131 | 249 | 3.5 | 69 | 33.67 |
| *Uttar Pradesh* | | | | | | | | | |
| 1 | Agra | 4,027 | 684 | 181 | 142 | 323 | 8.0 | 105 | 48.56 |
| 2 | Etawah | 4,326 | 488 | 142 | 84 | 226 | 5.2 | 57 | 53.69 |
| 3 | Firozabad | 2,361 | 649 | 29 | 25 | 54 | 2.3 | 57 | 46.3 |

Around 52 irrigation projects, including seven medium projects with a total live storage capacity of 271 million $m^3$, are under construction in the Chambal basin. It is expected that an additional area of 502,000 ha will be irrigated on the completion of these projects. Further, 376 irrigation projects, including 12 major (Manohar Thana, Parwan Dhanwas, Kalisindh, Gugar lift, Soni, Dhaulpur lift, Indira lift, Pipalda lift, Chambal lift, Pinhat lift, Kanera lift and Aisah lift in Bhind) with a total live storage of more than 743 million $m^3$, have been proposed in the Chambal basin. An additional area of 630,000 ha will be irrigated on completion of these projects. It is believed that diversion of such a large quantity of water from the Chambal River will severely affect the biodiversity of the entire basin.

### *Status of Protected Areas*

There are 22 PAs, covering 5,213.27 $km^2$ (4.2%), situated within the Chambal River basin (Table 6.2). Besides six PAs, covering an area of 1,385.18 $km^2$, are located at the periphery of the basin. Thus, a total area of 6,598.45 $km^2$ area (5.49%) in the region is protected. Some of the important PAs located in the Chambal basin are Ranthambhore Tiger Reserve, Keoladeo National Park, Sitamata WLS, Kuno Palpur WLS, the proposed second home for the Asiatic Lion and Sardarpur and Sailana WLS for the Endangered Lesser Florican (Table 6.2).

## Conservation Problems in the Region

### *Poverty*

Due to low development in the area, the problem of unemployment and poverty is rampant. In the absence of alternative means of livelihood, people, particularly in the rural areas, depend on biomass resources to meet their basic needs. Cutting of wood, bushes and other vegetation for firewood by local villagers has led to severe soil erosion and flattening steep sand banks at some places, thereby making them unsuitable for gharial nesting [5]. Fishing, the only means of survival for many local communities, with gill nets has contributed to the Gharial mortality. This affects both the Gharial and Gangetic Dolphin population of the National Chambal Sanctuary [11, 18, 22].

### *Development Activities*

The construction of dams and barrages for irrigation and hydroelectric power generation (Fig. 6.6) and the thermal power plants in the vicinity (e.g. Gandhi Sagar, Rana Pratap Sagar, Jawahar Sagar and a barrage at Kota) have checked the regular

**Table 6.2** Conservation status of the PAs of the Chambal river basin, India

| | Name of the PA | Status | Districts | Area (km$^2$) | PA type | Year | Major species |
|---|---|---|---|---|---|---|---|
| *Rajasthan* | | | | | | | |
| 1 | National Chambal | WLS | Kota, Dhoulpur | 280 | Wetland | 1979 | Gharial, Mugger, otter |
| 2 | Jawahar Sagar | WLS | Kota | 100 | Wetland | 1975 | Mugger, otter |
| 3 | Keoladeo | NP | Bharatpur | 28.73 | Wetland | 1953 | Migratory birds |
| 4 | Van Vihar | WLS | Dhaulpur | 59.93 | Terrestrial | 1955 | Sloth Bear |
| 5 | Kailadevi | WLS | Sawai Madhopur | 676.38 | Terrestrial | 1983 | Tiger |
| 6 | Ranthambhore | NP | Sawai Madhopur | 392 | Terrestrial | 1980 | Highest tiger density in the region |
| 7 | Sawai Man Singh | WLS | Sawai Madhopur | 103.5 | Terrestrial | 1984 | Tiger |
| 8 | Ramgarh Vishdhari | WLS | Bundi | 301 | Terrestrial | 1982 | Tiger |
| 9 | Bassi | WLS | Chittourgarh | 152.9 | Terrestrial | 1988 | Wolf |
| 10 | Sitamata | WLS | Chittourgarh, Udaipur | 422.94 | Terrestrial | 1979 | Tiger |
| 11 | Kesarbagh | WLS | Dhoulpur | 14.76 | Wetland | 1955 | Migratory birds |
| 12 | Bhensrodgarh | WLS | Chittourgarh | 229.14 | Terrestrial | 1983 | Sloth Bear |
| 13 | Ramsagar | WLS | Dhaulpur | 34.40 | Wetland | 1955 | Migratory birds |
| 14 | Shergarh | WLS | Baran | 98.71 | Terrestrial | 1983 | – |
| | Total | | | 2,894.39 | | | |
| *Madhya Pradesh* | | | | | | | |
| 1 | National Chambal | WLS | Morena, Bhind | 435 | Wetland | 1978 | Gharial, otter, Gangetic Dolphin |
| 2 | Gandhi Sagar | WLS | Mandsaur | 368.62 | Wetland | 1981 | Mugger, Tiger |
| 3 | Sailana | WLS | Ratlam | 12.96 | Terrestrial | 1983 | Lesser Florican |
| 4 | Ralamandal | WLS | Indore | 2.34 | Terrestrial | 1989 | Lesser Florican |
| 5 | Palpur Kuno | WLS | Morena | 344.68 | Terrestrial | 1981 | Proposed II home for lion |
| 6 | Ghatigaon | WLS | Gwalior | 511 | Terrestrial | 1981 | Great Indian Bustard |
| | Total | | | 1,674.6 | | | |
| *Uttar Pradesh* | | | | | | | |
| 1 | National Chambal | WLS | Agra, Etawah | 635 | Wetland | 1979 | Gharial, Gangetic Dolphin |
| 2 | Sur Sarovar | WLS | Agra | 4.03 | Wetland | 1991 | Birds |
| | Total | | | 644.28 | | | |

**Fig. 6.6** Unplanned developmental activities along the Chambal River have adversely affected integrity of the basin

flow of the Chambal River and have greatly reduced the flow in years of low rainfall. Irregular water release from the dams and barrages has made the habitat unsuitable for Gangetic Dolphin and caused inundation of the eggs of Gharial, turtles and breeding birds. On completion, the proposed irrigation projects on Chambal River will reduce the stream flow of the river affecting the Gharial, Gangetic Dolphin and other wildlife of the sanctuary [11].

### Scarcity of Biomass Resources

Southern tropical dry deciduous forest and northern thorn forest with very low ground cover largely dominate the area. Excessive grazing and removal of biomass for fuelwood has increased the soil erosion and ravine formation. Lack of availability of biomass makes the local communities more and more dependent on the PAs, which has meagre vegetation cover. The Kuno Palpur Sanctuary, National Chambal Sanctuary and Keoladeo National Park perhaps hold the highest density of feral cattle. Cattle grazing is highest in Sailana WLS, while crucial tiger habitats like Ranthambhore TR and Kailadevi WLS face a heavy onslaught of migratory cattle.

### Cumulative Impacts of Mining, Agricultural Practice in Ravines and Grazing

Quarrying in the basin is the primary cause of severe soil erosion. Mining of the Chambal's riverbed for stones and sand has further aggravated this problem. Frequent plaguing of ravines makes the soil prone to erosion causing siltation of the main river course. Sand mining and laying of roads have led to the reduction in the nesting sites of turtles and birds on the banks [11, 23].

### Expansion of Ravines

The advance of the ravines from the banks of the Chambal and its tributaries is endangering the existence of hundreds of villagers and vast tracts of agricultural land in the area. According to the projections of some studies, the formation of ravines could displace millions of people over the next decade. The socio-economic impact of ravine formation studied by Jiwaji University, Gwalior, revealed that youths are turning to the crimes like kidnapping in the adjoining Bhind district because their cultivable land is lost to ravines and there is no alternative employment due to lack of development.

### Pollution

Although the Chambal is considered as one of the least polluted rivers of the country, in the recent years, some stretches have been severely affected by sewage and industrial waste making adverse impacts on the river fauna. It was observed that around 58 mgd (approx.) of sewage and industrial waste from the Kota city found its way into the Chambal River through 25 drains in a stretch of about 15 km. The thermal plant Sriram Chemical Factory has been cited as sources of pollution for the National Chambal Sanctuary. Possible radiation from the Rajasthan Atomic Power Station is a source of pollution for the Jawahar Sagar Sanctuary. Use of pesticides and fertilisers in the basin is also adding to the pollution [24].

## *Why Integrated Conservation Planning for the Chambal Basin?*

Integrated regional planning is a process which provides a thoughtful structure for gathering and utilising scientific information involving stakeholders in a genuine analysis of land use alternatives for establishing clear and measurable objectives. It can provide for rational development activities including the conservation of

biodiversity in the region. Integrated regional planning addresses the interactions between terrestrial and aquatic systems along with considering the demands of those who use and who would use these systems. It refers to integrated resource management and ultimately leads to the sustainability of all systems in a region—biological, physical, ecological, social, economic and cultural.

There is an abundance of statues dealing with many aspects of river use, management and improvement. Their main objective is to control the allocation of resources between various users and minimise conflicts between them. There also exist several sectoral laws, controlled by different government agencies which are being used to regulate various activities irrespective of whether these affect the river. Most of these agencies work in isolation pursuing their respective departmental agenda while being largely unconcerned about the holistic picture. For example, in the Chambal basin, forests and parts of the river that are under the PAs come under forest and wildlife legislation, but outside these areas, extraction of sand from the riverbed is covered by the legislation regulating mining. The forest law can prohibit cutting of forest areas but cannot prevent the developmental activities outside of its area of jurisdiction which may have an adverse impact on the conservation values of the area. The situation is further complicated by the fact that the basin area falls within the jurisdiction of three state governments, making it more difficult for coordination of development initiatives.

Integrated regional planning seeks cooperation and coordination among stakeholders, and it is believed that it will solve the existing and future problems arising from uncoordinated resource use and allocation. Rather than addressing the problems and issues sectorally, it deals with these on a spatial scale.

## *Issues to be Addressed*

### Management of Water Resources

Sharing of the Chambal water resources by the three states without affecting its biodiversity values is one of the most important issues, which affects the economic growth in the region. There is a dispute among the three states regarding the sharing of water resources. Here it is worthwhile to mention that the flow in the Chambal River after the Kota Barrage is almost zero. The river has sustained the existing flow from Parvati River and from seepages. Further extraction of water is not advisable [11]. “The Interstate Control Board on Irrigation and Power” held its meeting after a gap of 10 years in 1999 because of which issues got piled up, hampering the progress of irrigation projects in the three states. There needs to be greater coordination among these states in solving the development problems in the region.

### *Economic Development of the Region Without Affecting its Conservation Values*

There are around 18 irrigation project proposals in the pipeline for Rajasthan state alone. While such projects can enhance economic status of the people in the region, in the long run this could reduce the water flow, which will affect the biodiversity of the area. Indiscriminate use of water resources for irrigation, thermal power plant and other domestic uses, discharge of effluents from fertiliser plants and domestic sewage have affected the water quality of the river.

### *Minimising the Impacts of Land Use and Water Development Projects*

The land use and the development projects which can impact significantly must be scrutinised through a stringent environment impact assessment. It is believed that extensive agriculture in ravines and mining for sand and sandstone have an impact on the basin in the form of severe soil erosion. It is imperative that sustainable water allocation plans for various resource users including maintenance of floodplain wetlands be examined at the time of impact assessment.

### *Reduce Dependency of Local Communities on Biomass Resources from PAs*

For sustainable biodiversity conservation, it is important to reduce the dependence of local people on natural resources in terms of fuelwood, fodder and NTFP and to reduce the number of feral and abandoned cattle in the region. This could be achieved by adopting the process of eco-development through people's participation and by developing alternatives to natural resources and increasing the supply of biomass resources outside the PAs. Isolated examples of success in eliciting people's support for conservation exist in Ranthambhore Tiger Reserve and Kailadevi WLS. In many cases, for example, in the National Chambal Sanctuary, micro plans for eco-development were prepared but could not be implemented due to lack of coordination among stakeholders.

### *Control of Soil Erosion and Ravine Reclamation*

The ravines affect the entire Chambal basin. A conservative estimate from the data for the 14 rivers in the greater Chambal basin is around 0.673 million ha [12]. Though the current figure is not available, there is an immediate need for checking the further progress of ravines into the agricultural lands. The decision about choosing the appropriate land use for ravines is a problem, which needs a clear analysis.

**Box 6.2** Guidelines for the integrated river basin management (Ramsar Convention, 1971)

1. Identify the key barriers to integrated river basin management and promotion of land and water use planning/management within a river basin, and work to overcome them.
2. Develop consultative processes which involve the various sectors and institutions responsible for water management, environmental protection and agriculture and a basin-wide plan for the conservation, utilisation and management of water resources.
3. Integrate wetland conservation into river basin management to benefit management goals such as flood management and conservation of biodiversity.
4. Promote the protection and restoration of wetland areas, and their biodiversity, within river basins.
5. Develop appropriate and socially acceptable cost-sharing mechanisms to cover the costs involved in the management of river basins.
6. Promote the establishment of appropriate mechanisms to bring together all major groups involved in river basin management to contribute towards the management of the basin.
7. Promote appropriate education and public awareness schemes as effective tools for integrated management of river basin.

## *Steps in the Process*

The Ramsar Convention on Wetlands has proposed detailed guidelines on sustainable river basin management (Box 6.2). For the Chambal basin, the following suggestions have been made.

## *Strengthening of Policy and Legislation for Integrated river Basin Management*

The shift towards integrated water resource management in a river basin requires the support of appropriate legislation and policy instruments, including economic instruments such as water pricing policies. The policy support would be needed for the following:

- Maintenance of essential ecological processes occurring within the river basin
- Allocation of water for all ecosystems within the basin
- Issuance of permits for water harvesting, diversion and use
- Regulation of agricultural water use, mitigation of effects of dams, limitations of pesticides and other agrochemicals in the basin

- Maintenance of water quality standards for various uses
- Regulation of human use of natural resources
- Location and type of development activities to be taken up in the area

### *Strengthening of Institutional Capacity*

For the sustained development of the basin *vis-a-vis* conservation, it is important that a river basin authority on the lines of the Murray-Darling Ministerial Council, Australia [25], be set up to look into the conservation development mechanism in the basin. The authority should have adequate representation from the policy makers of the central government and the three states, apart from eminent scientists from reputed institutions. The authority should

- Set standards and objectives for the integrated management of Chambal River basin as a single unit and determine the cost of achieving these objectives.
- Establish a process of cooperation and collaboration among various stakeholders in the basin.
- Collect and collate existing information on physical, biotic and socio-economic characteristics of the basin.
- Identify status and trends of landscape level processes and functions within the basin.
- Identify current and future landscape disturbance regimes that are affecting or may affect the basin.
- Select the best among a number of development alternatives by identifying costly and undesirable effects of the possible alternative projects.
- Establish a series of strategies, with timetables and benchmarks with detailed financial goals and budget projections, as well as criteria and methods for evaluating progress towards meeting the established goals.
- Develop mechanisms for protection and management of upper catchment and other priority areas.
- Prioritise strategies and specific actions to carry out required policy and legal changes and monitoring of compliance at regular intervals.

### *Involvement of Stakeholders and Public Awareness*

Around 28 major stakeholders exist in the basin (Fig. 6.7). In order to identify needs and concerns of stakeholders, public participation in the planning and management is important. The local community and other stakeholders can play an instrumental role in managing and monitoring rivers. For effective participation of stakeholders, it is necessary to establish mechanisms to identify and involve stakeholders [26] in planning and management of the basin, facilitate the active participation of stakeholders responding to their needs and to provide a forum for open discussion on

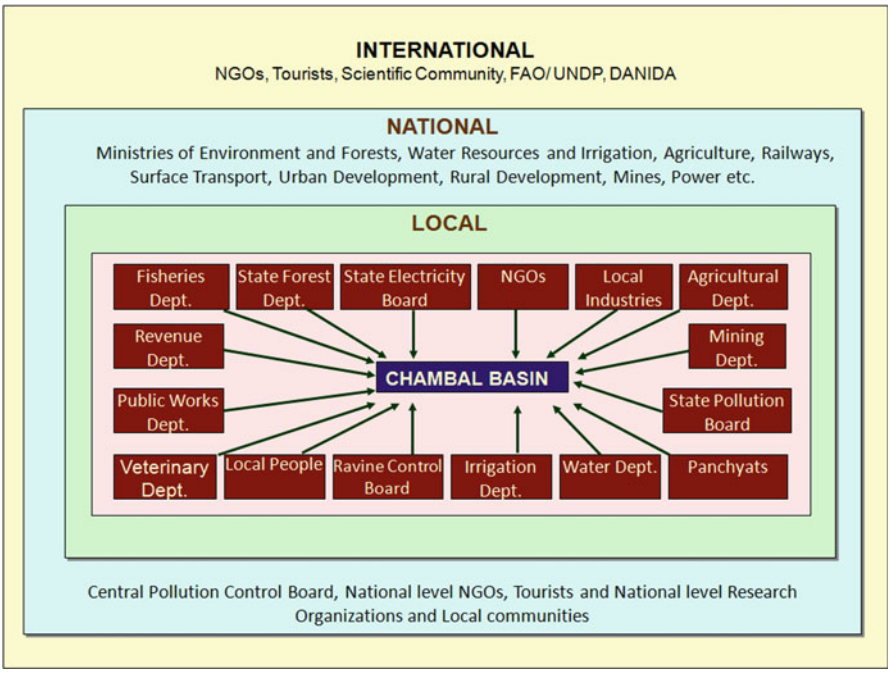


**Fig. 6.7** Major stakeholders in Chambal River basin

river basin management. It is necessary to respect the traditional knowledge and expertise of the local communities, besides building trust among local people for monitoring of natural resources.

## Conclusions

For effective management of the Chambal basin, it is important to go beyond protection measures for certain areas, habitats or landscape and impose binding requirements for coordination of sectoral policies. We can learn lessons from the experience of other countries such as Australia, USA, Italy and France who have been able to elicit the participation of local communities and user groups in decision-making relating to land and water use at a catchment scale. The Chambal basin has prospects of involving local communities through ecotourism (Fig. 6.8), widespread public awareness and through the existing network of forest protection and village eco-development committees, located in and around the forest, and PAs, in all the three states. However, it can only be practically executed by enabling legislation backed by strong political will.


**Fig. 6.8** Ecotourism could be a potential option to generate livelihood for the local communities in and around the Chambal basin

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# Chapter 7
# Reintroduction of Tigers in Sariska Tiger Reserve, Rajasthan

**K. Sankar, Qamar Qureshi, P.K. Malik, Parag Nigam, P.R. Sinha, R.N. Mehrotra, and Rajesh Gopal**

**Abstract** This chapter provides firsthand information on the reintroduction of tigers in Sariska Tiger Reserve. The first author was actively involved in the planning and operation of the revival of tigers at Sariska conducted by the Wildlife Institute of India (WII), Dehradun, India, in collaboration with the Department of Forests and Environment, Government of Rajasthan. After the extermination of tigers in Sariska Tiger Reserve (STR) in 2004, WII's report entitled "Status of tiger in STR" strongly suggested reintroduction of tigers in Sariska with a simulation of the population growth pattern of the proposed reintroduced stock to establish self-sustaining population with high reproductive fitness in the wild environment and ample genetic diversity. A suggestion to translocate an initial population of a total of five tigers (two males and three females) from Ranthambhore National Park (RNP) was made, with a supplementation of three tigers (one male and three females) in every three years for a period of six years. Accordingly, in December 2005, a "Species Recovery Plan for Tigers" in STR was prepared. An adult tiger and tigress were chemically immobilized, fitted with radio collars (VHF–satellite) and translocated from RNP to STR on 28th June and 4th of July 2008 respectively, and were kept in 1-ha enclosure. The tiger was released into the wild after eight days of observation on 6th July 2008, while the tigress was released on 8th July 2008 after three days of observation. On 26th February 2009, a female tigress was released. All these big cats are being monitored continuously for home ranges, feeding behavior, and reproduction through ground tracking using "homing in technique" and also through satellite tracking.

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## Introduction

Reintroductions have proved to be a valuable tool for recovery of the species that have become either globally or locally extinct in the wild [1]. Reintroductions have also provided an insight into the reasons of disappearance of a species from the areas where they were formerly found, but it requires that it is genuinely experimental and properly monitored [2]. Reintroduction is one such promising tool which has an important role to play in the current carnivore restoration efforts. On the contrary, reintroduction programs are expensive and time-consuming affair, and corresponding success rate is low which makes it difficult to justify, spending precious conservation money in favor of reintroduction as against other *in situ* conservation measures [3]. Therefore, it becomes highly imperative that reintroductions are based on sound scientific principles and methodology so that the success rates are high and the efforts are fruitful enough. The reintroduction and recovery of the Florida Panther (*Puma concolor*) in Florida, USA, during the early 1980s and reintroduction of African Wild Dog (*Lycaon pictus*) in Africa in the 1990s are two such instances on large carnivores that enriched our knowledge about the science and management of carnivore reintroductions.

## Background

The disappearance of tigers in Sariska during 2004 exemplifies the threat that exists to isolated tiger populations in many parts of the country [4]. Based on the past trends and experiences, it is sensible to presume that such losses and local extinctions in future will be more frequent, and we will have to undertake immediate reintroduction and restoration programs to save our natural heritage. It is perhaps not an isolated situation, and the recent national scale assessment reported that tigers have gone locally extinct from 97 districts in the last 150 years [5].

Reintroduction should establish self-sustaining populations with high reproductive fitness in the wild environment and ample genetic diversity [6]. It was suggested that three tigresses and two tigers may be brought from Ranthambhore Tiger Reserve to re-establish the tiger population in Sariska [4]. It was also suggested that after establishing five tigers, two batches of two to three tigers should be brought every three years to Sariska. The restocking is essential to maintain genetic and demographic viability of tiger population (Annexure A). The genetic stock of the tigers of Ranthambhore and Sariska Tiger Reserves may be assumed to be similar as both habitats are part of semiarid tracts in Aravalli Hills; therefore, to maintain the uniqueness of genetic stock of tigers in semiarid tract, the best choice will be Ranthambhore tigers. Adult tigers over two and half years of age are considered good for capture and reintroduction due to ideal medical fitness, as the body at this age has higher resistance to diseases; physical strength to take on the stress of relocation, fertility, and response when confronted with tourist are the important features that make a final choice.

Since the tiger population is dwindling drastically in its entire distribution range and Sariska which is the western most distribution of tigers [7] has seen its complete extinction once, over time, it has grown even more important to monitor and study the

relevant holistic, ecological, and socioeconomic aspects that will address important issues like population dynamics, demography, territory size, dispersal, food habits, and response to anthropogenic disturbance of the introduced tigers.

## Study Area

The Sariska Tiger Reserve (STR) (76°17′E to 76°34′E and 27°5′ to 27°33′N) is situated in the Aravalli Hill Range and lies in the semiarid part of Rajasthan [8] (Fig. 7.1). It became a wildlife sanctuary in 1955 and tiger reserve in 1979. The total area of the tiger reserve is 881 km$^2$, with three distinct core zones, core I (273.8 km$^2$), II (126 km$^2$), and III (97.5 km$^2$), and a buffer zone. The core I is a proposed national

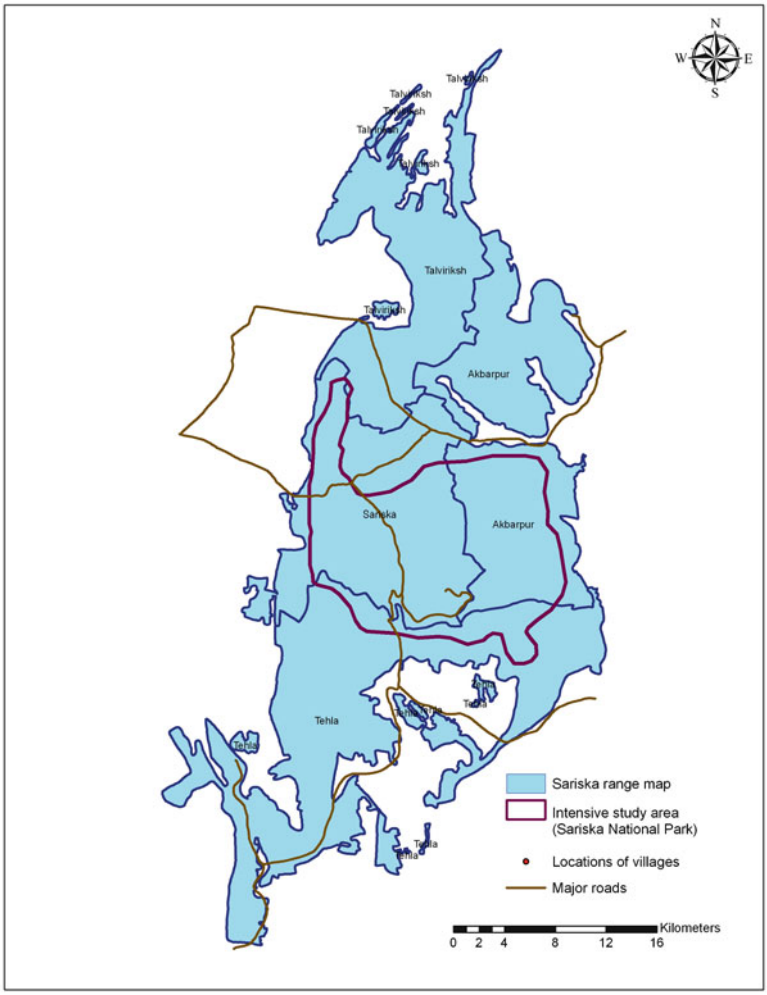


**Fig. 7.1** Location of Sariska Tiger Reserve

park and is presently awaiting a final notification. The terrain is undulating to hilly in nature and has numerous narrow valleys: two large plateaus, Kiraska and Kankwari: and two large lakes, Mansarovar and Mangalsar. The altitude of Sariska ranges from 540 to 777 m. There are two state highways, the Alwar–Thanagazhi–Jaipur and the Sariska–Kalighati–Tehla, which are over 44 km in length and traverse through the heart of the national park. The vegetation of Sariska corresponds to northern tropical dry deciduous forests (subgroups 5B: 5/E1 and 5/E2) and northern tropical thorn forest (subgroup 6B) [9]. Besides Chital, Sambar, Nilgai, and Wild Boar, the other ungulate prey species found in Sariska are the Four-horned Antelope or Chowsingha (*Tetracerus quadricornis*). A few Chinkaras (*Gazella bennettii*) were reported from the buffer zone around Baleta during late 1980s. Other wild prey species found are Hanuman Langur (*Semnopithecus entellus*), Rhesus Monkey (*Macaca mulatta*), Indian Crested Porcupine (*Hystrix indica*), Rufous-tailed Hare (*Lepus nigricollis ruficaudatus*), Indian Peafowl (*Pavo cristatus*), and Gray Partridge (*Francolinus pondicerianus*) [10].

There are 17 revenue villages located inside the tiger reserve, of which 13 are located in and around the outskirts of the buffer zone, and three villages Deori, Dabli, and Kiraska are situated in the core I. Ten villages are due for relocation since 1984 in the notified national park of the reserve. Beside this, there are six grazing camps or *Guadas*, namely, Kankwari, Umri, Haripura, Lilunda, Sukola, and Rotkala in core I. In the revenue villages, the occupation of the people is based on agriculture, but in the grazing camps, it is animal husbandry. A large number of buffaloes, goats, and a few cattle and sheep are kept in the villages. Recently one village, Bhagani, was successfully relocated during November 2007.

## The Capture and Translocation of Tigers

Five adult tigers (three females and two males) were chemically immobilized and radio-collared in Ranthambhore National Park (Ranthambhore) during the period from 23rd June to 4th July 2008 (Fig. 7.2). Young adults of approximately 2–4 years were selected based on visual health assessment and healthy body condition. Tigers were immobilized in early forenoon hours except one male which was immobilized in early afternoon because of the favorable conditions due to clouds and ambient temperature being around 32 °C. A mixture of xylazine and ketamine (500 mg + 400 mg, HBM) was used, 2.5 ml for females and 3.2–3.5 ml for males. The mixture provides synergistic effect and is most appropriate where carnivores need to be sedated for longer time. In the present case, it was visualized that the immobilized animals may be required to be kept for 2–3 h under sedation considering the time from sedation and radio-collaring and for the transport at the helipad site. A water container and sprayer were kept available to manage possibility of animal body overheating due to sedation. A 250-kg container was fabricated with nonslip wooden planks on the bottom and angle iron frames on sides and top for the transport of the animals. Two small windows were kept on the top of the container and also on two sides of the container for monitoring the animal during transportation and injection of medicaments if needed. Ventilation holes of 25 mm were created at regular intervals all over

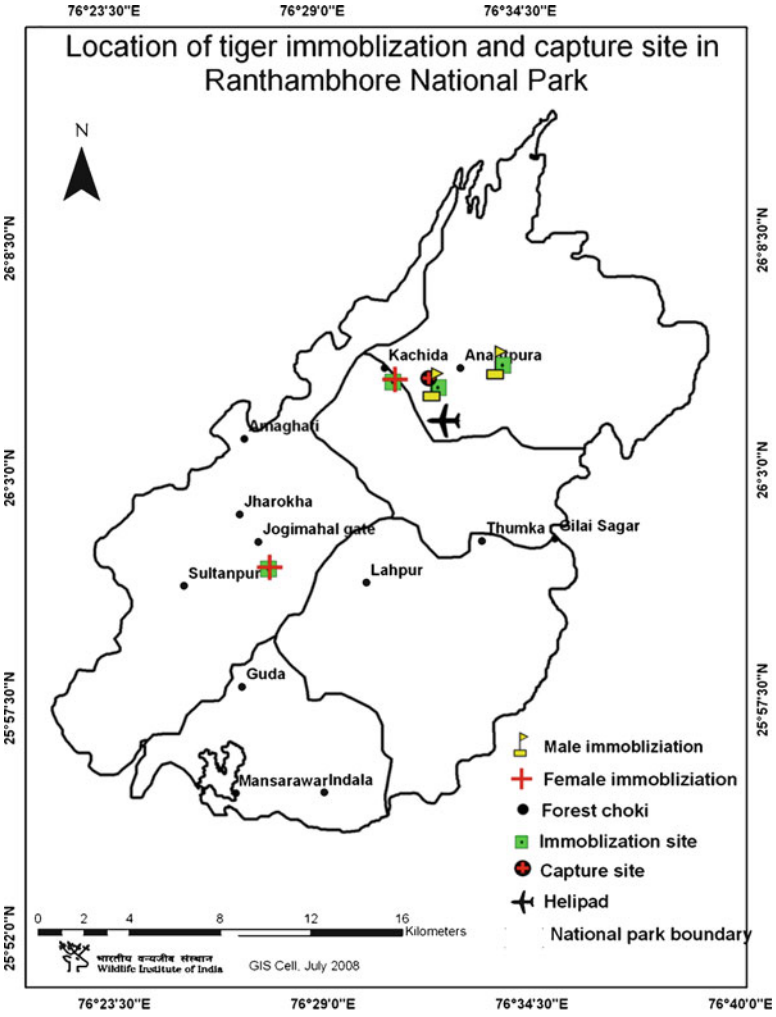


**Fig. 7.2** Location of tiger immobilization and capture site in Ranthambhore Tiger Reserve, Rajasthan

the container for proper ventilation. Care was taken to keep the container dark from inside, so that the animal remains calm during the transport. A small truck was used to bring the tiger in its container from the site of immobilization to the helipad inside Ranthambhore. An Indian Air Force helicopter (MI17) was used to transport the tiger from Ranthambhore to Sariska.

Among the five tigers immobilized and radio-collared, one adult male and one adult female were selected to be shifted to Sariska. The selected candidates, a tiger and tigress were chemically immobilized in Ranthambhore using a mixture of xylazine and ketamine (500 mg + 400 mg, HBM) on 28th June and 4th of July 2008, respectively (Fig. 7.3). The location of the animal capture in Ranthambhore is shown in Fig. 7.1. The captured tigers were fitted with radio collars (VHF–Argos–satellite),

**Fig. 7.3** Tiger radio-collaring in Ranthambhore Tiger Reserve


**Fig. 7.4** Tiger transportation by helicopter

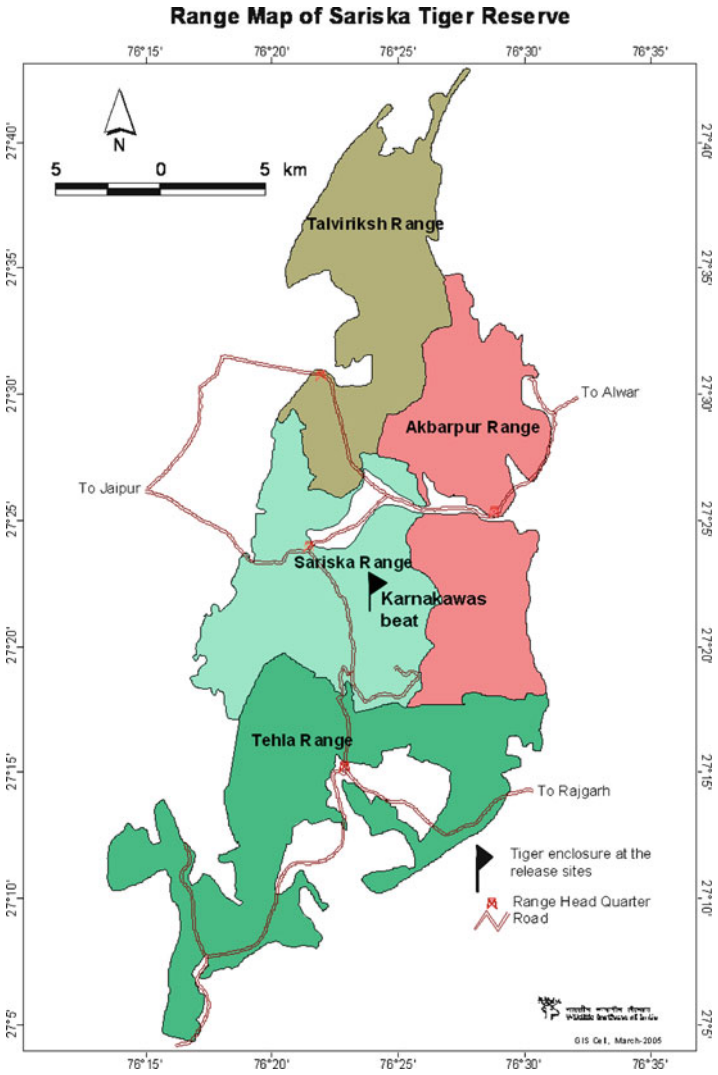


**Fig. 7.5** The tiger release site and enclosure in Sariska Tiger Reserve

kept under sedated conditions in a container, and were finally transported to Sariska by an Indian Air Force helicopter (Fig. 7.4). During the transport to Sariska, tigers in the container were monitored every five min. It was observed that the respiration of animals was regular and deep. Color of the conjunctiva was monitored continuously for any signs of cyanosis. The air journey from Ranthambhore to Sariska took 45 min for both the animals. Both tigers which were shifted to Sariska remained under sedation with vital functions within normal ranges. In Sariska, the tiger and tigress were released into two separate 1-ha enclosures on 28th June and 4th of July 2008, respectively. The location of enclosures in Sariska is shown in Fig. 7.5. A visual barrier of


**Fig. 7.6** The relocated tiger soon after the release at Sariska

three meters height fixed along the enclosure allowed the tigers to settle inside the enclosure without any stress and disorientation. The tiger was released in to wild after eight days of observation on 6th July 2008, and the tigress was released in to the wild on 8th July 2008 after three days of observation (Fig. 7.6).

## *Home Range*

Tigers were monitored continuously by a team of researchers and forest officials through ground tracking (VHF) using "homing in technique" and also through satellite tracking (Argos) [11–13]. These locations were plotted on Sariska map. Till October 2008, 119 locations for tiger and 155 locations for tigress were obtained. Minimum convex polygon (MCP) technique was used for home range calculation [14–16]. The advantage of the MCP is that it is one of the oldest techniques for home range estimation, comparable between species globally, and its inclusion as one or more methods of range calculation is, therefore, valuable.

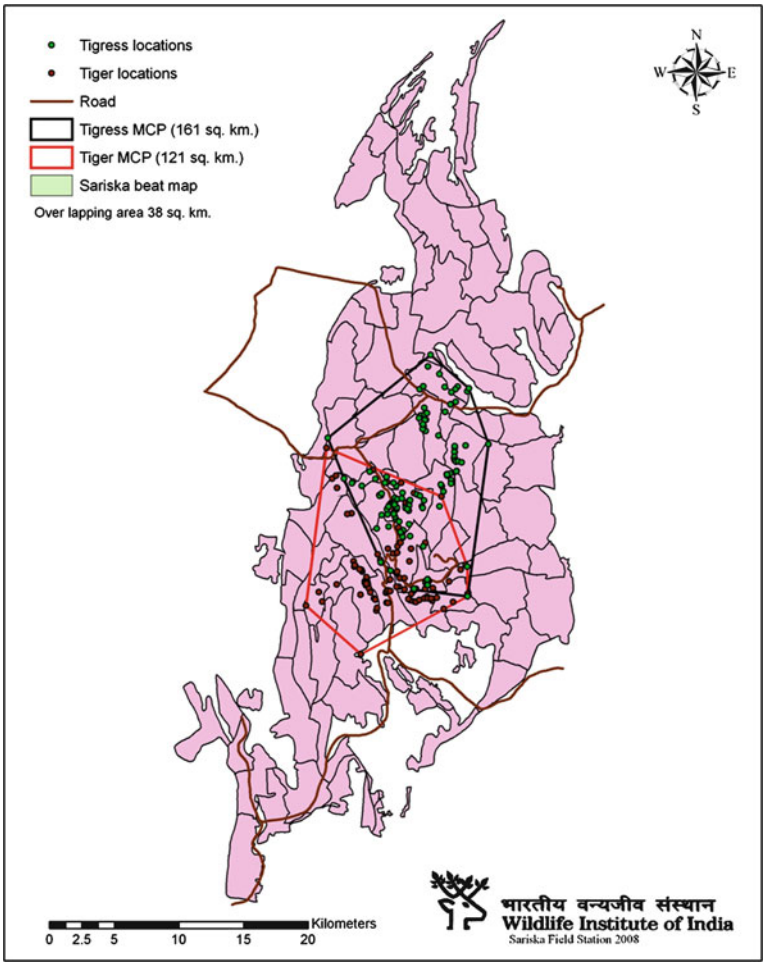


**Fig. 7.7** Maximum usage area of tiger and tigress up to 20.10.08

The estimated home range for tiger is 121 km$^2$ and for tigress 161 km$^2$. The home range overlap between male and female tigers was 38 km$^2$ (Fig. 7.7).

## *Food Habits*

Tiger kills were recorded as when encountered. In total, 31 kills of tiger and 26 kills of tigress were recorded till October 2008. Sambar (45.2%) constituted the major prey species for tiger followed by Chital (25.8%), Nilgai (22.6%), livestock (19.4%),

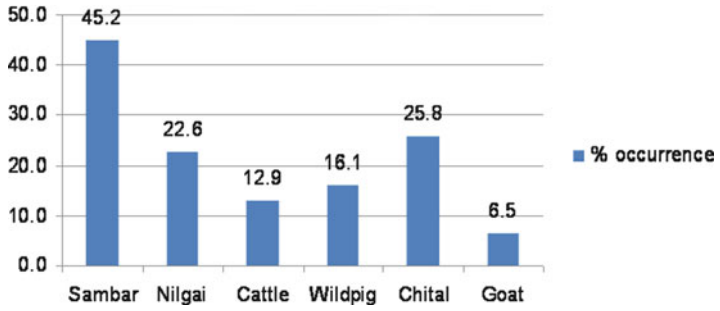


**Fig. 7.8** Percentage occurrence of different prey species found in tiger's kills

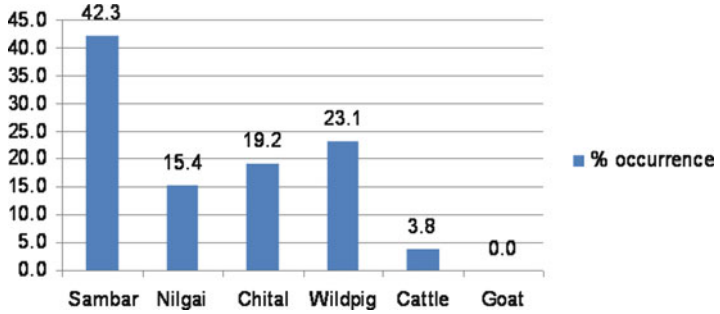


**Fig. 7.9** Percentage occurrence of different prey species found in tigress's kills

and Wild Boar (16.1%) (Fig. 7.8). Sambar (42.3%) constituted the major prey species for tigress followed by Wild Boar (23.1%), Chital (19.2%), Nilgai (15.4%), and livestock (3.8%) (Fig. 7.9). Sambar and Chital were the major prey species of tigers in Sariska [17, 18]. Similar findings were reported from Kanha [19], Bandipur [20], Rajaji National Park [21], and Ranthambhore [22].

## Discussion

Mammalian carnivores are characterized by classic relationship with their prey. It seems that carnivores are closely associated with prey size, prey biomass, and disturbance factors [23–25]. Prey density is critical for survival of large carnivore population. Looking at the current sociopolitical scenario, it is important to maintain core-breeding areas for tigers at landscape level. In any given national park, it

is important to maintain mini-cores as a source area for tiger and its prey. In Sariska Tiger Reserve, the Sariska–Pandupole Valley and adjoining hills (ca. 100 km$^2$) is the only area, which can be considered as mini-core. The reported presence of breeding tigers in this area till 2004 indicates relatively undisturbed core. The Sariska National Park (ca. 274 km$^2$) could possibly support 15 tigers (95% confidence interval: 10–21) based on tiger–prey equation [4, 25]. The ten villages from core zone I (notified national park area), once relocated, may create 274-km$^2$ area free from biotic interference which can support at least 15 adult tigers [4].

It is proposed that during the second year (2009), two tigresses and a tiger would be brought to Sariska from Ranthambhore for establishing initial population. While preparing such plans, care will be taken to implement the concepts of managing small and isolated carnivore populations, such as monitoring of carnivore, prey, and habitat and restocking periodically with more tigers to maintain genetic and demographic viability. The future study aims at the detailed learning of ecology, movement and ranging patterns, habitat use, food habits, and prey population of reintroduced tigers and also assess the response of tiger and its prey species to the removal of anthropogenic influence from relocated villages. The data generated from the study is expected to provide a framework of measure needed for conservation of tigers under these unique circumstances.

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## Annexure A

*Simulation of population growth pattern of reintroduced tiger population* [4]: To reestablish tiger population in Sariska, it is important to remove disturbance factors affecting habitat condition and prey availability to tigers. Reintroduction should establish self-sustaining populations with high reproductive fitness in the wild environment and ample genetic diversity [6]. We suggest that a tigress from (two females and two males) Ranthambhore National Park may be brought to establish the population in Sariska Tiger Reserve. We visualized following scenarios.

*Five tigers only*: Reintroduction of two males and three females with no supplementation in future. Mean final population for successful cases was 11.91 (0.17 SE, 3.32 SD). The deterministic population growth rate, based on females, with assumptions of no limitation of mates, no density dependence, and no inbreeding depression, was $r = 0.128$, lambda = 1.137, and $R_0 = 2.401$. The observed growth rate was 0.0589

(0.0022 SE, 0.2285 SD). In 500 simulations of population for 25 years, 126 went extinct and 374 survived. This gives a probability of extinction of 0.2520 (0.0194 SE) or a probability of survival of 0.7480 (0.0194 SE). The mean time to first extinction was 10.73 years (0.62 SE, 6.99 SD). The final observed heterozygosity was 0.7535 (0.0083 SE, 0.1605 SD) (Fig. 7.10a–c).

*Initial population of five tigers, which is supplemented by two tigers every 3 years*: Reintroduction of two tigers and three tigresses with supplementation of two tigers (male and female each) every three years in three subsequent batches, i.e., supplementation from third to ninth year. Mean final population for successful cases was 12.89 (0.13 SE, 2.89 SD). The deterministic population growth was $r = 0.128$, lambda = 1.137, and $R_0 = 2.401$. The mean observed growth rate without supplementation was 0.0784 (0.0021 SE, 0.2145 SD) and with supplementation 0.2954 (0.0058 SE, 0.2214 SD). In 500 simulations of population one for 25 years, 19 went extinct and 481 survived. This gives a probability of extinction of 0.0380 (0.0086 SE) or a probability of survivorship of 0.9620 (0.0086 SE). Mean time to first extinction was 9.70 years (1.40 SE, 8.88 SD). The observed heterozygosity was 0.8518 (0.0056 SE, 0.1237 SD) (Fig. 7.10a–c).

*Initial population of five tigers which is supplemented by three tigers every two years*: Reintroduction of one male and two females which is supplemented by two tigers every two years for three subsequent batches. The deterministic growth rate was $r = 0.128$, lambda = 1.137, and $R_0 = 2.401$. Mean final population for successful cases was 12.80 (0.14 SE, 3.05 SD). Without supplementation, the mean observed growth rate was 0.0664 (0.0021 SE, 0.2178 SD), and during years of supplementation mean growth rate ($r$) was 0.4441 (0.0074 SE, 0.2803 SD). In 500 simulations of population one for 25 years, 31 went extinct and 469 survived. This gives a probability of extinction of 0.0620 (0.0108 SE) or a probability of survivorship of 0.9380 (0.0108 SE). The mean time to first extinction was 5.77 years (0.79 SE, 8.10 SD). Observed heterozygosity was 0.8369 (0.0062 SE, 0.1334 SD) (Fig. 7.10a–c).

We modeled the more realistic scenario of three or five tigers being introduced in initial phase and supplemented with tigers at varying interval. The survivorship and inbreeding coefficient (Fig. 7.10a–c) of initial population of five and three tigers which is supplemented with two tigers every two or three years is good, and both have extinction probability <6%. The supplementation is most important to maintain the genetic vigor and can reduce the risk of extinction. The tiger population of five without supplementation has shown high rate of extinction (25%). This reintroduction scenario operates in a situation of very low or no poaching and no prey depletion and thus highlights the importance of either supplementing the introduced population or establishing dispersal coridors with Sariska. Given the insular nature of Sariska Tiger Reserve, the second option is far more formidable and the only option for a viable tiger population in a highly managed tiger population.

*Epilogue by the editors*: As per the above study, in the year 2009, one male and two female tigers were relocated to Sariska Tiger Reserve. By November 2010, the

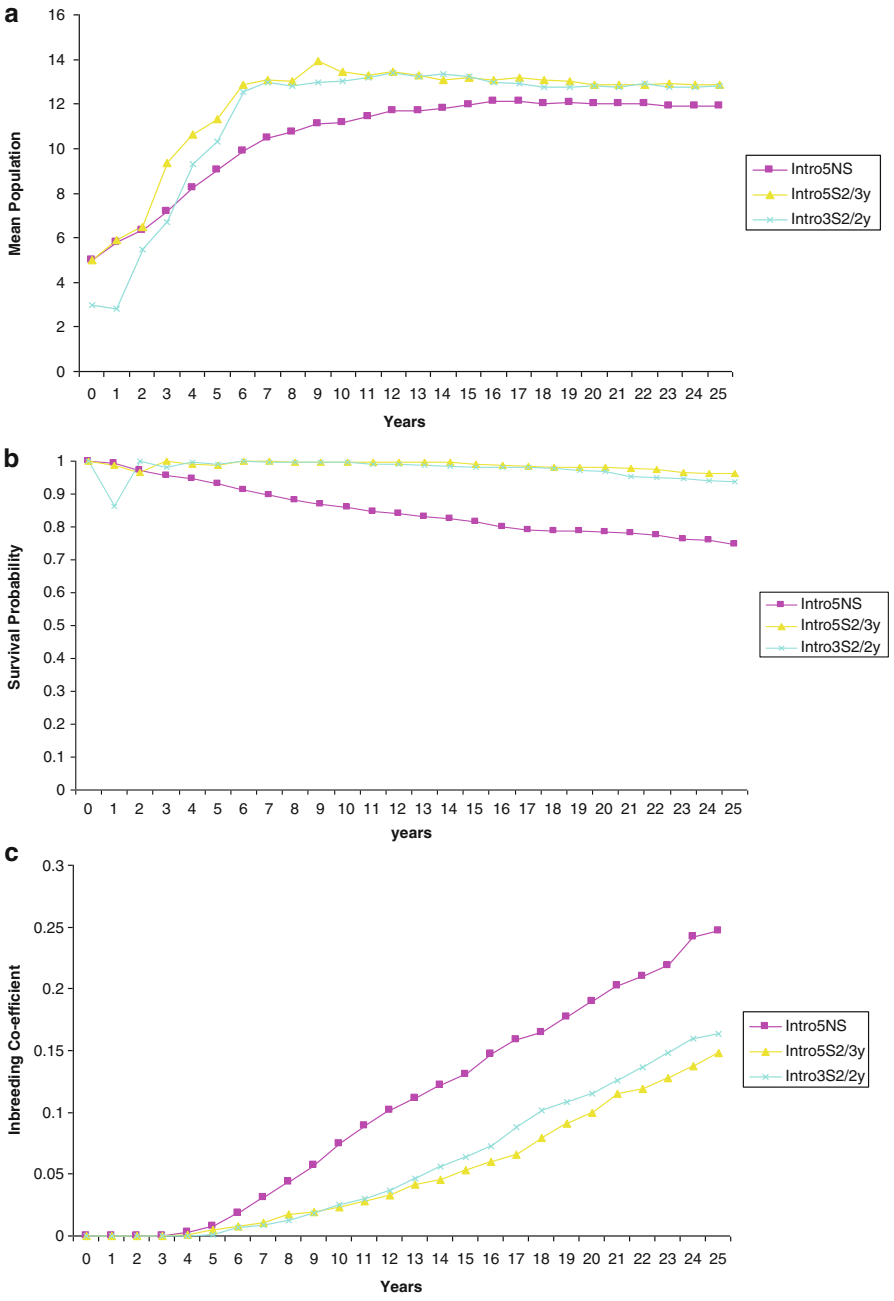


**Fig. 7.10** The mean population growth (**a**), survival probability (**b**) and inbreeding coefficient of reintroduction scenarios, Intro5NS—reintroduction of two males and three females with no supplementation, (**c**) Intro5S2/3y—reintroduction of two tigers and three tigresses with supplementation of two tigers every 3 years and Intro3S2/2y—reintroduction of one male and two females and supplementation by two tigers every two years

number rose to two males and three females and subsequently the very first relocated male tiger ST-1 was found dead due to feeding on a poisoned buffalo kill. Interestingly, a male tiger (now called ST-6 or T-07) rambling the forests near Keoladeo National Park, Bharatpur, was caught by author's team on 24 February, 2011 and released in STR. As of february, 2013, two male, five female tigers and two cubs are freely wandering at STR.

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# Chapter 8
# The Ramsar Sites of Rajasthan: Ecology and Conservation of Sambhar Salt Lake, Jaipur and Keoladeo National Park, Bharatpur

**Seema Kulshreshtha, B.K. Sharma, and Shailja Sharma**

**Abstract** This chapter presents the ecology and faunal diversity of Sambhar Salt Lake, Jaipur, and Keoladeo National Park (KNP) or Ghana, Bharatpur. The Sambhar Lake is a rain-fed playa of the arid zone of Rajasthan famous for salt production. It was given the status of a Ramsar Site in March 1990. It is also an Important Bird Area (IBA) due to migratory avifaunal population, especially flamingo and waterfowl. Current conservational threats owing to the drastic reduction in water spread and anthropogenic pressures are major concerns. Immediate conservation measures are required to revive this wetland. Eco-rehabilitation of its fast degrading catchment requires multidisciplinary approaches for sustainable lake basin management, water resource management, and forest management. KNP is an assortment of dry grasslands, woodlands, woodland swamps, and wetlands, acknowledged as one of the most enchanting and outstanding wetland reserves in the world and hence given the distinction of World Heritage site by the UNESCO. The importance of this park lies in the fact that this massive 29-km$^2$ mosaic of habitat is home to more than 375 species of plants, 400 species of avifauna, 50 species of ichthyofauna, 30 species of herpetofauna, and a variety of other invertebrates and mammals. This chapter also highlights the two Ramsar Sites from a historical perspective and the importance of human involvement for the betterment of these unique ecosystems. The authors

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have reviewed the ecological degradation in general, declining population of flamingos at Sambhar Lake, and extinction of Siberian Crane at KNP and have suggested measures for conservation.

## Introduction

Wetlands have always been of utmost importance for human existence since time immemorial. Inhabitants of the desert state of Rajasthan have traditionally protected and cared for the wetlands like a treasure owing to the severe water scarcity, frequent droughts, and famines in this part of the world. Wetlands, as the abode of rich biodiversity and dynamic ecotones, require wise resource management and implementation of the conservational strategies suggested by experts at national and international forums from time to time. The Ramsar Convention is one such endeavor that unites the globe for conserving our fast degrading wetlands. Among the 25 Ramsar Sites of India, Rajasthan owns two, namely, Sambhar Salt Lake and Keoladeo National Park (KNP). Although, both of these wetlands are located in different physiographic regions and have altogether diverse climatic conditions, they are commonly recognized as significant waterfowl habitats. It is unfortunate that KNP continues to be a privileged Ramsar Site with well-attended government, national, and international focus while Sambhar Lake being the largest inland saline wetland of India is rapidly deteriorating yet remains thoroughly ignored. In this review, we have tried to combine results of our own studies with the available information collected from various sources.

## Sambhar Salt Lake, Jaipur: A Rapidly deteriorating Ramsar Site in the Arid Zone of Asia

The arid zone of Rajasthan possesses five saline lakes, namely, Pachpadra Lake in Barmer district, Kuchaman Lake, Deedwana Lake in Nagour district, Phulera Lake, and Sambhar Lake in Jaipur district; out of them, the Deedwana Lake has already vanished while Phulera Lake is lying on the verge of extinction. The Sambhar Lake is the largest inland saline lake of India producing thousands of tons of good-quality salt for centuries (Fig. 8.1). It is located about 60 km. southwest of the Jaipur city. The ecological importance of the lake with respect to avifauna cannot be ignored, since it is one of the few habitats that receive thousands of migratory waterbirds specially the flamingos every year. Due to this distinction, the lake has been listed under wetlands of international importance in the year of 1990 under the "Convention on Wetlands of International Importance."

Sambhar Lake was formally declared as a Ramsar Site in 1990 by the Government of India and the Ramsar Bureau while recognition as an Important Bird Area (IBA) was bestowed in 2004 by the Bombay Natural History Society (BNHS) and BirdLife

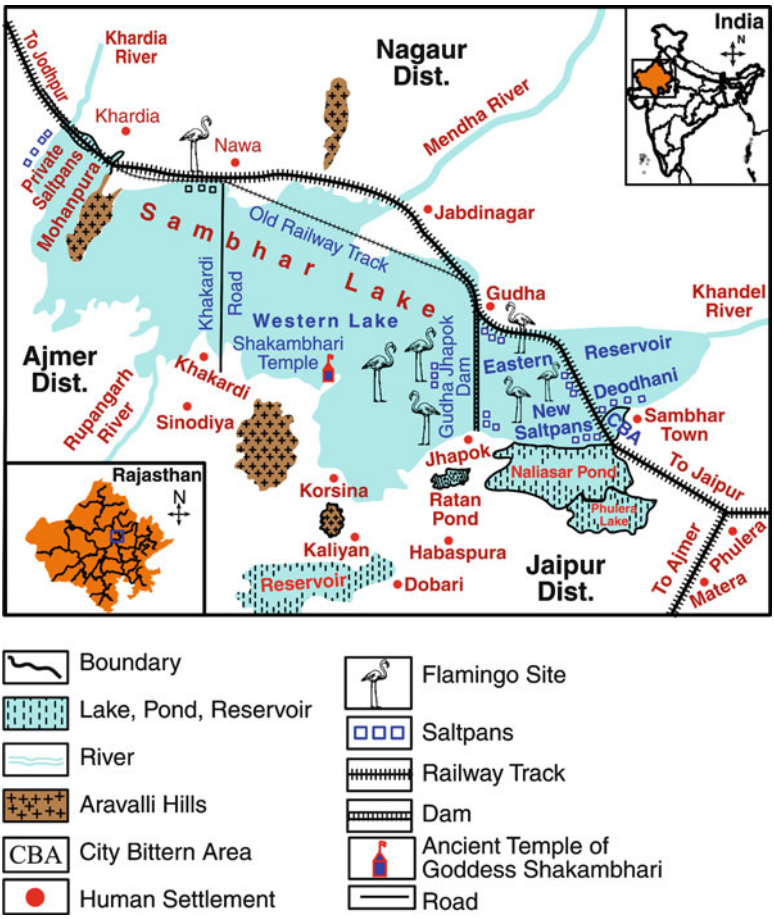


**Fig. 8.1** Location of Sambhar Salt Lake. *Courtesy: Dr. Seema Kulshreshtha, R.K. Verma and Dr. B.K. Sharma*

International, UK [1]. The migratory avifaunal population and species diversity of this lake depend entirely upon rainfall and seasonal variations. It is currently facing severe anthropogenic pressure and ecological crisis resulting into a rapid reduction in the bird population. There is a great need for developing an integrated conservation strategy for this important wetland to revive its status and lost glory.

## *Historical and Mythological Background*

As far back as 5000 years back, the 9th volume of *Adi Parva* of the great epic *Mahabharata* and 18 and 19 chapters of the ancient *Bhagavata Purana* mentions Sambhar town as capital of *Brishparva*—the king of demons. His royal priest

**Fig. 8.2** The ancient temple of Goddess Shakambhari situated at the periphery of Sambhar Lake. *Courtesy: Devendra Bhardwaj*

Shukracharya's daughter Devyani married to Yayati—the emperor of the then *Bharatvarsha* (now India), tenth in the line of descent from Lord Brahma—the God who created all humans [2]. Traditions ascribe the formation of Sambhar Lake in 551 A.D. when Shakambhari—the Goddess of *Chouhan Rajputs*—bestowed her blessings in return of some milk offered to a religious ascetic and changed the forest into a vast plain of silver which was later converted to salt upon the request by villagers of Sirthula (Fig. 8.2). Records show that Sambhar Lake has been used for salt production for the past 1,500 years. Archaeological excavations clearly indicate the existence of Sambhar town to be as old as Kushan and Gupta Periods, and the historical records prove it as the first capital of *Chauhan* kings [3, 4]. A small temple of the deity Bherudeo stands tall on the periphery of the lake near the Goddess Shakambhari temple (Fig. 8.3). During Emperor Akbar's regime, the income from the lake was estimated to be about Rs. 2,50,000 per month [2] which gradually rose to Rs. 15,00,000 in the reign of Emperor Aurangzeb. From 1844 onward, the *Shamlat*—a joint Government of Jaipur and Jodhpur—used to own the lake. Originally, there were about 60 villages around the lake. At that time, Nawa and Gudha were insignificant hamlets, but they gradually developed into salt marts. By the turn of 1870, the British Government had taken over the salt works from the Jaipur and Jodhpur *darbars* (kings). This went on till India's Independence in 1947, and since then, Sambhar Salt Plant renamed as Hindustan Salts Ltd., was being managed by the Central Government of India. Presently, the salt production is managed by Sambhar Salts Ltd.—a joint venture of Hindustan Salts Ltd. and the State Government of Rajasthan. It is the first iodization plant in the country which is being run with UNICEF support [5] (Fig. 8.4).

**Fig. 8.3** Bherodeo temple situated at the periphery of the lake. *Courtesy: Devendra Bhardwaj*

**Fig. 8.4** Sambhar salt extraction plant. *Courtesy: Dr. Seema Kulshreshtha*

**Table 8.1** District-wise area distribution of Sambhar catchment [6]

| District | Area (sq. km.) | Area(%) |
|---|---|---|
| Ajmer | 1,032 | 18.08 |
| Jaipur | 1,967 | 34.46 |
| Nagour | 1,042 | 18.26 |
| Sikar | 1,667 | 29.20 |
| Total | 5,708 | 100 |

**Fig. 8.5** Salt pans at Sambhar Lake. *Courtesy: Devendra Bhardwaj*

*Geographical Features*: The Sambhar Lake is situated in Jaipur, Ajmer, and Nagour districts of Rajasthan at 26° 52′N–27°02′N, 74°54′E–75°14′E (Table 8.1). It is elliptical in shape with a maximum depth of 3 m and a size of 230 sq. km in its full capacity. The lake is divided into two unequal parts by a 5.16-km-long dam made of sand stone between Jhapok and Gudha villages situated, respectively, in the south and north. The western part is a continuous sheet of water, while the eastern part is used for salt extraction and comprises of two large reservoirs and a number of salt pans called k*yars* for holding the brine (Fig. 8.5). Three canals connect the lake to the salt pans present in the north, south, and west directions. When the water of the western part gets concentrated, it is readily transferred to the east by the sluice gates for salt production (Fig. 8.6).

**Fig. 8.6** Good rainfall in the year 2010 led to influx of salty water from the main lake to the reservoirs via sluice gates. *Courtesy: Dr. Seema Kulshreshtha*

## *Catchment*

The lake has a 5,700-km$^2$ catchment area spread in three districts, namely, Jaipur, Nagour, and Ajmer, which extends up to the Sikar district in the north and northwest (Table 8.1) [6].

*Water Resources*: The Sambhar Lake is fed by four ephemeral streams, namely, Rupangarh from the south, Mendha from the north, Kharian from the northwest, and Khandel from the east besides many surface runoffs which flow only for a few days during rainy season amid good rainfall [7]. These streams differ in salt content and accordingly in the salinity levels. During the peak summer, these inflowing rivers almost dry up or have very little water. The three other major streams which flow during heavy rainfall are Ruprail, Bandi, and Turatmati. Several paleochannels lie buried beneath the sand, for example, some part of Anokhi and Ranoli—the two major tributaries of River Mendha which have disappeared during last two decades [8]. Disappearance of the ancient Saraswati and Drishadvati River system from the western part of Rajasthan during late Holocene Period reflects a geological evolution of saline lakes and their remnants in the west of Aravallis [9].

*Settlements*: The Sambhar town is situated toward the eastern side of the lake. A cluster of 38 small settlements including Jhapok, Korsina, and Khakhardi lay in

the south while the two salt marts and relatively bigger settlements, namely, Gudha and Nawa, are located in the north.

*Land Use Pattern*: The eroded land at Sambhar has increased from 24% in 1998 to 1933% in 2005, and 4% of the agricultural land has been converted for salt extraction activities resulting into an increase in the salt extracting area [6]. Though, efforts are being made to increase the agricultural and fallow land, scarcity of water and dependency of agriculture on rainfall nullify these efforts. Although, the Bisalpur water project has started supplying clean drinking water to the Sambhar town and the nearby villages, it is difficult to infer that it will help in irrigation, too.

*Satellite Wetlands*: Sambhar Lake has many satellite fresh water wetlands which also greatly support migratory and other waterfowls. The main water spots include Naliasar Pond, two water spots lying two and four kilometers away from Korsina and Gudha villages, respectively, in the southern periphery and *Ratan Talab.* Flamingos are not seen on these satellite wetlands but coot, duck, geese, and wader are commonly observed after good a rainfall or during winters [10].

*Geological Profile*: Geological stratification shows that the lowermost layer of the lake bed is made of micaceous schists covered by limestone nodules buried in clay. A thick layer of sand made of 20-m saliferous clay lies above it which after drying gives cracks to the lake bed. Sediments are rich in sodium chloride, sodium bicarbonate, sodium sulfate, and sodium carbonate, which are high on the surface (16% NaCl and 5.2% $Na_2So_4$) but decrease to 5% at a depth of 30–60 cm. During dry seasons, the lake bed seems covered with a thin layer of crystalline salt. The sources of salinity of the lake are controversial. According to the Official Report (2005) of Sambhar Salts Ltd., 5,500 million tons of salt is still lying beneath the lake surface.

*Climate*: The Sambhar Lake falls in the semiarid eastern zone and is situated on the gateway to the arid zone. The climate here is typical subtropical with annual seasonal variations. During summer, the climate remains very warm and dry with hot winds and dust storms blowing at 30–36 km/h while the temperature in general ranges from 38 to 41°C which at its peak rises to 45–47°C causing evaporation of the shallow lake water. During winters, the temperature falls to 5–19°C going down as low as 1.8°C during peak winters in the month of January.

## *Rainfall Records of Sambhar Lake*

Rainfall in the area is generally scanty ranging from 100 to 500 mm. Approximately 80% of the total rainfall occurs during July to October. Rainfall records of last 100 years at Sambhar Lake exhibit a wide variation resulting in frequent spells of drought while floods are rare [2, 5].

*Salt Production*: Agarwal [2, 11] has aptly described the history of salt production, process, costs, and revenues.

**Table 8.2** Physicochemical analysis of Sambhar Lake water during 2009–2010

| Parameters | Temp°C | pH | Transparency (cm) | Chloride (%) | Salinity (%) | Carbonate (ppm) | Bicarbonate (ppm) | Total alkalinity (ppm) |
|---|---|---|---|---|---|---|---|---|
| Unit | 8–42.3 | 7.8–9.9 | 19–68 | 2.8–161. | 7.4–273.4 | 178.6–564.5 | 391.4 | 51.8–1951.7 |

## *Physical Properties of Lake Water*

The lake water displays the following physical properties in general, except during peak summers.

*Color*: Color of the lake water changes from muddy to blue green or green in the rainy season until October due to algal growth. During summer, death and decay of algae coupled with high bacterial density and increased rate of water evaporation turns it light brown to brown and finally dark brown in color. Transparency of water is low and is greatly affected by the phytoplankton population and salinity. Oxygen concentration of the lake water declines in summer and increases in rainy season while salinity and alkalinity increase as the temperature rises in summer. Sulfur, found in the form of sodium sulfate in the sediments, produces hydrogen sulfide under anaerobic conditions giving the characteristic odor to the atmosphere. Nonmetallic elements like calcium and magnesium have also been found in the lake water [12, 13]. Algal growth has a negative correlation with the pH, transparency, temperature, density, chloride, sodium, salinity, carbonate, phosphate, and alkalinity but shows a positive correlation with nitrate [7] (Table 8.2).

## *Biological Diversity of Sambhar Lake*

Since Sambhar Lake is highly saline and most of the freshwater organism cannot survive at such high salinity, majority of the flora and fauna flourish during the rainy season when salinity is low. Unfortunately, the overall faunal diversity is fast diminishing. [5, 14, 15]

*Phytoplankton*: The lake water displays a variety of colors in different seasons due to the algal growth with *Arthrospira*, *Spirulina*, *Anabaenopsis*, and *Dunaliella* as the dominant forms which provide bluish-green tinge to the water during September–November. Cyanophyta dominates the algal flora being 87.3% of the total phytoplankton population. Dark brick-red color of the water in summers is due to *Dunaliella salina* and *Arthrospira platensis* [13, 16]. (Fig. 8.7). All in all, 13 species of phytoplankton are found in Sambhar Lake belonging to three major groups, namely, *Cyanophyta* (*Arthrospira platensis*, *Spirulina subsalsa*, *Anabaenopsis arnoldii*, *Oscillatoria minnesotensis*, *O. subbrevis*, *Pseudanabaena catenata*, *P. schmidlei*, *Synechococcus cedrorum*, *S. elongatus*, and *Phormidium*), *Chlorophyta* (*Dunaliella parva*), and *Bacillariophyta* (*Amphora ovalis* and *Nitzschia*). *Dunaliella salina* has ß-carotene pigment which is fast expanding natural carotene industry worldwide. It is also known to produce glycerol as a by-product. Pink color of the

**Fig. 8.7** Red color of the water in salt pans is due to alga *Dunaliella salina* and *Arthrospira platensis. Courtesy: Dr. Seema Kulshreshtha*

salt is due to *D. salina*. *Spirulina* is also considered to be a rich source of protein. In addition, the presence of bacteria *Serratia sambhariana* in decaying algae is observed during summers [17].

*Macrophytes*: No macrophyte is found in the lake; only succulent halophytes like *Salsola* and *Suaeda* species are seen on the saline moist margins of the lake (Fig. 8.8).

*Vegetation*: The natural vegetation in the catchment of Sambhar Lake is thorny scrub which is typical of the arid and semiarid zones. The surrounding Aravallis are covered with *Anogeissus pendula*, *Boswellia* sp., and *Euphorbia caducifolia*. Plain areas have trees like *Prosopis spicigera*, *Acacia nilotica*, *A. senegal*, *Capparis decidua* (Fig. 8.9), and *C. aphylla* and shrubs like *Salvadora persica* and *S. oleoides*. Coarse grasses such as *Saccharum spontaneum* and *S. bengalense* are also common. Of other grasses, *Cenchrus* sp. is widely grazed. The already thin vegetation cover is under severe anthropogenic pressure for both fodder and fuel wood. A checklist of the vegetation found at Sambhar has been given by Gopal and Sharma [5].

*Zooplankton*: Roonwal [18] had extensively studied the fauna of Sambhar Lake. A few zooplanktons such as *Cladocera*, *Copepoda*, *Branchianus*, *Cyclops*, and *Diaptomus* were seen during rainy seasons when the salinity is very low [5]. Baid [19] reported two species of protozoan. We observed a few *Cyclops*, *Miona*, and *Cladocera* during the rainy season of 2008 which disappeared as the salinity of the lake water increased in October 2008. Invertebrate such as *Berosus indicus*, *Ephydra*

**Fig. 8.8** Succulent *Salsola* sp. on the dried margins of the lake. *Courtesy: Dr. Seema Kulshreshtha*

**Fig. 8.9** *Capparis aphylla* (*Kair*) shrubs in the lake catchment. *Courtesy: Dr. Seema Kulshreshtha*

*malellia*, and *Eristalis* [20] and shells of *Indoplanorbis exustus* and *Gabbia orula* were collected from dry margins of the lake [5]. A brine shrimp *Artemia salina* was reported by Baid [19, 21–23] which disappeared during the floods of 1970s. After that, attempts to introduce and culture brine shrimp failed possibly due to low oxygen levels of the salt pans [24]. We did not notice any other invertebrate in the lake water though the catchment has some common insect species like *Schistocerca* (locust), *Agrian*, and *Petalura* (dragon flies) while *Vespa* and *Polistes* sp. (wasp) were present on the dry margins of the lake [14].

*Aquatic Beetles*: *Cybister tripunctatus asiaticus*, *Eretes sticticus* and *Hyphoporous severini* were reported by Baid [19]. Twenty two species of aquatic beetles belonging to the family Dytiscidae were reported by Vazirani [25] in a 16-km radius covering Naraina, Phulera, Bahadurpur, and Koni villages. Roonwal [17] reported as much as 35 species of aquatic beetles from Sambhar Lake watershed area. However, no scientific study has been actually made on the beetles of Sambhar Lake during last 15 years. In our study, we could find only 16 species of beetles in 2009, namely, *Cybister tripunctatus asiaticus*, *Eretes sticticus*, *Hyphoporous severini*, *Canthydrus lactablis*, *Laccophilus chinesis inefficiens*, *L. parvulus* (found at Phulera ), *L. flexuosus* and *L. sharpii* (both found at Gudha), *Hyphydrus flavicans*, *H. musicus*, *Guignotus flammulatus*, *G. pusillus*, *Hyphoporous severini*, *H. kempi*, *Rhantaticus* sp., and *Sandrauoltus dejaeni.* Interestingly, during 2007 and 2008, only 4–6 varieties of small-sized terrestrial beetles, namely, *Tenebris*, *Scarabaeus*, *Anthrenu*, *Cicindela*, and *Epicauta*, were observed in the catchment area [14].

*Vertebrate Fauna*: Several freshwater fishes have been reported to enter the lake with the incoming streams during rainy season and die out due to its high salinity [5]. No fish was ever seen during our own study. Common amphibians such as *Euphlyctis hexadactylus* and *Bufo* sp. are generally seen in the catchment. A variety of reptiles like *Geochelone elegans, Hemidactylus flaviviridis, H. brookii, Crossobamon orientalis, Chamaeleon zeylanicus, Varanus bengalensis, Eryx johnli, Ptyas mucosa, Coluber gracilis, Spalerosophis arnarius, Bungarus caeruleus, Naja oxiana etc*. have also been observed in the catchment area. The harsh and saline conditions of the lake do not attract mammals, although some common species of small mammals like *Suncus murinus, Paraechinus micropus, Funambulus pennantii, Tatera indica, Rattus rattus, Mus musculus* and *Mus booduga* inhabit the catchment area. Bluebull or Nilgai *Boselaphus tragocamelus* is a common pest in the crop fields situated on the periphery of Sambhar town. The wildlife includes Leopard *Panthera pardus*, Striped Hyena *Hyaena hyaena*, Golden Jackal *Canis aureus*, Hanuman Langur *Semnopithecus entellus*, Rhesus Monkey *Macaca mullatta,* Common Palm Civet *Paradoxurus hermaphroditus*, Bengal Fox *Vulpes bengalensis*, Indian Grey Mongoose *Herpestes edwardsii* and Indian Hare *Lepus nigricollis*. A large colony of about 550 Indian Flying Fox *Pteropus giganteus* was observed by us on an old Banyan *Ficus bengalensis* tree near the Deodhani gate [26]. Domestic animals of this area are estimated to be 7.5 million including dogs, house cat, pig, cattle, sheep, buffalo, camel, goat, donkey, and horse which are confined to the catchment. Grazing by herds of sheep by *Rebari* or *Raika* community is a very common sight (Fig. 8.10).


**Fig. 8.10** Grazing by sheep herds belonging to *Rebari* or *Raika* community in the catchment. *Courtesy: Dr. Seema Kulshreshtha*

## *Avian Diversity*

Adam [27, 28] and Hume [29] were the first to observe the avifauna of Sambhar Lake. Since then, the rich avifaunal diversity especially flamingos of the lake has been attracting researchers [2, 5, 10, 30–43]. Vijayan *et al*. [44] have categorized the conservation status of important avifauna of the lake as follows: *Critically Endangered*, White-rumped Vulture *Gyps bengalensis* (sighted only once in April 2006); White-naped Tit P*arus nuchalis* (now not seen around Sambhar Lake since last five years); and Near Threatened Painted Stork *Mycteria leucocephala* (not sighted during present study period), Lesser Flamingo *Phoeniconaias minor*, Cinereous Vulture *Aegypius monachus*, Red-headed Vulture *Sarcogyps calvus* (now considered as Critically Endangered by BirdLife International in 2012), and Dalmatian Pelican *Pelecanus crispus* which was not seen during our study period (2006–2010) is considered Vulnerable.

Kulshreshtha *et al.* [10, 41] observed 52 terrestrial avian species belonging to 10 orders and 24 families which included 11 winter visitors and 41 commonly seen resident species. Order Passeriformes had the maximum number of species (Table 8.3). Crested Lark seen earlier on the dry margin of the lake is now uncommon. Critically Endangered Sociable Lapwing was not seen during our study.

**Table 8.3** A checklist of terrestrial avifauna of Sambhar Lake

| S. No. | Common name | Zoological name | R/M |
|---|---|---|---|
| 1 | Gray Francolin | *Francolinus pondicerianus* | R |
| 2 | Indian Peafowl | *Pavo cristatus* | R |
| 3 | Yellow-crowned Woodpecker | *Dendrocopos mahrattensis* | R |
| 4 | Common Hoopoe | *Upupa epops* | R |
| 5 | Indian Roller | *Coracias benghalensis* | R |
| 6 | Common Kingfisher | *Alcedo atthis* | R |
| 7 | Little Green Bee-eater | *Merops orientalis* | R |
| 8 | Greater Coucal | *Centropus sinensis* | R |
| 9 | Asian Koel | *Eudynamys scolopacea* | R |
| 10 | Rose-ringed Parakeet | *Psittacula krameri* | R |
| 11 | Little Swift | *Apus affinis* | R |
| 12 | Spotted Owlet | *Athene brama* | R |
| 13 | Rock Pigeon | *Columba livia* | R |
| 14 | Eurasian Collared-dove | *Streptopelia decaocto* | R |
| 15 | Laughing Dove | *Stigmatopelia senegalensis* | R |
| 16 | Shikra | *Accipiter badius* | R |
| 17 | Black Kite | *Milvus migrans* | R/WV |
| 18 | Common Kestrel | *Falco tinnunculus* | W/V |
| 19 | Northern Harrier | *Circus melanoleucos* | WV |
| 20 | Southern Gray Shrike | *Lanius meridionalis* | R |
| 21 | Long-tailed Shrike | *Lanius schach* | R |
| 22 | Indian Treepie | *Dendrocitta vagabunda* | R |
| 23 | House Crow | *Corvus splendens* | R |
| 24 | White-bellied Minivet | *Pericrocotus erythropygius* | R |
| 25 | Black Drongo | *Dicrurus adsimilis* | R |
| 26 | Indian Robin | *Saxicoloides fulicata* | R |
| 27 | Black Redstart | *Phoenicurus ochruros* | R/WV |
| 28 | Brown Rockchat | *Cercomela fusca* | R |
| 29 | Desert Wheatear | *Oenanthe deserti* | WV |
| 30 | Variable Wheatear | *Oenanthe pictata* | WV |
| 31 | Rosy Starling | *Sturnus roseus* | WV |
| 32 | Common Myna | *Acridotheres tristis* | R |
| 33 | Brahminy Starling | *Sturnus pagodarum* | R |
| 34 | Asian Pied Starling | *Sturnus contra* | R |
| 35 | Bank Myna | *Acridotheres ginginianus* | R |
| 36 | Dusky Crag Martin | *Hirundo concolor* | R |
| 37 | Plain Martin | *Riparia paludicola* | R |
| 38 | Red-vented Bulbul | *Pycnonotus cafer* | R |
| 39 | White-eared Bulbul | *Pycnonotus leucotis* | R |
| 40 | Large Gray Babbler | *Turdoides malcolmi* | R |
| 41 | Crested Lark | *Galerida cristata* | R |
| 42 | Ashy-Crowned Sparrow-lark | *Eremopterix griseus* | R |
| 43 | Lesser Short-toed Lark | *Calandrella rufescens* | R |
| 44 | White Wagtail | *Motacilla alba* | WV |
| 45 | Yellow Wagtail | *Motacilla flava* | WV |

(continued)

**Table 8.3** (continued)

| S. No. | Common name | Zoological name | R/M |
|---|---|---|---|
| 46 | Citrine Wagtail | *Motacilla citreola* | R/WV |
| 47 | Tawny Pipit | *Anthus campestris* | WV |
| 48 | House Sparrow | *Passer domesticus* | R |
| 49 | Chestnut-shouldered Petronia | *Petronia xanthocollis* | R/M |
| 50 | Purple Sunbird | *Nectarinia asiatica* | R |
| 51 | Baya Weaver | *Ploceus philippinus* | R |
| 52 | White-throated Munia | *Lonchura malabarica* | R |

Abbreviation: *R* Resident, *WV* Winter visitor, *M* Migrant


**Fig. 8.11** Desert Wheatear *Oenanthe pleschanka* is an uncommon bird at the lake. *Courtesy: Sunil Singhal, Kota*

Most of the Passerines described by Adam around the lake are also quite rare now. The White-naped Tit, endemic to India, was collected by Adam in the vicinity of Sambhar, but it has not been seen in recent years due to the loss of dry forest around the lake [45–47]. Baya *Ploceus megarhynchus* nests which were commonly seen earlier are rare now due to the chopping of *Acacia* trees. Desert Wheatear *Oenanthe pleschanka* (Fig. 8.11) is also an uncommon bird in the catchment. Degradation of the ecology of watershed and catchment area is clearly reflected by a severe decline in the species-richness of the terrestrial bird communities. The community of water birds had 46 species (11 resident and 35 winter visitor/migrant) belonging to three orders and 12 families, with the largest species diversity in the order Ciconiiformes. Among winter migrants, the Ruff *Philomachus pugnax* (Fig. 8.12) and Kentish Plover had the maximum population while only one River Tern *Sterna aurantia* (Fig. 8.13) was sighted during 2006 [43] (Table 8.4). Indian Stone Curlew *Burhinus indicus* (Fig. 8.14) was seen more and often. Black-winged Stilts *Himantopus him-*

**Fig. 8.12** Ruff *Philomachus pugnax* is a common water bird at the lake. *Courtesy: Sunil Singhal, Kota*


**Fig. 8.13** River Tern *Sterna aurantia* is occasionally sighted. *Courtesy: Sunil Singhal, Kota*

*antopus* were also commonly sighted. Most of the aquatic avian species were seen to emigrate as soon as the salt concentration of the lake water increases. The diversity and population of aquatic avifaunal species (both resident and migratory) greatly depend on the water level of the lake and hence can be monitored as an important lake management tool representing the ecological health of the lake. The declining avifaunal diversity of the Sambhar Lake can be considered an important bio-indicator of the ill health of the lake [10].

**Table 8.4** Waterbirds of Sambhar Lake and satellite wetlands

| S. No. | Common name | Zoological name | *R* |
|---|---|---|---|
| 1 | Graylag Goose | *Anser anser* | WV |
| 2 | Red-crested Pochard | *Rhodonessa (Netta) rufina* | R |
| 3 | Western Gadwall | *Anas strepera* | WV |
| 4 | Spot-billed Duck | *Anas poecilorhyncha* | R |
| 5 | Ruddy Shelduck | *Tadorna ferruginea* | WV |
| 6 | Northern Pintail | *Anas acuta* | WV |
| 7 | Northern Shoveler | *Anas clypeata* | WV |
| 8 | Common Teal | *Anas crecca* | WV |
| 9 | Demoiselle Crane | *Anthropoides virgo* | M |
| 10 | Common Crane | *Grus grus* | M |
| 11 | Chestnut-bellied Sandgrouse | *Pterocles exustus* | R |
| 12 | Eurasian Curlew | *Numenius arquata* | WV |
| 13 | Indian Stone Curlew | *Burhinus indicus* | R |
| 14 | Black-tailed Godwit | *Limosa limosa* | WV |
| 15 | Little Stint | *Calidris minuta* | WV |
| 16 | Temminck's stint | *Calidris temminckii* | WV |
| 17 | Marsh Sandpiper | *Tringa stagnatilis* | WV |
| 18 | Broad-billed Sandpiper | *Limicola falcinellus* | WV |
| 19 | Ruddy Turnstone | *Arenaria interpres* | WV |
| 20 | Common Sandpiper | *Actitis (Tringa) hypoleucos* | W/V |
| 21 | Curlew Sandpiper | *Calidris ferruginea (testacea)* | WV |
| 22 | Green Sandpiper | *Tringa ochropus* | WV |
| 23 | Wood Sandpiper | *Tringa glareola* | WV |
| 24 | Common Redshank | *Tringa tetanus* | WV |
| 25 | Common Greenshank | *Tringa nebularia* | WV |
| 26 | Ruff | *Philomachus pugnax* | WV/PM |
| 27 | Indian Stone Curlew | *Burhinus indicus* | R |
| 28 | Red Phalarope | *Phalaropus fulicarius* | V |
| 29 | Little Ringed Plover | *Charadrius dubius* | WV/R |
| 30 | Kentish Plover | *Charadrius alexandrinus* | WV |
| 31 | Lesser Sand Plover | *Charadrius mongolus* | WV |
| 32 | Red-wattled Lapwing | *Vanellus indicus* | R |
| 33 | Brown-headed Gull | *Larus brunnicephalus* | WV/PM |
| 34 | Black-headed Gull | *Larus ridibundus* | WV/PM |
| 35 | Whiskered Tern | *Chlidonias hybrida* | WV |
| 36 | Gull-billed Tern | *Sterna nilotica* | WV |
| 37 | Little Grebe | *Tachybaptus ruficollis* | R |
| 38 | Black-winged Stilt | *Himantopus himantopus* | R |
| 39 | Pied Avocet | *Recurvirostra avosetta* | WV/PM |
| 40 | Cattle Egret | *Bubulcus ibis* | R |
| 41 | Intermediate Egret | *Mesophoyx intermedia* | R |
| 42 | Little Egret | *Egretta garzetta* | R |
| 43 | Indian Pond Heron | *Ardeola grayii* | R |
| 44 | Greater Flamingo | *Phoenicopterus roseus* | WV |
| 45 | Lesser Flamingo | *Phoeniconaias minor* | WV |

Abbreviation: *R* Resident, *WV* Winter visitor, *PM* Passage migrant

**Fig. 8.14** Indian Stone Curlew *Burhinus indicus* is frequently seen on the lake. *Courtesy: Devendra Bhardwaj*

*Flamingo*: Sambhar Lake is one of the most important wintering grounds for the flamingos in India. The flamingos in Rajasthan have been regularly sighted on two wetlands: Sambhar Lake and Pachpadra Salt Lake at Balotra in Barmer district. Two species of flamingos found in India, namely, the Greater Flamingo *Phoenicopterus roseus* (Fig. 8.15 a–c) and the Lesser Flamingo *Phoeniconaias minor* (Fig. 8.16), frequently visit Sambhar Lake. *P. minor* is a Near Threatened species according to the Birdlife International and IUCN Red Data List (BirdLife International, 2012). During our study period (2006–2010), mixed flocks of Greater and Lesser Flamingos (having >70% of Greater and <30% Lesser Flamingos generally) frequently visited the lake (Fig. 8.17). The Lesser Flamingos were the first ones to leave the lake around the first week of March while Greater Flamingos stayed longer if the lake conditions remained favorable [43]. The reason is that Greater Flamingo is a generalized feeder which can shift to different species of prey if algae are not present while Lesser Flamingo is a specialist feeder of blue-green algae and diatoms and is partial to high-salinity lakes [48]. Low-salinity condensers and reservoirs during and post-monsoon period offer an important source of food, while flamingos avoid salt works during the peak salt season between April and June [49]. A flock of 257 Lesser Flamingos and only eight Greater Flamingos were seen in October 2006. Juveniles were seen with every flock visiting the lake; especially in late February of 2008, about 350 juveniles were seen. During the rainy season of 2006 and 2007, inadequate rainfall in the area adversely affected the population of flamingos. After a good rainfall (>500 mm) in the rainy season of 2008,


**Fig. 8.15** Greater Flamingo *Phoenicopterus roseus* (**a**) adult (**b**) juvenile (**c**) an adult preparing for the flight. *Courtesy: Amish Patel*

the winter of that year witnessed a large number (around 3,000–3,500) of flamingos, consisting of almost 1/3 population of Lesser Flamingos which finally migrated out in early April of 2009 [43]. No flamingos sighting during December 2010 and January 2011 despite good rainfall and adequate water in the lake surprised us. During December 2011 and January 2012, a mixed flock of about 2,000 flamingos were seen wandering on the main lake.

**Fig. 8.16** Lesser Flamingo *Phoeniconaias minor. Courtesy: Niranjan Sant*

**Fig. 8.17** A mixed flock of Greater *Phoenicopterus roseus* and Lesser Flamingo *Phoeniconaias minor* at Deodhani Salt Pans, Sambhar Lake, during winter. *Courtesy: Devendra Bhardwaj*

## Potential Threats to Sambhar Lake

The Sambhar Lake faces multiple conservation-related problems due mainly to the involvement of a large number of stakeholders, yet no effective protection measures have been taken so far to improve the deteriorating ecology of the lake [50–52]. If the situation continues, it might face the fate similar to the Deedwana Lake which has totally disappeared [53]. Currently, major threats to the already diminishing ecology of the lake are as under:

1. *Shrinkage of water spread*: Apart from the harsh climatic conditions, considerable reduction in the water spread of the lake has been caused due to the formation of large number of anicuts on the inflowing rivers by the state irrigation department. Although the recently launched Bisalpur Water Project shall soon replenish the current water crisis in the Sambhar town, it is unlikely to have any positive impact, whatsoever, on the ecology of the lake and the surrounding forest cover.
2. *Siltation and disturbances in the lake bed*: The main lake bed has been badly exploited for procuring soil by the villagers in the southwest part toward Nawa in Nagour district. Due to change in the nature of lake bed, a large amount of silt blows into the lake and deposits at the bottom. It reduces the brine level and ground water level causing both shrinkage of the lake size and capacity. Trespassing of vehicles through the lake bed further complicates this problem.
3. *Excessive resource utilization*: Since no license is required for salt extraction, the lake has been overloaded for producing as much as 20 times more salt than it could produce annually. According to an estimate, Sambhar Salts Ltd. extracted 50,000 tons of salt in the year 2008 as compared to private manufacturers who extracted 2.8 million tons. In addition, the illegal manufacturers of the salt steal brine via underground pipes by employing turbines.
4. *Altered land use pattern*: Eroded land of the Sambhar catchment area has increased during past seven years since agricultural land as well is being used illegally for salt extraction. These altered land use patterns are mainly due to various anthropogenic pressures which have intensified the process of desertification of Sambhar area by increase in eroded land making it a serious issue of the entire Indian arid zone [54].
5. *Deforestation*: Forest covers are mostly confined to the dissected rocky and hilly areas in a much degraded form. Overgrazing and large-scale tree-cutting of the residual dry forest of *Acacia* and *Prosopis* in the watershed have further led to siltation and sedimentation of the lake. Human settlements of Sambhar and Phulera towns are also fast extending, and urbanization is taking place on a large scale, resulting in a considerably thin forest cover.
6. *Anthropogenic activities*. The most devastating anthropogenic action has been the construction of 12.4-km road from Nawa to Khakarki village near Korsina in the southwest of the lake, dividing the lake bed into two unequal parts (Fig. 8.1). This may severely affect the population of the migratory avifauna and may

diminish the status of this Ramsar Site. In addition, the tourists often visit the lake, being unaware of the ethics of bird-watching, disturb flamingos, and create panic among the flocks even making them leave the place sometimes. Poaching of flamingos and other birds by local hunters, tribes, and villagers continues as a common and age-old malpractice. Recently, there was shocking news of Greater Flamingo chicks being bought at high rates and served in the hotels of Jaipur City (Rajasthan Patrika, dated September 29, 2009, a front-page, top headline). Sambhar Salts Ltd. officials are devoted to their primary job of salt extraction with no unit deployed to take care of the conservation aspects of the lake. The salt industry tries to get rid of the algae present in the brine of reservoirs in their efforts to produce quality salt despite the fact that the algae make the favorite food for flamingos.

## *Legal Aspect of Conservation*

The existing environment laws related to conservation are replete with loopholes which are easily exploited by the profit-minded industrialists who use these loosely worded laws to escape the snare of prohibition placed by the lawmakers.

## *Conservation Efforts by the Government*

Sambhar Lake was chosen as one of the 11 lakes within the "11th Five-Year Plan" of the Government of India under the National Lake Conservation Program (NLCP) for the conservation and beautification of wetlands. "Sambhar Wetland Conservation Project" completed during 2001–2005 by the Forests and Wildlife Department of Government of Rajasthan ended with expenditure of a huge sum of money with no improvement of the ecology of the lake.

## *Suggestions for the Conservation of Sambhar Salt Lake*

The participation of people is important for raising a strong voice against the existing anthropogenic pressures. It is very surprising that the periphery of the nearby Phulera Lake (though, never seen having water during last 5–6 years) is being encroached by land mafia and no one really seems to bother. If implemented, the following solutions would be most appropriate, practical, and cost-effective alternatives in this regard:

1. The conservation planning of the lake has to be done in a carefully planned and phased manner with feedback from experts in which immediate eco-sensitive

**Fig. 8.18** A scenic beauty of Sambhar Lake. *Courtesy: Devendra Bhardwaj*

priority areas shall be categorized [6]. The first priority for conservation should be given to the areas which are worst affected and need immediate attention. The main lake (waterfowl habitat), marshy areas of the lake, dried and cracked bed, and basin of the lake fall in this category. The second preference should be given to the periphery of the lake, where human activities are at its peak which needs to be strictly prohibited in the priority eco-sensitive zones by the government and other responsible stakeholders.

2. The watershed area, which has many satellite freshwater spots (namely, Naliasar water pond, Korsina pond, and Gudha pond) used by the villagers and is home to a variety of geese, duck, common crane, and pelican, should be conserved since potable water is hardly available in the area. To this end, social adaptation for potential response to land/water resource management in the villages and acceptance of alternative land use pattern are also a must.
3. *Dunaliella salina* algae are a great source of ß-carotene and glycerol, while *Spirulina* found in the lake is a well-known source of protein for human consumption. There is a grave need that the ecosystem of the lake should be managed by using its resources scientifically and wisely.
4. The lake may become a wonderful ecotourism destination due to its scenic beauty and unique ecosystem only if developed with well-planned strategies (Fig. 8.18).

## Keoladeo National Park (KNP) or Ghana, Bharatpur

The Keoladeo National Park, better called as the Ghana, is known to have originated from a natural depression which was an evanescent rain-fed wetland [55]. Construction of *Ajan Bund* (a temporary reservoir, locally known as *Kohni Bund*) in the eighteenth century actually marked the beginning of human involvement in the conversion of this natural depression into a permanent waterfowl reserve [56]. Subsequently, several earthen bunds which divide the park into blocks (Fig. 8.19) were constructed with sluice gates to regulate the water level. Excess water passes out via Jatoli after mixing up with Bharatpur city's main flood drain; however, a certain amount of water always remains in the park until it dries up naturally during peak summer.

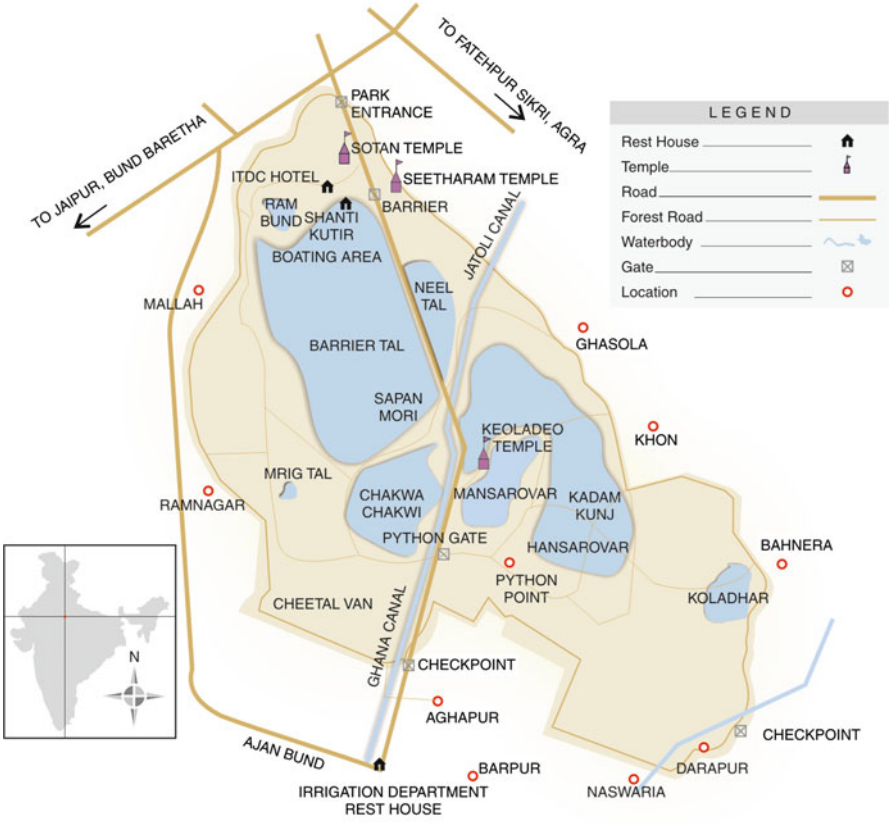


**Fig. 8.19** Keoladeo National Park (KNP), Bharatpur. *Courtesy: Bittu Sehgal, Sanctuary Asia Photo Library*

## *Historical Background*

The name "Keoladeo" refers to Lord Shiva—the Hindu God whose temple is located at the center of the park. The presence of *Kadamb* (*Mitragyna parvifolia*) grooves further proves that the existence of Keoladeo wetland is at least a few centuries old [56]. The park is believed to be a part of River Yamuna which had changed its course during the ancient period [57]. The legend regarding the formation of KNP goes like this—a natural depression developed in 1899 somewhere within the existing KNP area. This area was later developed into a duck shooting reserve by the then Maharaja of Bharatpur toward the end of nineteenth century. When Prince Harbhamji of Morvi State of the erstwhile Gujarat was appointed Administrator of Bharatpur, inspired by the shooting reserves while in England, he got bunds and dykes constructed at KNP toward the latter half of nineteenth century that increased the water-holding capacity of the depression. In 1901, the area was flooded with water through Ajan Bund for the first time. Over a period of time, this area developed into a fine system of fresh-water marshes and began to attract large populations of migratory birds (Box 8.1).

**Box 8.1** Major historical events at KNP

1726–1763: Construction of Ajan Bund on River Gambhiri by Maharaja Surajmal of Bharatpur
1850–1899: "Ghana" was converted into a deer shooting preserve
1899: Conversion of the natural depression into a duck shooting reserve by Prince Harbhamji of Morvi
1901: First ever artificial flooding of the reserve via Ajan Bund
1902: December 02—Formal inauguration of the reserve by Lord Curzon; duck shooting organized on the occasion
1919: Demarcation of the boundaries of the reserve
1925: The Forest Act of Bharatpur was passed and the shikar department brought under the forest department
1938: Lord Linlithgow shot a maximum of 4,273 birds on November 12
1956: "Ghana" was notified as a protected area and named the Ghana Bird Sanctuary
1967: "Ghana" was declared as a reserved forest area under the Rajasthan Forest Act, 1953
1972: Hunting rights of the erstwhile rulers withdrawn
1977–1981: Masonry wall was constructed all around the park
1981: "Ghana" was declared as a Ramsar Site
1981: Ghana Bird Sanctuary was upgraded to a national park and cattle grazing inside the park banned
1985: The park was declared as UNESCO World Heritage site

**Fig. 8.20** Swamp at Keoladeo National Park (KNP), Bharatpur. *Courtesy: Anish Andheria/ Sanctuary Asia Photo Library*

## *Geographical Features*

*Location*: The KNP situated at the confluence of the Gambhiri and Banganga Rivers (27° 07′ 06″–27° 12′ 12″ N latitude and 77° 29′ 05″–77° 33′ 09″ E longitude at an average elevation of 174 msl) is two km southwest of Bharatpur city, 52 km from Agra, and 180 km from Delhi. It is 29-km$^2$ flat with a gentle slope toward the center, forming a depression of submergible area of about 8.5 km$^2$.

*Climate*: KNP experiences extreme climatic conditions. The diurnal temperature varies from 0.5°C in January to 50°C in May. Mean relative humidity ranges from 62% in March to 83.3% in December. Rainfall occurs through the southwest monsoon mainly during July–August. The mean annual precipitation is 662 mm with an average rainfall lasting 36 days per year [58].

*Physical and Edaphic Features*: The KNP area consists of an artificially created flat patchwork of marshes in the Gangetic Plain which is maintained by a system of canals, sluices, and dykes. Normally, water is fed into the marshes twice a year via inundations of the Gambhiri and Banganga Rivers, which are impounded on arable land by means of an artificial dam (Ajan Bund). The bund is usually flooded to the depth of two meters maximum throughout the monsoon season (July–September). From February onward, it begins to dry up and by June, water is seen only in a few pockets (Fig. 8.20). For much of the year, the area of the wetland is 1,000 ha. Soil is predominantly alluvial although some clay formation took place as a result of the periodic inundations [58].

**Fig. 8.21** Waterbirds of Keoladeo National Park nesting on trees. *Courtesy: Devendra Bhardwaj*

## *Biological Diversity*

### I. Floral Diversity and Habitats

The principal vegetation at KNP is of a mixed pattern with xerophytic and semi-xerophytic species predominantly consisting *Acacia nilotica*, *Prosopis cineraria*, *Salvadora oleoides*, *Capparis decidua*, and *C. seperia* [59]. However, *Acacia catechu* and *Anogeissus pendula*, typical of the Bharatpur area, are conspicuous by their absence [60]. Prasad *et al*. extensively studied the flora of KNP [59, 61–63]. Its unique mosaic of habitat types ranges from temporary swamps and potholes which can hold water only for a few weeks to flood plains where water flows over for several months—from land which is wet only during the rains to the land which does not hold even raindrops. Woodlands with thickets are distributed in scattered pockets. The physiognomic types recognized are forest, woodland, scrub woodland, savanna woodland, tree savanna, shrub savanna, low grassland with scattered trees and shrubs, plantations, and wetlands [64]. Each of the major types is further divided into subdivisions according to dominant or characteristic species and based on the density of trees or thickets.

Broadly, the habitat at KNP could be conveniently classified as wetland (11 $km^2$) and terrestrial habitat (18 $km^2$) which include grassland (5 $km^2$) and woodland (13 $km^2$). The wetland constitutes one-third of the KNP and is the lifeline of the park due to its unique biodiversity. It is actually the wetland habitat that attracts thousands of migratory waterfowl (Fig. 8.21). The migratory as well as resident birds

use wetlands for part or entire life cycle. Other than the avian species, variety of microbes, insects, amphibians, reptiles, fishes, and mammals are an integral part of this unique ecosystem. Grassland habitat at KNP is dominated by *khus* grass *(Vetiveria zizanoides)*—a tall coarse grass the roots of which contain an expensive aromatic oil. The grassland provides an excellent habitat for insects, insectivorous birds (roller, drongo, and flycatcher), francolin, quail, and mammals like Chinkara, Nilgai, and Wild Boar.

*Wetland Vegetation*: The wetlands of KNP are home to more than 90 species of flowering plants of which *Paspalum distichum*, a perennial grass, is the most dominant [61]. The other vegetation includes free floating (*Spirodela polyrhiza*, *Lemna perpusilla*, *Eichhornia crassipes*), rooted with floating leaves (*Nymphaea pubescens*, *N. nouchali*, *Nymphoides cristatum*), unanchored submerged (*Ceratophyllum demersum*, *Utricularia aurea*, *U. stellaris*), rooted submerged (*Hydrilla verticillata*, *Najas minor*, *Potamogeton crispus*), emergent, amphibious (*Eleocharis dulcis*, *Scirpus littoralis*, *Ipomoea aquatica*), and marshland plants (*Caesulia axillaris*, *Eclipta prostrata*, *Echinochloa colonum*).

Prasad *et al*. [59] observed four main plant associations in the KNP wetland, namely, *Hydrilla–Najas* confined to the deepest areas with open water and loose muddy bottom. Common waterfowl species feeding in this habitat are coot, pochard, pelican, cormorant, and darter; *Spirodela–Wolffia* which occur in open-water areas and keep drifting along with the wind. Common waterfowl species in this habitat are Cotton Pygmy Goose and Common Coot; *Paspalum–Ipomoea* found in shallow water areas and moist soil. Common wetland species are Garganey, Purple Moorhen, Indian Pond Heron, egrets, geese and *Corchorus–Melochia* found near the dykes and bordering areas of wetlands and uplands, the latter being the major habitat for the Siberian Crane.

*Terrestrial Vegetation*: Land vegetation at KNP is classified as Mitragyna patch consisting of a few patches of *Mitragyna parviflora*; woodland dominated by *Acacia nilotica*, *Ziziphus mauritiana*, and *Salvadora persica*; scrub woodland formed by *Mitragyna parviflora*, *Acacia nilotica*, and *Syzygium cumini*; and undergrowth formed by *Salvadora persica*, *Capparis sepiaria*, and *Prosopis juliflora*. Savanna and other grasslands are formed mainly by grasses such as *Vetiveria zizanioides* and *Desmostachya bipinnata*, mostly in Koladehar area, and *Prosopis cineraria*, *Acacia nilotica*, *A. leucophloea*, *Ziziphus mauritiana*, and *Salvadora persica* are the common trees and shrubs of this habitat. Lowland grassland of *Sporobolus helvolus* and *Cynodon dactylon* occurs in some parts of the KNP with few scattered trees and shrubs such as *A. nilotica*, *P. cineraria*, *S. persica*, and *Kirganelia reticulata*.

*Plantation*: *A. nilotica* and *P. juliflora* were planted by the forest department. *P. juliflora* has spread all over the park, and its extermination is being carried out now as a part of park management. Apart from the above, the park has several saline sandy patches where scattered growth of *S. oleoides*, *S. persica*, and *P. juliflora* is seen. Sparse growth of *Salsola baryosma*, *Suaeda fruticosa*, and *Sporobolus ioclados* are forming the ground cover. Overall, the flora of the park comprises of 375 species of angiosperms [59].

**II. Faunal Diversity**

1. *Invertebrates:* Mahajan *et al*. [65–70] and Vijayan [71] have studied the invertebrates of KNP while Venkataraman [72–74] reported cladocerans of KNP. In fact, macroinvertebrates such as worms, insects, and molluscs are food for the fish and birds and, hence, constitute a major link in the food chain and functioning of this wetland ecosystem [71]. Many aquatic insects spend part of their life inside the water as larvae such as Odonata and Diptera or as larvae and adults such as Coleoptera and Hemiptera. Aquatic insects at KNP include bugs, beetles, striders, swimmers, chironomid larvae, and nymphs of dragonflies and damselflies. The Tortoise Beetle (*Cassida circumdata*) along with its larvae devours leaves of the weed *Ipomoea aquatica* and checks its growth to a certain extent in the autumn and winter. Land insects are in abundance and have a positive effect on the breeding of land birds. Palot and Soniya [75, 76] reported 40 species of butterfly whereas Trigunayat and Singh [77] listed 35 species from KNP. Mehra *et al*. [78] added 16 more species making a total of 68 butterfly species at KNP. Palot and Soniya [79] also reported 16 species of Odonates from KNP.
2. *Vertebrates:* The vertebrate diversity of KNP is detailed below:
   (a) *Ichthyofauna:* The fish fauna of the park was studied by Moona [80] and Kumar and Vijayan [81]. There are 43 species of fishes belonging to 8 orders, 16 families, and 31 genera. 37 species enter the park along with the water from inflowing rivers, and six species are breeding residents, namely, *Channa punctatus*, *C. striatus*, *C. marulius*, *Heteropneustes fossilis*, *Clarias batrachus*, and *Colisa fasciata*. With these six species, *Labeo* sp. and *Cirrhinus* sp. are also commonly found in KNP. Kumar *et al*. [82] found that out of the total 46 species collected at KNP, 41 species were recorded from the Banganga–Gambhiri River system which is the main source of water for KNP. Prusty *et al*. [83] accounted 58 species in their studies.
   (b) *Herpetofauna:* Vijayan [71] documented seven species of amphibians, 28 species of reptiles, six species of frog (family Ranidae: four species, family Microhylidae: two species), and one species of toad (family Bufonidae). Out of the 12 species documented in Rajasthan, KNP harbors eight species of anurans [84, 85].

The number of reptiles found in KNP is high considering its size [86] which could be due to its strategic placement bordering the dry semiarid and wet Gangetic Plains. KNP has eight species of lizards and 14 species of snakes [71, 86]. Interestingly, Rajasthan has only 11 species of turtles [87, 88] while KNP alone has seven species. Absence of the Indian Star Tortoise *Geochelone elegans* at KNP may be due to the wet conditions and inundation during monsoon, whereas a high population of the Indian Rock Python *Python molurus* is mainly due to the availability of a protection and abundant food [86].

*Avifauna:* KNP holds a considerable number of birds in its diverse habitat. One of the major conservation values of the park is its role as wintering habitat for a multitude of migratory waterfowl belonging to 21 species [87, 88]. The park also acts as


**Fig. 8.22** Common Teal *Anas crecca. Courtesy: Sunil Singhal, Kota*

**Fig. 8.23** Striated Heron *Butorides striatus*. *Courtesy: Sunil Singhal, Kota*

a staging ground during immigration and emigration of waterfowl from the Palearctic region. KNP remained the only wintering ground for the central population of the Siberian Crane until 2003 [89]. The number of bird species at KNP has crossed 350 with many new additions and sightings in the latter half of the twentieth century [1]. The total count of bird species reviewed in the year 2010 accounted a staggering 398. Few of the magnificent water birds of KNP include Common Teal *Anas crecca* (Fig. 8.22), Striated Heron *Butorides striatus* (Fig. 8.23), Oriental Darter or Snakebird *Anhinga melanogaster* (Fig. 8.24), Great Cormorant *Phalacrocorax carbo* (Fig. 8.25), Purple Swamphen or Moorhen *Porphyrio porphyrio* (Fig. 8.26),


**Fig. 8.24** Oriental Darter or Snakebird *Anhinga melanogaster*. *Courtesy: Sunil Singhal, Kota*


**Fig. 8.25** Great Cormorant *Phalacrocorax carbo*. *Courtesy: Sunil Singhal, Kota*

Ruddy Shelduck *Tadorna ferruginea* (Fig. 8.27), Eurasian Spoonbill *Platalea leucorodia* (Fig. 8.28), Asian Openbill *Anastomus oscitans* (Fig. 8.29), Northern Pintail *Anas acuta* (Fig. 8.30), Purple Heron *Ardea purpurea* (Fig. 8.31), and Painted Storks *Mycteria leucocephala* (Fig. 8.32a, b).

**Fig. 8.26** Purple Swamphen or Moorhen *Porphyrio porphyrio*. *Courtesy: Aditya Roy*

**Fig. 8.27** Ruddy Shelduck *Tadorna ferruginea*. *Courtesy: Sunil Singhal, Kota*

*Mammals:* All in all 28 species of mammals including six species of larger herbivores, namely, Sambar, Chital, Nilgai, Blackbuck (now extinct from KNP), Wild Boar, and feral cattle (now extinct), and six species of carnivores, for example, Golden Jackal, Striped Hyaena, Jungle Cat, Fishing Cat, Common Civet, Smooth–coated Otter occur inside the park [71]. A Panther was reported in the 1960s (Department of Forest, KNP) and was also sighted for few months during 1987 (September)–1988

**Fig. 8.28** Eurasian Spoonbill *Platalea leucorodia*. *Courtesy: Sunil Singhal, Kota*

**Fig. 8.29** Asian Openbill *Anastomus oscitans*. *Courtesy: Sunil Singhal, Kota*

(May) [71]. In 1999, a tigress was sighted inside the park for few months. In February 2011, a young male Bengal Tiger, a habitual wanderer from Ranthambhore National Park, was seen rambling the Bharatpur forests which was later caught and released in the Sariska Tiger Reserve. Blackbuck is now very rare sight (only 1–2 in 2008). Similarly, Hanuman Langurs are of rare sighting at Aghapur checkpost.


**Fig. 8.30** Northern Pintail *Anas acuta* Pair. *Courtesy: Sunil Singhal, Kota*

**Fig. 8.31** Purple Heron *Ardea purpurea*. *Courtesy: Sunil Singhal, Kota*

## *Avifaunal Research at KNP*

The only central population of Siberian Crane (*Leucogeranus leucogeranus*) which visited KNP until the year 2003, in addition to a large congregation of both resident and migratory waterfowls, made KNP an important site for ornithological research. One of the most noticeable prospective studies in the field of wetland ecology was


**Fig. 8.32** (**a**) Nests of Painted Storks *Mycteria leucocephala* at KNP. *Courtesy: Devendra Bhardwaj*. (**b**) A single Painted Stork at the nest. *Courtesy: Urva Sharma, Kota*

conducted by the Bombay Natural History Society (BNHS) for a period of ten years (1980–1990) with financial assistance from US Fish and Wildlife Service and the Ministry of Environment and Forests, Government of India [71]. This study had covered almost all the aspects and components of the KNP. The very first scientific note targeted the information on duck [90] shooting followed by observations [91–93]. The Chapter 15 of *The Fall of Sparrow* (an autobiography of Dr. Salim Ali) described the intense program of bird ringing and migration studies in the late 1950s and 1960s at Bharatpur with the financial support of WHO, MAPS (Migratory Animals Pathological Survey), Smithsonian Institution, and Fish and Wildlife Service of the US Department of the Interior [94–99]. During 1960s, the BNHS continued bird migration-related studies initiated by Dr. Salim Ali [100–102]. Apart from this, KNP has always been the center of attraction for many ornithological projects [89, 103–113]. A systematic listing [114–135] kept on updating KNP avifaunal checklist which has now crossed 350 accounting approximately 70% of the total avifauna of Rajasthan [1]. Mehra *et al.* [136] reviewed the systematic studies of avifauna conducted since early 1900s till early decade of 2000s along with the published records of bird species and prepared a checklist of 398 bird species.

## *Threatened Avifaunal Species of KNP*

KNP was identified as one of the IBAs (Important Bird Areas) under the categories A1 (threatened species), A4i (1% threshold population), and A4iii (≥20,000 water birds) [1]. Fifteen Globally Threatened bird species and 12 Near Threatened species are a part of the avifaunal composition of KNP (Table 8.5). Heronries made by several breeding species of storks, cormorants, herons, egrets, ibises, spoonbills, and darters and a number of ducks, coots, rails, etc. occur much above their 1% threshold numbers. The large congregation of millions of waterfowls marks KNP as a birders' paradise.

## *Siberian Crane Leucogeranus leucogeranus*

The most important species of KNP had been the Siberian Crane—one of the Critically Endangered cranes of the world [137]. Every year, a major part of its western population covered a distance of 6,000 km from Siberia to reach KNP (Bharatpur) [138]. The population of the Siberian Crane visiting the park had declined 100 times since 1960s to 1990s, and from year 2003, there was no sighting at all (Tables 8.6 and 8.7). A few records of their sightings outside the park are available [139]. Vijayan [71] mentioned a single individual at Dihala Jheel, Madhya Pradesh, during 1987–1988. Three Siberian Cranes at Talab-e-Shahi, Dholpur, in January 1990 and two at Urmila Sagar, Dholpur, in February 1990 were seen.

**Table 8.5** List of Globally Threatened and Near Threatened birds of KNP [1]

| S. No. | Species |
|---|---|
| | *Critically Endangered* |
| 1 | White-rumped Vulture (Indian White-backed Vulture) *Gyps bengalensis* |
| 2 | Long-billed Vulture *Gyps indicus* |
| 3 | Siberian Crane *Leucogeranus leucogeranus* |
| 4 | Sociable Lapwing *Vanellus gregarius* and |
| 5 | Red-headed Vulture *Sarcogyps calvusto* |
| | *Vulnerable* |
| 6 | Lesser Adjutant *Leptoptilos javanicus* |
| 7 | Lesser White-fronted Goose *Anser erythropus* |
| 8 | Baer's Pochard *Aythya baeri* |
| 9 | Pallas's Fish Eagle *Haliaeetus leucoryphus* |
| 10 | Greater Spotted Eagle *Aquila clanga* |
| 11 | Eastern Imperial Eagle *Aquila heliaca* |
| 12 | Sarus Crane *Anthroides antigone* |
| 13 | Indian Skimmer *Rynchops albicollis* |
| 14 | Stoliczka's or White-browed Bushchat *Saxicola macrorhyncha* |
| 15 | Dalmatian Pelican *Pelecanus crispus* |
| | *Near Threatened* |
| 16 | Spot-billed Pelican (Gray Pelican) *Pelecanus philippensis* |
| 17 | Darter (Snakebird) *Anhinga melanogaster* |
| 18 | Painted Stork *Mycteria leucocephala* |
| 19 | Black-necked Stork *Ephippiorhynchus asiaticus* |
| 20 | Black-headed Ibis (Oriental White Ibis) *Threskiornis melanocephalus* |
| 21 | Lesser Flamingo *Phoeniconaias minor* |
| 22 | Ferruginous Pochard *Aythya nyroca* |
| 23 | Gray-headed Fish-eagle *Ichthyophaga ichthyaetus* |
| 24 | Cinereous Vulture *Aegypius monachus* |
| 25 | Pallid Harrier *Circus macrourus* |
| | *Endangered* |
| 26 | Black-bellied Tern *Sterna acuticauda* |

## Conservation and Management Issues

Conservation and management aspects of KNP mainly revolve around excessive resource utilization. Removal of fuel wood and fodder by the villagers and grazing continue as one of the major issues. The wading of buffaloes in the water disturbs birds, damages their eggs, and stirs up the mud. To thwart their entry, a brick wall was built around the park, and in 1982, cattle grazing was banned at KNP soon after it was declared a National Park [140]. The main concern, however, is a regular water supply to the park. Another critical issue is excessive growth of *Paspalum distichum* caused due to the ban on buffalo grazing. Uncontrolled spread of the invasive *Prosopis juliflora* at KNP is yet another issue which needs to be tackled seriously.

**Table 8.6** Wintering population of Siberian Cranes in KNP

| | Number of individuals | | | |
|---|---|---|---|---|
| Year | Adult(s) | Juvenile(s) | Total | Reference |
| 1964–1965 | 200 | – | 200 | David [107], Johnsgard 1983 |
| 1969–1970 | 76 | – | 76 | Spitzer 1981 |
| 1974–1975 | 63 | 6 | 69 | Spitzer 1981 |
| 1975–1976 | 61 | 7 | 68 | Sauey [138] |
| 1976–1977 | 57 | 7 | 64 | Sauey [138] |
| 1977–1978 | 55 | 8 | 63 | Sauey [138] |
| 1978–1979 | 43 | – | 43 | Sauey [138] |
| 1979–1980 | 33 | 3 | 36 | Sauey [138] |
| 1980–1981 | 33 | – | 33 | Sauey [138] |
| 1981–1982 | 38 | 6 | 44 | Vijayan [71] |
| 1982–1983 | 36 | 6 | 42 | Vijayan [71] |
| 1983–1984 | 37 | 5 | 42 | Vijayan [71] |
| 1984–1985 | 41 | 7 | 48 | Vijayan [71] |
| 1985–1986 | 37 | 6 | 43 | Vijayan [71] |
| 1986–1987 | 38 | 6 | 44 | Vijayan [71] |
| 1987–1988 | 31 | 3 | 34 | Vijayan [71] |
| 1988–1989 | 23 | 4 | 27 | Vijayan [71] |
| 1989–1990 | 17 | 2 | 19 | Vijayan [71] |
| 1990–1991 | 10 | 1 | 11 | Vijayan [71] |
| 1991–1992 | 6 | 1 | 7 | Department of Forest, KNP |
| 1992–1993 | 5 | – | 5 | Department of Forest, KNP |
| 1993–1994 | – | – | – | Department of Forest, KNP |
| 1994–1995 | – | – | – | Department of Forest, KNP |
| 1995–1996 | 3 | 1 | 4 | Department of Forest, KNP |
| 1996–1997 | 3 | 1 | 4 | Department of Forest, KNP |
| 1997–1998 | 2 | 0 | 2 | Department of Forest, KNP |
| 1998–1999 | 2 | 0 | 2 | Department of Forest, KNP |
| 1999–2000 | 2 | 0 | 2 | Department of Forest, KNP |
| 2000–2001 | 2 | 0 | 2 | Department of Forest, KNP |
| 2001–2002 | 2 | 0 | 2 | Department of Forest, KNP |
| 2002–2003 | 0 | 0 | 0 | Department of Forest, KNP |

*Source*: Department of Forest, Keoladeo National Park, 2008

**Table 8.7** Wintering population of Siberian Cranes outside KNP

| Year | Number of individuals sighted | Place | Reference |
|---|---|---|---|
| 1987 | 1 | Dihala Jheel, Madhya Pradesh | Vijayan [71] |
| Jan 1990 | 3 | Talab-e-Shahi, Dholpur, Rajasthan | Vijayan [71] |
| Feb 1990 | 2 | Urmila Sagar, Dholpur, Rajasthan | Vijayan [71] |

## *The Infamous Water Crisis at KNP*

The region has a history of floods and drought, the frequency of which has changed over the decades, with a decrease in floods and increase in droughts during the 1980s [141–144] and in 2000s. Banganga and Gambhiri Rivers were the sources of

water for Ajan Bund, but Gambhiri remained the only source since 1980s. Further, the water flow of Gambhiri was also reduced owing to the construction of Panchana Dam at upstream. Good monsoon improved the conditions in 1990s, and water to the park was no more a problem. The water issue again resurfaced with the increase in the height of Panchana Dam accompanied with scanty rainfall which resulted in the drying of Gambhiri downstream. As a result, the ponds and reservoirs along the course of the Gambhiri were adversely affected, and the park faced the worst ever water crisis. The issue could be resolved only after two years by getting the water supply from the Govardhan Drain and later by Panchana Dam, but the Siberian Cranes probably remained unaware of the development and never ever arrived again at KNP.

## *Prosopis juliflora Invasion at KNP*

The shortage of water supply along with scanty rainfall made *Prosopis juliflora* spread all over the park. In the year 2007, the park management planned to uproot the invader flora through people's participation by forming Eco-Development Committees (EDCs) in the villages surrounding the park. Till March 2010, about 3/4 of the park was cleared from this species. At present, the mother trees are almost cleared, and the new saplings are being uprooted and burnt in controlled manner. The success, however, would actually depend on the inundation of the park with water.

## *Paspalum distichum at KNP*

The proliferation of yet another unwanted grass—*Paspalum distichum*—has displaced many tuberous macrophytes that form an important food source for the waterfowl. In the past, this grass could be effectively managed via cattle grazing and trampling. Colonization of open-water areas by the grass has caused a significant decline in the population of many species of waterfowl especially diving ducks. Heronries had to be abandoned in areas where the weed took over and the fish population declined as a result.

The wetland ecosystem of Keoladeo has remained stabilized by the constant interaction of the primary producers and the consumers. The cattle (primary consumers), being an integral part of KNP for two centuries, actually helped stabilize the ecosystem and arrested the process of succession. Their exclusion from the park has created a near catastrophe. Bulldozing, burning, and water level manipulation have been attempted to limit the growth of the obnoxious weed, but to no avail. A team of scientists from Bombay Natural History Society, after ten years ecological study of the wetland, has suggested that regulated grazing by cattle should be reintroduced during the peak growing season of *Paspalum.* Prior to 1980, beside grazing their cattle, villagers from the surrounding rural areas removed firewood from the park as well as the roots of *Vetiveria* (*Khus* plant) used for making screens. Cessation of these activities has led to the accumulation of these combustible materials and resulted in frequent fires inside the park. In addition, the unchecked growth of *khus*

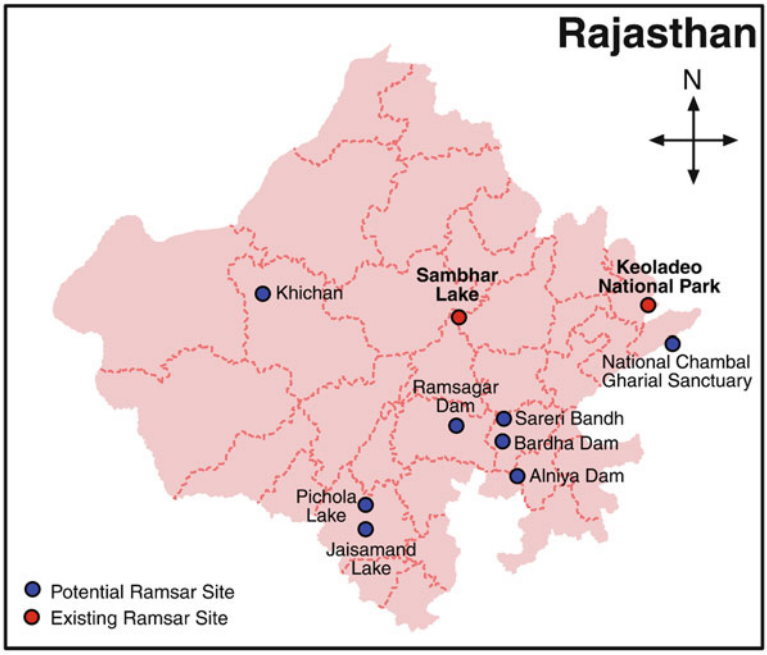


**Fig. 8.33** Existing and potential Ramsar Sites of Rajasthan. (Modified with permission from Islam and Rahmani, 2008 or Reference Number 145). *Courtesy: Drs. Seema Kulshreshtha and B.K. Sharma*

is destroying the habitat of ungulates that require open grasslands with relatively shorter grasses. Keoladeo is illustrative of a wetland where human intervention in the form of biomass removal is important for the well-being of this ecosystem.

## Potential Ramsar Sites of Rajasthan

Some important bird areas have been suggested by Islam and Rahmani [145] for consideration as potential Ramsar Sites on account of their wonderful avifaunal diversity and population. The list includes Khichan, Ramsagar Dam, Alniya Dam, Pichola Lake, Sareri Bandh, Bardha Bandh, Jaisamand Lake, and the National Chambal Sanctuary (Fig. 8.33). Please also see Chap. 2 from *Faunal Heritage of Rajasthan: Ecology and General Background of Vertebrates*, Vol. 1; B. K. Sharma et al. (eds.), 2013 and Chaps. 1, 18 and 20 from this volume for more pictures and relevant details.

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**Epilogue by the editors** On the occasion of World Wetland Day (February 4), the Ministry of Environment and Forests (MOEF), Government of India's indications toward reviving Siberian Crane breeding project at KNP is a welcome first step for the conservation of this magnificent migratory bird which has altogether stopped visiting the park since 2003. The MOEF plans to develop this project in association with the WWF-India and International Crane Foundation. On the same lines, the MOEF has plans to revive and conserve Sambhar Salt Lake which is spread over an area of 225 sq km. Illegal salt extraction, mining, encroachment, anicut formation and drainage has caused severe shrinkage of the lake reducing its area to 100 sq km. during past decades. The tourism department, Government of India has recently decided to develop Sambhar Lake as a tourist spot which is a welcome first step towards the conservation of this ancient lake.

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# Chapter 9
# Impact of Mass Mortility of Gharial *Gavialis gangeticus* (Gmelin, 1789) on its Conservation in the Chambal River in Rajasthan

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**Abstract** This chapter attempts to elucidate conservation ecology of Gharial and critically examines the impact of mass deaths on the conservation prospects of Gharial in National Chambal Wildlife Sanctuary (NCWLS), Rajasthan. The Gharial *Gavialis gangeticus* is listed as Critically Endangered in the IUCN Red List and is the only surviving species of the crocodilian family Gavialidae, endemic to the Indian subcontinent. Less than 1,400 individuals survive in the wild today, of which less than 200 are breeding-sized adults. On the verge of extinction in mid-1970s, populations in several protected areas have been supplemented with the captive reared Gharial since 1979, as a part of conservation efforts. NCWLS is a tri-state sanctuary, managed separately by the forest departments of Madhya Pradesh, Uttar Pradesh and Rajasthan. Sadly, between December 2007 and March 2008, deaths of 111 Gharial were recorded, mostly from a 40-km long segment of the river, extending from Barahi of district Bhind, Madhya Pradesh, to Udi (downstream Sahson) in district Etawah, Uttar Pradesh. Preliminary veterinary findings point out to toxicants as the cause of deaths, however, their nature, composition, source and pathway to the affected Gharial are not clear. Threats such as proposed modification of river flow by dam construction could acutely reverse conservation gains in what is probably the last viable refuge of the species and also jeopardise survival of the Critically Endangered Painted Roof Turtle, which is also found here.

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## Introduction

Crocodilians are survivors from the great reptilian age and are implicated as "keystone species" that maintain the ecosystem structure and function by their activities. This includes selective predation on fish species, recycling nutrients and maintenance of wet refugia in droughts [1]. The family Crocodylidae belongs to the order Archosauria and is represented by three distinct subfamilies: the Crocodylinae, Alligatorinae and Gavialinae [2]. The members of the recent Gavialinae may have evolved from the long-snout eusuchians in the Eocene and Oligocene Eras between 65 and 57 million years ago. Geographically, the gavialines after originating in the North Africa are believed to have spread to the Indian subcontinent in the east, Europe in the north and as far westwards as North and South America. In the Indian subcontinent, gavialine remains have been found in the Pliocene deposits of the Shivalik Hills as well as from the Narmada Valley [3]. They are, therefore, of considerable scientific interest, not only for their role in the ecology of the region, but also as a window to an ancient geological era as *living fossils*.

The Gharial *Gavialis gangeticus* Gmelin 1789, endemic to the Indian subcontinent, was once abundant and common with an estimated population of 5,000–10,000 in the 1940s. It covered a historic range of 20,000 km$^2$ from the Indus to the Irrawaddy [4]. Currently, it occurs in the Indus, Ganges, Brahmaputra and Mahanadi River systems [5–10]. It is believed that the Gharial is now extinct in Myanmar, Bhutan and Pakistan. In Bangladesh, fewer than 20 individuals may be present [7]. By the mid-1970s, it was on the verge of extinction due to loss of habitat, mortality in fishing nets [11], poaching [8, 12–14] and prevalence of superstitious (*mystical*) beliefs [15, 16]. Until 1995, the population of Gharial was around 1,200 in the Chambal River within the National Chambal Sanctuary [17], 25 Gharial in the Girwa River within the Katarniaghat Wildlife Sanctuary and 30 in the rivers of Nepal [18]. Apart from these, a nonbreeding population of 15 Gharial was reported from Ken Gharial Sanctuary, 32 in Sone Gharial Sanctuary [19] and 42 in River Ramganga in Corbett National Park, Uttarakhand, India [10]. However, since 1999, the Gharial population has shown a dramatic decline throughout its entire range. There were 436 breeding adults in 1997, but by 2006, this number had declined to just 182 (a reduction of 58% over the last 10 years) [20]. The total breeding population of Gharial in the world is now estimated to be less than 200 individuals, making Gharial a Critically Endangered species [20].

## National Chambal Sanctuary

The National Chambal Sanctuary (Fig. 9.1) lies in the three states: Rajasthan, Madhya Pradesh and Uttar Pradesh, stretching from Kota in Rajasthan to the confluence of the Chambal River with the Yamuna in Uttar Pradesh, extending 600 km and encompassing a total area of 63,500 ha; River Chambal is a perennial, clear and fast-flowing river originating in the Vindhya Hill Range, and within the

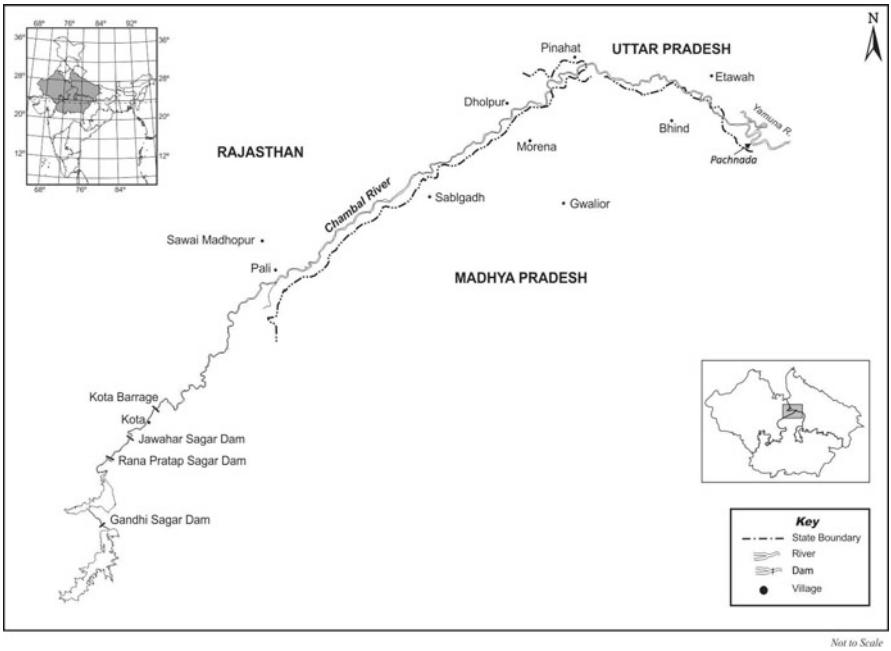


**Fig. 9.1** National Chambal Sanctuary, India

sanctuary, it flows through areas of deeply eroded alluvium, rapids over rock beds, sand banks and gravel bars, along with steep banks and bends [21]. The river averages 400 m in width and 1–26 m in depth. During the monsoon season, the water level rises to 10–15 m and often spreads 500 m from either bank. Maximum and minimum discharges of the river recorded are 54,500 $m^3/s$ and 27,000 $m^3/s$, respectively [9]. Ambient temperatures range from 2°C to 46°C. Annual precipitation largely depends on the south-west monsoon which lasts from the third week of June till early October. Much of the sanctuary area is a ravine thorn forest [22], evergreen riparian vegetation is absent and the severely eroded river banks and adjacent ravine lands have sparse ground cover. Research and conservation management has benefitted the protection of aquatic species such as the Smooth-coated Otter *Lutrogale perspicillata*, Marsh Crocodile *Crocodylus palustris*, Gharial *Gavialis gangeticus*, Gangetic River Dolphin *Platanista gangetica* and several species of turtles. Nearly 150 bird species are reported [23].

Studies on Gharial are scanty, and the only known distribution of the species in Rajasthan is now recorded from the National Chambal Sanctuary. The state of Rajasthan was involved in the countrywide crocodile programme in the late 1970s which resulted in the creation of the National Chambal Sanctuary with the aim to rehabilitate the Gharial. Reintroduction of Gharial and Mugger into the wild in protected areas of Rajasthan perhaps dates back to the late 1960s (Fig. 9.2). Jaipur Zoo of Rajasthan is one of the first zoos in the country to breed Muggers in captivity

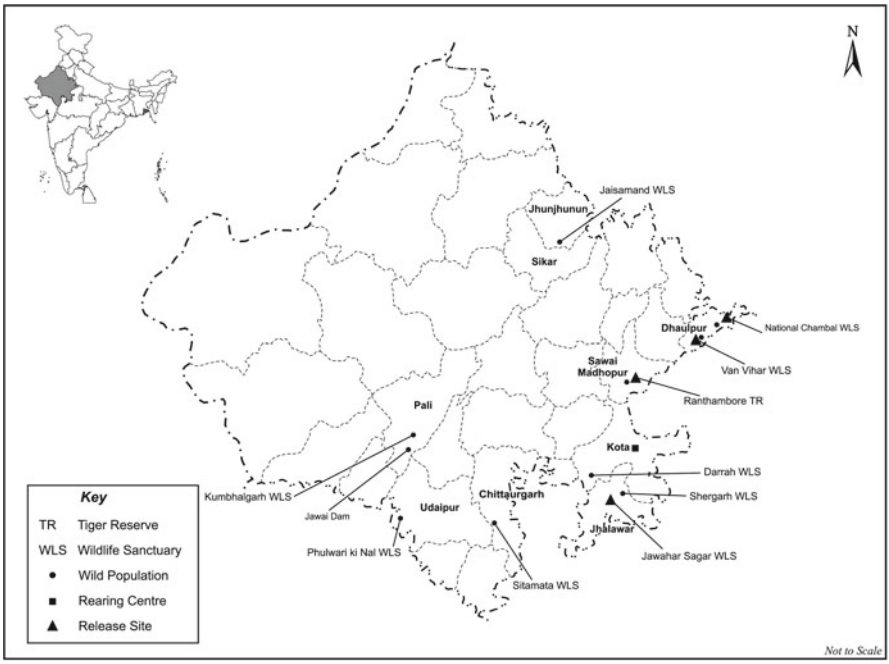


**Fig. 9.2** *Ex situ* and *in situ* conservation sites of Gharial *Gavialis gangeticus* in Rajasthan

successfully. A small Gharial-rearing station was set up at Kota in Rajasthan but ceased to function, once the states of Uttar Pradesh and Madhya Pradesh had set up larger facilities to rear these crocodilians for release into the wild in the Chambal River. Thereafter, Rajasthan has more or less resorted to protection of crocodilians in the wild [24].

The three species of Indian crocodilians are the Mugger or Marsh Crocodile *Crocodylus palustris*, the Salt-water Crocodile *C. porosus* and the Gharial *Gavialis gangeticus.* The Gharial is both taxonomically and structurally unique, being the only living representative of a once well-represented family and having the most attenuated snout of all crocodilians. Gmelin first described the Gharial [25]. Anderson gave the first description of a nest, eggs and young [26], while Hornaday described the habits, vocalisation, excrescence, nesting and the month of April as the laying period [27]. It is interesting to note that the name Gharial is derived from *ghara*, an Indian word for a *pot* because of a bulbous knob (narial excrescence) present at the end of their snout. The *ghara* also renders the Gharial, the only visibly sexually dimorphic crocodilian.

Annandale emphasised on the preference of Gharial for deep fast-flowing rivers [28]. However, adult Gharial has also been observed in still water branches (*jheel*) of rivers surrounded by sand hills [10]. Whitaker and Basu [8] suggested that Gharial show a preference for the comparatively velocity-free aquatic environments of deep *kunds* or holes at river bends and confluences. Smaller animals seem to conserve

energy by resting out of the main stream, in sheltered backwaters, particularly during the monsoon (July–September). Sand and rock outcrops are preferred basking sites, and these animals show considerable site fidelity. A male maintains a *harem* and guards its territory. In general, it has been observed that interspecific aggression is analogous to intraspecific territorialism, with size being the most important determinant of dominance [8]. Mating usually occurs during December and January and nesting from March to May which corresponds to the dry season having lower water level. Crossed snouts are a common feature of courtship behaviour, and the male uses its *ghara* as a hook on the female's snout for leverage when mounting. Martin and Bellaris [29] suggests that the *ghara* on the male's snout maybe an important component of breeding, functioning as a vocal resonator. Steeper sandbanks are used for nesting, although, there are anecdotal references of Gharial-nesting in a muddy bank [30, 31]. It is possible that Gharial are communal nesters, as reported for the Nile Crocodile *Crocodylus niloticus* [31, 32]. Females excavate a *pitcher*-shaped egg chamber of an average 40 cm depth in the sandy banks above the flood line at a distance of 2.5–14.5 m from water and at a height of 1–3.5 m above water [8]. In a single night, a female can lay a maximum of 60 eggs in layers of two or more. Whitaker and Basu [8] suggest that these layers are formed by the action of gravity rather than by a deliberate effort of the female. The eggs are the largest of any crocodilian species [4], weighing an average of 160 g. Prior to actual deposition of eggs, the female exhibits nesting behaviour consisting of movement to the vicinity of nest site, travel over the nest sites and the digging of trial nests. Spoor formation at trial nests confirms that the hind legs are used for digging, although, females have been observed engaged in apparent nest hole digging with their forelimbs. Eggs hatch after 83–94 days [4, 30]. The female Gharial is known to guard her nest and digs up the young in response to hatching chirps, but, unlike many other crocodilians, it does not assist the hatchlings to the water [4]. Crèche formation and protection of young have also been reported [8, 30], and it is speculated that the crèche lasts till the first rise of the river to flood level which generally occurs by the end of July.

The phenomenon of temperature-dependent sex determination (TSD) is found in crocodilians. Unlike genetic sex determination (GSD), the sex of the embryo is determined not by sex chromosomes at fertilisation, but by a critical temperature-sensitive period during incubation. In all crocodilians, the greatest percentage of males is produced around 31–32° C, with more females produced above and below this temperature. However, above 35° C and below 27° C, embryos rarely survive [33]. Whitaker and Basu [8] recorded the range in weight and length of the hatchlings as, 82–130 g and 34–39.2 cm. Singh [34] reported growth rate in Gharial as a metre increase in 12–18 months. Shortt [35] proposed that 4.20 m is the upper limit for female Gharial and well over 5.70 m for male Gharial. Bustard [36] however estimates that the Gharial reaches over 8 m and that 6–7 m animals were once common. Biswas [37] reported the breeding size of female Gharial at c. 2.6 m, while for the male Gharial, a length of over 3 m and an age of 13–14 years. The only longevity record available in literature is from a female Gharial at the London Zoo which died in 1972, at the age of about 29 years and its total length being 3.43 m [8, 29, 38], although, the late maturity and large size of the species suggest a longer life span.

Gharial are known to be the most predominantly fish-eating species of all extant crocodilians. Possession of a strongly attenuated snout and rows of uniform sharp teeth supported by a relatively long, well-muscled neck make it the most efficient fish catcher. Neill [39] and Singh [40] have described the feeding in juvenile Gharial. It usually involves a "sideways snap", wherein the fish is manoeuvred back to the opening of the gullet by jerking its head back to the side; the fish usually slides in the head first. Singh [41] also reported that juvenile Gharial feeding on tadpoles and fish seems to rely more on tactile reception than on sight for catching the prey. Gharial also tear the prey apart by the head jerk technique used by other crocodilians. Whitaker and Basu [8] record that captive juvenile and subadult Gharial are fairly heavy feeders, with larger animals subsisting on proportionately less food and also the rate of consumption is temperature-related. In addition to fish, a variety of prey items for Gharial have been reported, for example, turtles [35, 42] and birds and weeds [43]. Gastroliths have been found in the stomach of Gharial which in some cases were human ornaments rather than stones, giving rise to the controversy that Gharial may have ingested the limbs of their human victims, while authorities maintain that these were facultatively ingested from among riverbed debris. A very large Gharial is easily capable of dispatching a human prey, just like a large-sized estuarine or Nile Crocodile *Crocodylus niloticus*, but the paucity of reports of Gharial attacking mammalian prey like cattle and goats suggests that if true, such instances are very rare indeed.

It is observed that due to feebly developed front feet in Gharial, terrestrial movement is greatly restricted [8]. Hornaday [27] first described the "lazy" sliding gait of the Gharial on land, though Singh and Bustard [44] reported the three gaits (high walk, belly run and gallop) in Gharial up to 10 months of age, as described in Nile Crocodile *Crocodylus niloticus* [32]. Bustard and Singh [45] described the gait of the larger animals as a "forward slide"— pushing with all four limbs. Over the land, movement by Gharial is not likely to occur, but in case of necessity such as accidental isolation in a dry area, short distances can be negotiated by smaller individuals [8]. The heavily muscled tail, well-webbed hind feet and elongated smooth body of Gharial are adaptations for an aquatic existence. Whitaker and Basu [8] account that movement in adult Gharial is local and is more inclined towards the maintenance of the home range, while in juvenile Gharial, the dispersal is predictably longer.

## Conservation priorities for the Gharial in the territories of the state of Rajasthan with special reference to population restoration actions in response to the mass death event

Wildlife conservation is a state subject in India. Although, most of the important Gharial habitats in Rajasthan have been included in the National Chambal Sanctuary, the Gharial range in many areas outside the boundaries of the PAs of the state. Its current status in Rajasthan is not conclusively known. Locations outside the PAs from where Gharial have been reported include the segment of the Chambal

upstream of the Kota in the Jawahar Sagar Dam and adjoining streams [30, 46] between Kota and the upper extremity of the National Chambal Sanctuary at Keshoraipatan and also in the Kalisindh (Basu; unpublished information). Within the National Chambal Sanctuary, 273 Gharials were enumerated along 298 km of the border of Rajasthan-Madhya Pradesh during a boat survey conducted in 2007 (Madhya Pradesh, Forest Department 2007). The mass death event that resulted in the mortalities of 111 adult and subadult Gharials of the National Chambal Sanctuary had a significant effect on the wild Gharial population of the state, with only a single mortality of a juvenile captive reared Gharial recorded during the event. However, it may be recalled that mortalities that have occurred in the segments of the Chambal River along the interstate border due to slackening of PA protection had a consequence on the population in this segment that was no less serious than the mass death event.

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# Chapter 10
# Conservation and Management of Wetland Birds in Rajasthan: Perspectives and Challenges

**Lalitha Vijayan and V.S. Vijayan**

**Abstract** The authors have presented challenges and strategies for wetland conservation in the state of Rajasthan. With only 10.4% area of India, Rajasthan harbours 42% of a total of 1,225 species of birds. Wetland avifauna is also very profound such that 40% of the country's 325 wetland bird species were recorded during a survey of 47 major wetlands outside the protected areas of the state in 2002. Among these wetlands, 24 had one or more threatened bird species and four wetlands had three threatened species each. In all, 624 birds of six Endangered species and 7,713 birds of seven Near Threatened species were sighted. Prioritization of wetlands presented in the text categorizes wetlands as eight internationally important and qualified to be declared as Ramsar Sites, nine nationally important and the rest locally significant wetlands. Recently, 24 sites have been identified as Important Bird Areas (IBAs), including 10 wetlands, some of which are already protected. The loss of 31% wetlands has been alarming in a span of ten years in 13 districts of Rajasthan, which is expected to increase with the rapid pace of development and climate change. Economic value of wetlands has also been mentioned. Conservation threats, namely, habitat loss and degradation and contamination by pesticides and heavy metals, are also highlighted in this chapter. This chapter highlights the need for formulation of a National Wetland Conservation and Sustainable Use Strategy and Action Plan by bringing together the wetland authorities at national, state and village levels comprising members from among all the key stakeholders.

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## Introduction

Wetland birds form one of the interesting components of biodiversity of any locality as they are valuable in several ways, helping the life of people and the environment around us [1]. Besides the direct benefit they accrue, they are considered as one of the best indicators of the environment [2]. The importance of wetlands has been realized for ages, as it is closely associated with life. The origin of human civilizations around the water sources, especially the freshwater wetlands including rivers, lakes, reservoirs, ponds and marshes, stands testimony to this. In the recent times, wetlands have been considered as wastelands without realizing the ecological and economic importance, although wetlands are the most important ecosystems of the world and their productivity is twice that of the tropical rainforest. Six percent of the total surface area of the world is covered by wetlands [3]. Ignorance of their values or no concern about these with more interest in the development programmes, especially urbanization, has caused the disappearance of many wetlands. Loss of wetlands and its degradation has been increasing and poses a serious threat to the existence species of several birds. Recognizing this is an important conservation tool. A global initiative for the conservation of wetlands was taken by the International Union for Conservation of Nature (IUCN) and International Waterfowl and Wetlands Research Bureau (IWRB, at present Wetlands International) which resulted in the Ramsar Convention in 1971, the Convention on Wetlands of International Importance, especially as waterfowl habitats. India is a party to this as well as the Convention on Migratory Species (CMS) which would support the conservation of wetland birds including migrants. India is, thus, bound to protect the wetlands, birds and other biodiversity. However, we have been losing the extent and quality of wetlands which necessitate an urgent action plan based on the ecological, economic and conservation values of the wetlands. It is imperative to generate a database on the wetlands of the state with all information, especially the area, water quality, biodiversity and socio-economic aspects. Attempts have been made to document the wetlands of the country through various ways [4–7]. Space Application Centre [8] mapped the wetlands using remote sensing data and could document the extent of wetlands mostly of 56 ha and above in size. Later, Prasad *et al*. [9] studied the land use in 72 districts selected in ten states and mapped inland wetlands above two hactares in size. They also used the data generated by SAC [8] to obtain a better picture of the inland wetlands in the country with the estimate of 7.00 million ha as against 3.56 million ha by SAC [8].

Waterfowl, one of the key resources of the wetlands and which could be studied easily, has been monitored since 1967 by IWRB and was coordinated later by Asian Wetland Bureau (AWB) for Asia and at present, by Wetlands International Asia Pacific. This was supposed to give trends in the population changes of the waterfowl which could also indicate the health of the wetland (Wetlands International, www.wetlands.org). The National Wetland Programme has envisaged a comprehensive conservation and management programme for the wetlands of the country (Ministry of Environment and Forests, Government of India). The first step in conservation of biodiversity is to assess the resources and identify the important sites and prioritize these [10–13]. Birds were used as the major criteria for prioritizing the sites selected

**Table 10.1** Area of wetlands ($km^2$) in the 13 districts in Rajasthan and variation over a decade (Modified from Vijayan *et al.* [15])

| S. No. | Districts | In 2000–2001 | In 1992–1993 | % loss/gain in a decade |
|---|---|---|---|---|
| 1 | Barmer | 3.33 | 14.82 | 77.53 |
| 2 | Bharatpur | 29.68 | 48.37 | 38.63 |
| 3 | Bhilwara | 74.82 | 186.22 | 59.82 |
| 4 | Chittourgarh | 258.73 | 287.47 | 10.00 |
| 5 | Jaipur | 45.99 | 109.59 | 58.03 |
| 6 | Jaisalmer | 108.86 | 17.88 | +508.84 |
| 7 | Jalore | 1.54 | 35.10 | 95.60 |
| 8 | Jodhpur | 2.20 | 21.06 | 89.55 |
| 9 | Nagour | 13.64 | 24.57 | 44.49 |
| 10 | Pali | 84.78 | 189.93 | 55.36 |
| 11 | Sawai Madhopur | 51.42 | 162.01 | 68.26 |
| 12 | Tonk | 134.36 | 175.84 | 23.59 |
| 13 | Udaipur | 52.26 | 105.30 | 50.37 |
| | Total | 861.61 | 1,378.16 | 37.48 |

for study [14]. The study sites were selected based on the criteria of size derived from the data generated by SAC, Ahmedabad and also data on birds, secondary data from the Asian Waterfowl Counts of 1990s, and consultation with some resource persons. A total of 47 such sites were surveyed in Rajasthan for birds and for use of the resources, assessment of their ecosystem service values, their conservation problems and suggested necessary actions [15].

## Status of Wetlands

The land use statistics of Rajasthan [16] did not depict wetlands as a category, as in other states. The baseline data on the wetlands of size >56 ha was generated by Space Application Centre based on the satellite data of 1992–1993 which showed 1,054 inland wetlands covering an area of 3,449.64 $km^2$ [8]. Land use maps prepared by SACON for 13 selected districts out of 32 districts using remote sensing data of 2000–2001 from IRS LISS III documented 2,135 wetlands >2 ha covering an area of 861.61 $km^2$ is given in Table 10.1 modified from Vijayan *et al.* [15]. The spatial distribution of wetlands (Fig. 10.1) shows that corresponding to the physiographic division of the state, the wetlands in the south-east are many and are prominently clumped in dense clusters. In contrast, in the north-west, they are a few and far apart. The wetlands of Rajasthan include lakes, ponds, playas, reservoirs and waterlogged areas. Seepage wetlands formed as a result of the irrigation from the Indira Gandhi Canal are, yet, another major addition to the wetland types of the state. It was found that the land use and seasonal pattern in water levels varied from district to district in the 13 districts studied (Table 10.1). The area under wetland was the highest in Chittourgarh,

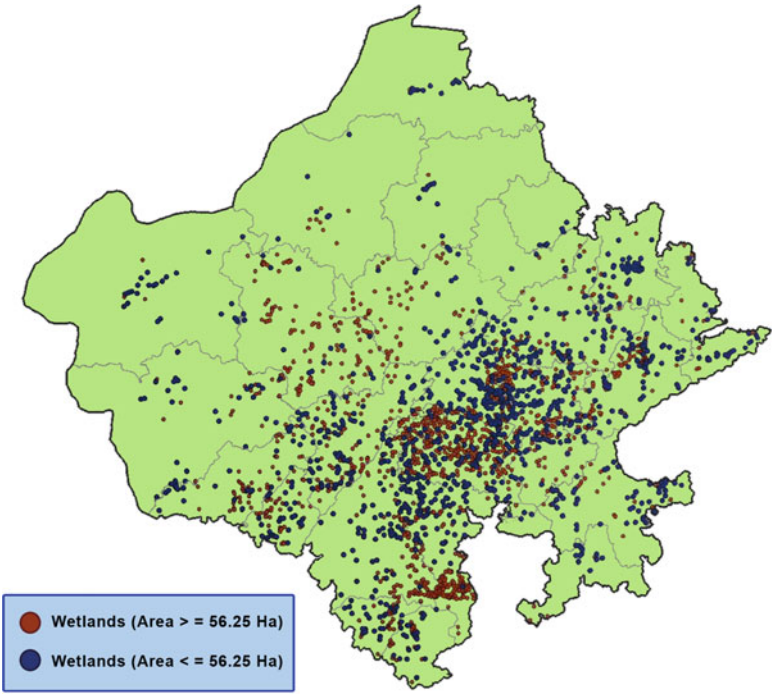


**Fig. 10.1** A map depicting wetlands of Rajasthan

2.41% of the geographical area of the district, followed by Tonk, 1.87% of the district. The extent of wetland was least in Barmer, Jalore and Jodhpur districts, that is, 0.01% in each district. In Jaisalmer, a desert district, significant area (109 km$^2$) was under wetland due to lakes formed by waterlogging from the Indira Gandhi Canal. Ponds and lakes contribute to most of the wetlands in the 13 districts studied. In Chittourgarh, almost all the wetlands were oxbow type. In all these districts, almost all the wetlands were below 56.25 ha in size with the highest number in Chittourgarh (460) followed by Bhilwara (340) and Tonk (334).

## Wetland Birds

The documentation of waterfowl in the country on a wider scale was initiated through the Asian Waterfowl Counts (AWC) conducted since 1967 by the International Waterfowl and Wetlands Research Bureau and later by the Asian Wetland Bureau or the Wetlands International. The AWC has been gaining momentum with more participants covering more number of sites [17]. The data has been compiled and analysed, and the recent analysis for 11 years from 1994 to 2004 [18–21] showed that the number of sites counted varied very much and the same

**Table 10.2** Data from the Asian Waterfowl Counts (*Source*: Lopez and Mundkur [18], Li and Mundkur [19, 20])

| S. No. | Year | Sites | Birds |
|---|---|---|---|
| 1 | 1994 | 28 | 65,708 |
| 2 | 1995 | 19 | 48,022 |
| 3 | 1996 | 10 | 49,500 |
| 4 | 1997 | 1 | 61,031 |
| 5 | 1998 | 1 | 4,831 |
| 6 | 1999 | 23 | 67,720 |
| 7 | 2000 | – | – |
| 8 | 2001 | 15 | 21,877 |
| 9 | 2002 | 10 | 19,526 |
| 10 | 2003 | 11 | 11,343 |
| 11 | 2004 | 10 | 24,103 |

sites were not counted regularly and completely (Table 10.2). There was no definite pattern for the counts as it was done on a voluntary basis without proper coordination, and hence, the data was not very valuable for monitoring the population. It was proposed to have a more coordinated effort to mitigate the problems and generate valuable data by monitoring selected wetlands [19–21]. However, this programme helped in creating awareness and the data provided information on some of the sites as important with large congregations of birds and distribution of species including some of the threatened species. Such information helped in the protection of some sites as Wetlands of National and International Importance (Ramsar Sites) and Important Bird Areas. Two sites in Rajasthan, namely, Keoladeo National Park, Bharatpur, and Sambar Lake were designated as Ramsar Sites in 1983 and 1990, respectively [22].

A more systematic study was conducted by SACON [15] on the inland wetlands as a participatory programme involving various institutions and individuals from different parts of the state with Manoj Kulshreshtha through the Bombay Natural History Society as the State Coordinator of Indian Bird Conservation Network. The fieldwork was done in 47 selected wetlands, mostly outside PAs, during December 2001–February 2002. Birds were identified using Ali and Ripley [23] and Grimmett *et al.* [24]. Data was compiled by the State Coordinator.

Rajasthan, with only 10.4% area of India, has 42% of the 1,225 species of birds of the country. Wetland avifauna also is so rich that 40% of the country's 325 wetland birds were recorded in a study of SACON during 2001–2002. In all, 75,210 birds of 123 species, including four terrestrial species, were recorded in 47 wetlands. The highest population of birds (20,098) was noted at Sardar Samand and the highest species richness (69) at Jawai Dam; 18 species had more than 1,000 individuals, while four species had more than 5,000 individuals. The latter were the Bar-headed Goose (12,355), Coot (8,984), Lesser Flamingo (6,423) and Greater Flamingo (5,537). Most of the waterbirds were migratory and only a few were resident as found in Keoladeo National Park, Bharatpur [25–27], and in the total wetland birds of India [28–30]. Of the 47 wetlands, 24 had one or more threatened

**Table 10.3** Sightings of Threatened and Near Threatened birds in Rajasthan

| S. No. | Species | Number of birds | Number of sites |
|---|---|---|---|
| *I. Threatened species* | | | |
| 1 | Dalmatian Pelican *Pelecanus crispus* | 200 | 7 |
| 2 | Greater Spotted Eagle *Aquila clanga* | 1 | 1 |
| 3 | Lesser Adjutant *Leptoptilos javanicus* | 13 | 2 |
| 4 | Long-billed or Indian Vulture *Gyps indicus* | 80 | 9 |
| 5 | Sarus Crane *Grus antigone* | 149 | 16 |
| 6 | White-rumped Vulture *Gyps bengalensis* | 181 | 9 |
| | Total birds | 624 | 6 |
| *II. Near Threatened species* | | | |
| 1 | Black-bellied Tern *Sterna acuticauda* | 10 | 3 |
| 2 | Black-headed Ibis *Threskiornis melanocephalus* | 722 | 19 |
| 3 | Black-necked Stork *Ephippiorhynchus asiaticus* | 4 | 1 |
| 4 | Ferruginous Duck *Aythya nyroca* | 79 | 4 |
| 5 | Lesser Flamingo *Phoenicopterus minor* | 6,423 | 3 |
| 6 | Oriental Darter *Anhinga melanogaster* | 76 | 1 |
| 7 | Painted Stork *Mycteria leucocephala* | 399 | 17 |
| | Total | 7,713 | 7 |

bird species and four wetlands had three threatened species each (based on BirdLife International) [31]; 624 birds of six threatened species and 7,713 birds of seven Near Threatened species were observed (Table 10.3). Six of the water bodies studied in Rajasthan had more than 1% of the Asian population of one to four species of waterfowl. More than 80% of sites had 20 or more bird species. Six wetlands had more than 50 species while only two wetlands had below 10 species. Little Cormorant and River Tern were the most widely distributed birds, occurring in 40 out of the 47 wetlands surveyed. They are either resident or local migrant, moving according to the availability of water. Other widely distributed species were the Coot (39 wetlands), Black-winged Stilt and Grey Heron (each in 38 wetlands) and Northern Shoveler (37 wetlands).

It has already been reported by Wetlands International in 2006 that the region of Asia holds more globally threatened water bird populations than any other region of the world [21] and in India, they were more in the Indo-Gangetic Plain which includes a part of Rajasthan [15].

## Prioritization of Wetlands

As there are hundreds of thousands of wetlands in India of varying sizes and qualities [32], it is important to prioritize them for conservation actions. Initial attempts for this were through questionnaire surveys by MoEF [5], WWF-India and Asian Wetland Bureau [32] and Samant [7]. However, the exercise conducted by SAC [8] went beyond listing important wetlands of India, but we went a step ahead and mapped them. Detailed information was collected on the wetland resources through

a participatory approach by SACON. We identified and prioritized 47 wetlands in Rajasthan through this exercise. Prioritization was based on the birds as they are considered as the best indicators of the wetland ecosystem [2, 33]. The criteria used were of birds observed in these wetlands, which were similar to some of those of the Ramsar Convention [14] such as (1) total number of species of waterfowl, (2) abundance of waterfowl, (3) species with 1% biogeographic population [34], (4) number of threatened species based on BirdLife International [31, 35], (5) number of Near Threatened species based on BirdLife International [31, 35], (6) abundance of threatened birds, (7) abundance of Near Threatened birds and (8) number of raptors. Besides these, size of the wetland was also considered. Rating was done for each criteria and the total value was considered for ranking the site and, thus, prioritized them [15]. The wetlands were ranked into four categories (Table 10.4). The eight top ranking wetlands with priority ratings of >15 were grouped into the first rank, the next nine in the second rank (ratings of 10–14), another nine in the third rank (ratings of 5–10) and the last 21 in the fourth rank (rating <5). Sardar Samand, Jawai Dam, Kharda Dam, Ranakpur Dam, Alniya Dam, Chandlai Lake, Ummed Sagar (Shahpura) and Bardha bandh (Talera) were the top-raking sites which should be given high priority for conservation. The second set of nine wetlands is important at the national level. Some of the wetlands in the third and fourth ranks should also be considered on priority, as their lower rank was only because of the drought condition that prevailed in the state during the year of census. Earlier records are in favour of their promotion to higher priority.

## Ecosystem Service Values

Wetlands are reported as the most productive ecosystems in the world, and in terms of economic and ecosystem service values, they outweigh the forest ecosystem by about seven times [36]. An estimate shows the extent of wetlands in India to be around 13.1 million ha and the ecosystem service values taking the average global value [37] to be around Rs. 7,151.08 billion per year, and this should be considered as an income to the national budget [36]. The calculations were done based on the published information from United States by Costanza *et al*. [37] and for India by Vijayan *et al*. [15, 36]. The services considered for evaluation are (a) disturbance regulation, (b) waste water treatment, (c) water storage and supply including ground water recharge, (d) cultural, (e) recreation including tourism, (f) habitat refuge, (g) food production, (h) gas regulation, (i) raw materials and (j) water regulation. The estimates are considered in a situation where the ecosystem service is not available and the state has to spend so much money to have such a service, for example, water control, water filtration or removal of pollutants [38, 39].

The available data shows that Rajasthan had around 344,964 ha of wetlands covering lakes, ponds, playas, waterlogged (manmade) and reservoirs [8]. The aggregate minimum ecosystem service values of these wetlands would be around Rs. 234,580 million as per the estimates based on Costanza *et al*. [37] and Vijayan *et al.* [15, 36].

**Table 10.4** Wetland sites prioritized for conservation in Rajasthan (modified from Vijayan *et al*. [15])

| Site | Name of wetland | Rank |
|---|---|---|
| 1 | Sardar Samand | 1 |
| 2 | Jawai Dam | 1 |
| 3 | Kharda Dam | 1 |
| 4 | Ranakpur Dam | 1 |
| 5 | Alniya Dam | 1 |
| 6 | Chandlai Lake | 1 |
| 7 | Ummed Sagar (Shahpura) | 1 |
| 8 | Bardha Bandh (Talera) | 1 |
| 9 | Fateh Sagar | 2 |
| 10 | Kaylana &Takhat Sagar | 2 |
| 11 | RMC Canal (from Simliya 45–65 km) | 2 |
| 12 | RMC Canal seepages (from Kota 7–16 km) | 2 |
| 13 | Mansagar Lake | 2 |
| 14 | Mansarovar (Tahala) | 2 |
| 15 | Bandh Baretha | 2 |
| 16 | Rajsamand Lake | 2 |
| 17 | West Banas Dam (Sarupganj) | 2 |
| 18 | Gajner (palace and village) Tanks | 3 |
| 19 | Jaitpur village Tank | 3 |
| 20 | Ramsagar Bandh (Hindoli) | 3 |
| 21 | Sabla Lake | 3 |
| 22 | Gambhiri Dam | 3 |
| 23 | Patela (Talwara) Lake | 3 |
| 24 | Balsamand | 3 |
| 25 | Mansarovar | 3 |
| 26 | Parvati Sagar | 3 |
| 27 | Sainthal | 3 |
| 28 | Barli village Tank | 4 |
| 29 | Ghosunda Dam | 4 |
| 30 | Sareri Bandh | 4 |
| 31 | Sei Dam | 4 |
| 32 | Ummedganj Tank | 4 |
| 33 | Khajuriya Lake | 4 |
| 34 | Surwal | 4 |
| 35 | Surwania Lake | 4 |
| 36 | Talabeshahi | 4 |
| 37 | Badopal (Suratgarh) | 4 |
| 38 | Bhanda village Tank | 4 |
| 39 | Jaisamand | 4 |
| 40 | Jawaja Lake | 4 |
| 41 | Kalakho | 4 |
| 42 | Pichola Lake | 4 |
| 43 | Ramsagar Lake | 4 |
| 44 | Gadisar Lake | 4 |
| 45 | Mangalsar | 4 |
| 46 | Chadwas village Tank | 4 |
| 47 | Nakki Lake | 4 |

## Threats

Major threats for the conservation of wetlands and wetland birds identified are the loss and degradation of wetlands, overexploitation of resources mainly fishes and vegetation and hunting or poaching of birds [40, 41].

### *Loss of Wetlands*

Loss of wetlands has been reported in various regions in the world [40] and in India because of several reasons [18, 42]. Reduction in the extent of wetlands over a decade (1992–1993 to 2000–2001) in the 13 districts was studied in Rajasthan as estimated from the land use maps [9, 15], and it was about 37% but about 56% in 12 districts. The estimated wetland cover of 1992–1993 [8] had undergone a drastic change, and it is a matter of serious concern. All the districts, except Jaisalmer, had a loss of wetland area, varying from 10 to 96% (Table 10.1). The worst affected districts were Jalore with a loss of 96% followed by Jodhpur (90%). This is of great concern as the situation has been worsening in the last few decades with frequent droughts as reported in Bharatpur affecting the wetlands and the birds adversely [25, 43].

In India, several reasons have been attributed to the loss of wetlands such as reclamation for various development programmes including agriculture, industries, construction of infrastructure, dumping of solid waste, overgrowth of vegetation/weeds and so on [15, 18, 22].

### *Habitat Degradation*

Habitat quality of the wetlands is degraded by various means. Change in the water quality through contamination by pollutants from various sources has been one of the major causes which are explained below. Influx of nutrients from domestic waste and some industries causes eutrophication which could lead to overgrowth of vegetation and changes in the habitat diversity and the total biodiversity. Infestation by weeds, especially alien species such as water hyacinth, *Prosopis juliflora*, has been reported in many wetlands in India and Rajasthan as a major threat [15, 25, 26, 42].

### *Contamination*

Pollution has been the major cause for the degradation of wetlands, especially the quality of water, sediment and the biota, endangering the life of many species of

**Fig. 10.2** Sarus Crane with chick at KNP

birds [44]. Wetlands have been polluted by effluents from industries, domestic sewage, solid waste, fertilizers and pesticides [15, 25, 26]. The levels of heavy metals and residues of pesticides in three wetlands studied showed only lower levels which appear to be safe for human beings and piscivorous birds as well [45–47], but if the same concentrations continue for long, it will exert toxic effects [15]. Misra [48] found residues of organochlorine pesticides in some birds in the Mahala reservoir in Rajasthan, but the levels were not indicative of poisoning. Also the levels recorded in the fishes from Keoladeo NP in 2002 were less than that recorded in the late 1980s [15]. However, poisoning of birds by pesticides has been reported in and around Bharatpur [25, 44, 49]. Sarus Crane *Grus antigone* (Fig. 10.2), one of the common birds in North India, had drastic decline in the population and became globally threatened which might be mainly because of the impact of pesticides [49]. Similarly, other two abundant species, the White-rumped Vulture (*Gyps bengalensis*) and Indian Vulture (*Gyps indicus*), also declined drastically [50, 51] mainly due to veterinary medicine diclofenac [52]. The decline in the population of the Vulnerable Pallas's Fish Eagle *Haliaeetus leucoryphus* [53] could be due to the impact of pesticides as found in the Himalayan Grey-headed (Lesser) Fish Eagle *Ichthyophaga humilis* [54]. Painted Stork breeding seen at KNP, Bharatpur, may come under this threat. It is reported that the annual consumption of pesticides in Rajasthan is about 3,101 Mt which is expected when India is listed as the largest manufacturer and consumer of pesticides in Asia [55]. Two-thirds of the total consumption in the country is of HCH and DDT for agriculture and public health purposes, respectively [56], which are highly persistent and enter into the different levels of food web.

## Conservation Strategies

Conservation and wise use of wetlands requires management planning for which a policy and an action plan have to be evolved [15, 57, 58]. Of the 47 wetlands prioritized, eight wetlands in the first rank are qualified to be declared as Ramsar Sites [15] as per the Ramsar Convention Bureau [14]. Conservation strategies should be evolved based not only on the biodiversity but also on the basis of socioecological uses, as the wetlands are being used by various agencies and the local community. Areas with higher biodiversity values and low to medium use values could be declared as protected areas. Other areas could be protected as conservation areas with sustainable use after a detailed study on the socio-economic problems. Here, the management should be with community participation as suggested earlier [1, 6, 15, 59]. Such areas should be protected and monitored by a committee with representatives of the stakeholders, including government and non-government agencies [15]. Wetlands that have low to medium biodiversity and socio-economic values should also be considered as conservation areas or conservation reserves so that through proper management the biodiversity of the wetland is also eventually enhanced. The sites selected for study by Vijayan *et al*. [15] were based on the earlier data on birds [17, 18]. Hence, the lower conservation values for some sites during this study should be examined to include these also into the higher priority areas for conservation, and necessary immediate conservation action is needed for the prioritized sites. It was suggested [15, 36] that a National Wetland Conservation and Sustainable Use Strategy and Action Plan and a National Wetland Authority be formulated to implement the action plan and to oversee, liaise and initiate appropriate policy legislations and action-oriented programmes. A similar authority is needed at the state and local (*Panchayat*) levels comprising members from all the stakeholders including government and non-government agencies and the public. Please see Chap. 2 from *Faunal Heritage of Rajasthan: Ecology and General Background of Vertebrates*, Vol. 1; B. K. Sharma et al. (eds.), 2013 and Chaps. 1, 8 and 18 from this volume for more pictures.

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# Chapter 11
# Conservation and Management of Demoiselle Crane *Anthropoides virgo* at Kheechan in Rajasthan

**Pushp Jain, Bhojraj Jeenagar, and Satya Narayan Rajpurohit**

**Abstract** This chapter describes a wonderful migratory bird of the western Rajasthan, the Demoiselle Crane. Found at Kheechan village in Jodhpur district, this is the second most abundant population of the world's cranes. The love for Demoiselle Crane and their conservation is engraved in the religion, culture, and attitude of people of Kheechan. This chapter also narrates the history of population of these cranes in 1930s and a tremendous increase of the population to 11,500 (±10%) in the year 2004–2005. Field researches, including first tourism survey done in 2004–2005 and the capacity building document, are discussed in brief. Conservation issues like unscientific management due to ignorance of people about the Demoiselle Crane ecology, lack of scientific research, unorganized tourism, drying up of ponds at times, naked electric cables causing death of some cranes every year, and lack of medical care for sick and injured birds have been discussed in this chapter. Observations and records of more than a decade provide a good insight into the ecology of the Demoiselle Crane at Kheechan. A 10-point action plan for strengthening conservation and scientific management of Demoiselle Crane at Kheechan by the local communities, a pilot study was carried out by WWF India during 2003–2005 to speed up community conservation efforts. Potential suggestions for conservation management plan are also given in this chapter.

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## Introduction

Demoiselle Crane (*Anthropoides virgo*) is the second most abundant crane of the world's cranes after the Sandhill Crane. Its total population is estimated to be between 2,00,000 and 2,40,000, according to "The Cranes, Status Survey and Conservation Action Plan." [1] The three eastern populations of the eastern Asia, Kazakhstan/Central Asia, and Kalmykia are 70,000–100,000, around 100,000, and 30,000–35,000 birds, respectively. The Black Sea population consists of approximately 500 individuals. A disjunct resident population in the Atlas Plateau of northern Africa is believed to include no more than 50 individuals. A small breeding population exists in Turkey. The Kazakhstan or the Central Asian population migrates to the western part of Indian subcontinent via Afghanistan and Pakistan. It arrives in Gujarat, Maharashtra, and Karnataka and in drought years to Madhya Pradesh and Andhra Pradesh states of India. The eastern Asia population migrates via China, crosses over Himalayas, and passing through eastern Indian subcontinent, generally mixes with the birds from Kazakhstan/Central Asia. *En route*, the birds stop at number of places. The Demoiselle Crane's conservation status is "Least Concern" under version 3.1 of IUCN Red List Categories (2012) [2]. The species is listed in Appendix II of CITES. Nevertheless, shrinking and degrading habitats are threats to the species [1].

Kheechan is a village located five kilometers from Phalodi (subdistrict headquarters) in the Jodhpur district of Rajasthan state of India (Fig. 11.1). Demoiselle Cranes migrate to the village regularly, and their number is increasing every year owing to a unique community effort of feeding them. During a site visit in February 2004, amazing views of thousands of birds at the Bird Feeding Home (BFH) in the morning (Fig. 11.2) and resting at the village ponds in the afternoon (Fig. 11.3a, b) were testimony that Kheechan is of international natural history importance as quoted by George Archibald, Director, International Crane Foundation, USA, during his visit to the village on February 21, 1996. Birds also roost at the salt pans (Fig. 11.4). It was heartening to know that the local communities feed the birds. The people, though, were not aware of the correct name of the species or where it came from. Tourists were found to drive right to the edge of the BFH, disturbing the birds, making them fly away which would come back when the disturbance stopped. Much information is not available regarding Demoiselle Cranes at Kheechan except an article by Otto Pfister published in the OBC Bulletin, dated December 24, 1996. Interactions with officials of local administration and the forest department did not reveal any additional information.

Thus, to understand the unique conservation efforts of the local communities and see where strengthening is desirable, a Project "Strengthening conservation and management of migratory Demoiselle Crane by local communities at Kheechan village in Rajasthan" laid the foundation for creation of "Community Reserve" which was conceived in collaboration with the World Wide Fund for Nature–India (WWF India) and was implemented during August 2004–February 2006.

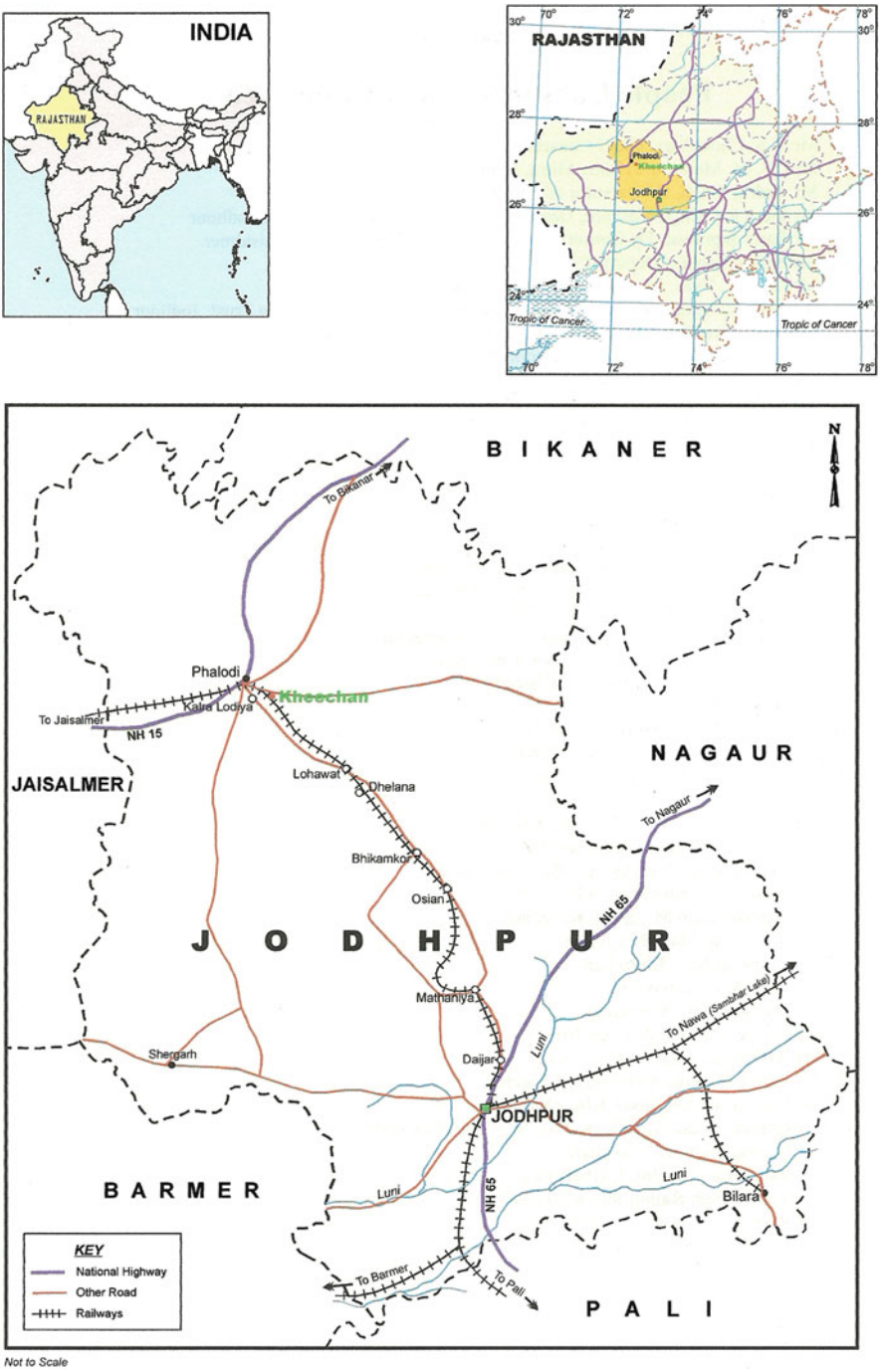


**Fig. 11.1** A map showing land use by Demoiselle Cranes at Kheechan (*Courtesy: Pushp Jain*)

**Fig. 11.2** Demoiselle Crane, *Anthropoides virgo,* in large number at Bird Feeding Home, Kheechan (*Courtesy: Pushp Jain*)


**Fig. 11.3** (**a**) and (**b**) Distant and close views of a group of Demoiselle Crane, *Anthropoides virgo,* resting fearlessly at a Kheechan village pond (*Courtesy B: Sunil Singhal*)

**Fig. 11.4** A typical salt pan where Demoiselle Crane roosts (*Courtesy: Pushp Jain*)

## Materials and Methods

The Team: The team comprised of all the authors and Sewa Ram Mali and Bhagirath Jeengar, both of whom are tourist guides and keen crane watchers.

Project Note: A one-page project note was prepared in the local language and was circulated among the villagers and other stakeholders.

Field Visits: Pushp Jain, Principal Investigator of the project, made the field visits to Kheechan on March 1–2, 2004, to plan activities and October 6–7, 2004, for creating the team and networking. In the year 2005, project consultation on draft action plan as it emerged from the study was considered, while in 2006, post-project visit was made to lobby with the local communities for the creation of a voluntary reserve at Kheechan. All the other team members belonged to Kheechan and carried on project activities throughout the period of project.

## Field Activities

### Discussions with Important Stakeholders

Extensive consultations were held with officials of the forest department, officials of district and subdistrict administration, as well as NGOs/CBOs relevant to Demoiselle Crane management and conservation at Kheechan and village level self-government representatives.

Non-governmental organizations/community-based organizations who had been or are associated with crane management and conservation in Kheechan/Rajasthan:

Mr. S. N. S. Rajpurohit, Founder, Marwar Crane Foundation, Kheechan, Phalodi, District Jodhpur, Rajasthan; Mr. Hanuman Singh Bishnoi, Founder, Kelnsar Vikas Samiti, Kheechan, Phalodi, District Jodhpur, Rajasthan; Prof. S. M. Mohnot (Vriksha Mitra), Founder, School of Desert Science, Jodhpur, Rajasthan; Mr. Ratan Lal Maloo, Pioneering Manager, Bird Feeding Home, Kheechan, Phalodi, District Jodhpur, Rajasthan; Mr. Trilok Chand Gulechha, Sarvodaya Leader, Jodhpur, Rajasthan; Ms. Asha Bothra, Executive Director, Meera Sansthan, Jodhpur, Rajasthan; Brig. Shakti Singh, Manager, HH Maharaja Hanwant Singh Charitable Trust, Jodhpur, Rajasthan; Maharaj Guru Prakash Muniji, Jain Saint, Kheechan; and Akhil Bhartiya Kheechan Jain Sangh, Chennai, Tamil Nadu.

*Panchayati Raj* Institutions (local self-governance institutions)—Kheechan

*Sarpanch* (Head)—Mr. Jyotish Giri; *Up-sarpanch* (Deputy Head)—Mr. Hamid Khan; *Ward Panch* (Member)—Mr. Ghewar Chand Khatik (Kalal); *Ex-Sarpanch* (former Head)—Suresh Jain; and *Ex-Sarpanch* (former Head)—Deepa Ram.

### District and Subdistrict Administration

Mr. Naresh Pal Gangwal, District Collector, Jodhpur; Mr. J. S. Monga, Subdistrict Magistrate, Phalodi; Mr. Man Mohan Singh, Deputy Superintendent of Police, Phalodi; and Mr. K. B. Katta, Additional District Judge, Phalodi.

*Interviews of Villagers*: An effort was made to reconstruct the history of the Demoiselle Crane at Kheechan through informal discussions with old people of the village.

Additionally, an effort was made to understand people's general perception about the conservation of the Demoiselle Crane and gather suggestions for improving conservation management, if any. This was done with a questionnaire, and 25 semi-structured interviews were conducted.

### Demoiselle Crane Count

Demoiselle Crane count (migration season during the year 2004–2005) was done.

### Tourism Survey

Tourism Survey (2004–2005)—A form was prepared to document visitors' names, numbers, nationality, and comments. The survey was carried out at two places by team members, BFH, and the village ponds. The survey at BFH was detailed with filling of forms, while at ponds it was a simple count and recording of category either as Indian or foreigner.

### Capacity Building Document

This document was prepared with the objectives of informing people about:

1. Ecology of Demoiselle Crane: This is largely called out from "The Cranes Status Survey and Conservation Action Plan," compiled by Curt D. Meine and George W. Archibald [2].
2. Uses of *panchayat* land as per the law: To inform the local people about the rules and regulations for *panchayat* land to make them aware about the use or misuse of village land, the extracts from (a) Rajasthan Panchayat Act, 1953, and (b) Rajasthan Panchayati Raj Rules, 1996 [3], were distributed to villagers.
3. Villagers and locals were also informed that hunting these cranes is banned under the relevant sections of the Wildlife (Protection) Amendment Act, 2006 and the penalty there upon is given.
4. Villagers and management of BFH were also informed about the possible impact of pesticides present in grains on grain-eating birds [4].
5. Status quo on land use in Khasra No. 170 at Kheechan: The judgment of the Rajasthan High Court in a Writ Petition No. 4325/96, 2001, ordering maintenance of status quo of the land use in the disputed Khasra No. 170, in view of the land being used by Demoiselle Cranes for resting. The extract from the judgment is presented in the document.
6. Draft action plan to support management and conservation of Demoiselle Crane at Kheechan was prepared.
7. Voluntary community crane conservation area at Kheechan: Guidance for creation of the reserve and a set of rules to start with are enumerated. To inspire the local communities about forming such a reserve, some examples of Community Reserve in India are presented in this document. (Note: This is not proposed as a protected area as defined under the Wildlife (Protection) Amendment Act, 2006).

*Village Level Consultation*: A half day, village level consultation on the draft action plan was organized on 2006 at Kheechan. About 200 villagers participated in the consultations, and several of them openly voiced their views. The consultation helped in finalizing the action plan.

## Results

### *Identification of Major Issues*

- There is a Bird Feeding Home at Kheechan. This is about 300 $m^2$ (50 m × 60 m) of open air enclosed area on the periphery of the village, where grain is spread for the birds to feed. During the migration season, Demoiselle Cranes visit the home every day for feeding. The home is being run largely with donations by the Jain community since the mid-1980s. The institutional arrangement for management of the Bird Feeding Home is weak. It is being solely managed by a 74-year-old man who died very recently. Currently, there is no known second line of management.
- There are several ponds around the village. Demoiselle Cranes use them for drinking water and resting. Water in ponds dries up in case of severe drought. Then the cranes have to fly long distance for drinking water.
- There are live, naked, overground electric cables in and around the village. Scores of cranes die each year due to this.
- Unorganized tourism—There is no regulation of visiting tourists. This results in frequent disturbance to the cranes at feeding and resting places.
- Tourism is having a negative impact on poor kids of the villages, who take it as an opportunity to beg. The kids, to please tourists, throw stones at resting cranes to show the species in flight.
- Indifference of the local and subdistrict administration and forest department toward Demoiselle Crane.

### *Capacity Building Document*

The previously felt need of the stakeholders and local people was fulfilled with the availability of this document. This has proved to be a ready reference whenever there is a discussion about Demoiselle Crane at village or subdistrict level.

### *Demoiselle Crane Count at Kheechan*

An effort was made to do a basic count of Demoiselle Crane at Kheechan and surrounding areas from where it is reported, by the local people. Places covered in the surrounding of Kheechan were water bodies at Malio Ka Banda, Baap, Khara, Kanasar, and Surpura.

In 2005, between 7.00 a.m. and 10.00 a.m., authors concentrated on the visual counting of arriving cranes at Kheechan. (Local information is that during this time of the year, most of the nearby cranes flock at Kheechan.) At the same time, locals counted the cranes remaining at Malio Ka Banda, Baap, Khara, Kanasar, and Surpura.

The total number of Demoiselle Crane, in and around Kheechan, in migration season 2004–2005 was counted to be 11,505 (±10%).

### *Tourism Survey*

A Tourism Survey was carried out in the year 2004–2005 (September to April). The survey reveals that around 12,300 tourists visited Kheechan during the period.

Some important conclusions of the survey were as follows:

- 20 special interest visitors, e.g., photographers, conservationists, and ornithologists, visited Kheechan.
- Ninety percent of the visitors were foreigners, while only ten percent were Indian.
- Tourism at Kheechan is unregulated and unorganized.
- Kheechan attracted the attention of tour operators even before the government tourist organizations could visualize the potential. But there is little tourism literature on Kheechan. Nevertheless, Jodhpur–Jaisalmer–Bikaner–Barmer (The Desert Circuit) has many resorts, hotels, and tour operators. Depending upon the itinerary suggested by them, general tourists visit Kheechan. Special interest visitors, e.g., wildlife photographers, and ornithologists, plan and come prepared especially for Kheechan.
- There are two main areas for crane watching: ponds in the east, where the cranes rest, and the Bird Feeding Home in the west, where the cranes feed in the morning.
- The survey records indicated that during 2004–2005, of the total number of tourists that visited Kheechan, maximum were from the UK. This was followed (in descending order) by visitors from France, Germany, Holland, Belgium, and Switzerland, and a few tourists visited from USA, Australia, Israel, Czech Republic, Thailand, and Taiwan also. There had been, on occasion, Indian visitors too.

### *Action Plan*

A 10-point action plan for supporting management and conservation of Demoiselle Crane at Kheechan by the local communities was prepared [5] (Table 11.1).

## Discussion

People living in Rajasthan, particularly in its western part, where Kheechan lies, believe in "*Vasudeva Kutambakam*," i.e., all species living on the earth are part of one family; this is strongly and truly reflected in their religion, and attitude. This is the reason why wildlife is flourishing in this otherwise hostile Thar Desert region where sustenance is difficult for human beings themselves. Even in the situation of

**Box 11.1** Roosting of Cranes Around Kheechan

For the implementation of the project, two private visits (2006 and December 2008) to Kheechan were made. Team comprised of Dr. Wolfgang-Martin Boerner (Professor Emeritus and Director, UIC-ECE Communications, Sensing & Navigation Laboratory, Chicago, USA) and Pushp Jain. Dr. Wolfgang is a glob-trotting, serious crane watcher. Bhoj Raj Jeengar and Sewa Ram Mali, previously associated with the project team, also contributed in these visits. We extended our work during these visits, to look at crane roosting sites that could not be studied during the WWF India Project implementation. We explored around the Phalodi *tehsil* and talked to the local people about roosting places of cranes. We came to know that the *tehsil* has a belt of salt-producing areas. A salt area is locally called "Reen," e.g., Guddi Reen, Malar Reen, and Baap Reen. The area starts about 15 km from Kheechan and extends to Baap (about 35 km). Wolfgang has seen Demoiselle Crane breeding areas in Mongolia. He found the Phalodi landscape similar looking. He felt that the salt-producing area also matches with the situation in Mongolia, where there are saltwater lakes.

Wolfgang's one premise was that "cranes arrive at roosting sites before sunset and leave roosting sites before sunrise." He concluded "since cranes arrive at Kheechan much after the sunrise, they must be coming from long distances. Thus, that they are roosting far away, probably at salt pans, is corroborated." Furthermore, according to Wolfgang, "salt pan as a roosting site is ideal for cranes, since they are safe from predation because cats, dogs, jackals, wolfs or leopards do not enter salt pans. There is very little habitation in salt areas, which also suits the cranes."

Sewa Ram during October–November 2008 made five exploratory visits to the Phalodi salt belt to pinpoint the crane roosting sites. He had seen cranes arriving and settling in the Reen areas, but due to disturbance of vehicles and/or salt pan staff, they keep shifting places. The whole team has seen the cranes in large number at Guddi Reen and Malar Tal Reen areas in December 2008. We had meetings with two salt leasers, Mr. Pawan Kumar Baid and Mr. Prem Ratan Paliwal. Their data on salt area are as follows:

- 2,000 leases for salt production
- 15-km-long and 4-km-wide belt
- 10% of area used for production of salt
- No association of salt producers

(These statements have to be verified from independent and official sources.) They also informed that few years ago, only some cranes used to visit the Reen area. In fact, some of the salt producers used to spread grains for them as a cultural/religious practice. Of late their numbers have increased tremendously.

(continued)

**Box 11.1** (continued)

They told us that the roosting of cranes in salt pans has two main impacts:
Wherever the crane's feet fall, salt does not form.
Droppings of crane soil make the salt dirty (inferior quality).
Now salt producers discourage cranes from roosting in salt pans by the following means:

- No more spreading of grain.
- Keep lights on in the pan area.
- Raise a scarecrow in the pan area.
- Fire crackers.

Our findings about the roosting sites of Demoiselle Crane in and around Kheechan can be concluded as follows:

- The cranes used to feed twice a day at the Bird Feeding Home till 2003–2004 migration season (the grain used to be spread twice a day) and would roost at Kheechan ponds. The practice of spreading grain at BFH has been reduced to once, and the Cranes' established feeding routine got disturbed.
- During 2004–2005, we found them roosting at Malion Ka Banda about seven kilometers from Kheechan. This was a sewage wastewater pond. The pond was drained in 2005–2006, and cranes lost this roosting site.
- We were frequently told of cranes roosting at Baap Talab (a big pond). Talking to people there, we found that they were roosting here in 2007–2008 season but none in 2008–2009 seasons.
- During 2008–2009 migration season, Demoiselle Cranes were found to be roosting in salt areas of Phalodi.

From all account, at least during the last five years, crane's roosting areas are constantly changing because of other changes taking place as highlighted above. Quite clearly, there is need to carry out long-term crane ecology study at Kheechan in near future.

drought, people collect donations to make arrangements for water, food, and fodder for wildlife.

Many farmers in the region are reported to pray to God after sowing seeds in the field in the following manner: *Hey God! Give good crops for ants, crows, pigeons, peafowl …sisters, daughters and guests. With their fortune, I may also get a bite*. They do not sow the crop for themselves alone! This clearly indicates the farmers' belief that wildlife has an equal share in the produce. Quite naturally, they are compassionate toward wildlife.

The Demoiselle Crane finds a special place in several of the folk songs and folk love stories of Rajasthan. One famous folk song refers to the Demoiselle Crane as a messenger for lovelorn ladies to their husbands working in faraway lands. Parents call their daughters, departing after marriage to the husband's home, as "Kurjadi." Kurjadi is a pet name for the female Demoiselle Crane here.

**Table 11.1** Action plan for the status survey and conservation of Demoiselle Crane

| S. No. | Action point | Background | Potential implementing agencies |
|---|---|---|---|
| 1 | Ponds<br>(a) Protection of the catchment area: fencing and prevention of further encroachment, and planting of trees<br>(b) Polluted rainwater flow from habitation/encroached area to ponds should be restricted<br>(c) Water availability in the ponds, round the year, should be ensured | (a) Demoiselle Crane may not be totally dependent on water, but they are known to prefer sites which have some water body nearby<br>(b) Cranes drink water at ponds. They also rest near the ponds<br>(c) During severe drought, these ponds dry up<br>(d) The catchment area of the ponds is not protected. It is decreasing and getting denuded of trees due to encroachment and illicit felling | Local administration, irrigation department, village *panchayat*,<br>Marwar Crane Foundation |
| 2 | Village *panchayat* may declare Kheechan a "voluntary community crane conservation area" and form simple rules to regulate tourism and restrict anticonservation land use | (a) Protection of Demoiselle Crane at Kheechan is entirely based on cultural and religious values<br>(b) Erosion of cultural and religious values is taking place all over the country<br>(c) Strong institutional structure for conservation of Demoiselle Crane at Kheechan is not evident | Local communities<br>Village *panchayat* (village local self-governance body) |
| 3 | Jain community should institutionalize management of the Bird Feeding Home and keep a check on the quality of grain fed to the cranes | (a) Mr. Ratan Lal Maloo has been dedicatedly managing the Bird Feeding Home since 1983. He is now 74. He says that his health is not supporting him. He cannot supervise the spreading of grains two times a day. So the grain is now being spread once a day only<br>(b) Mr. Suresh Jain, another face of the Jain community at Kheechan, says that, given the responsibility, he does not have the kind of dedication of Mr. Maloo or the time to devote to the Bird Feeding Home<br>(c) Among the Jain families residing in Kheechan, there is virtually no person who can take up the responsibility of the Bird Feeding Home<br>(d) Present institutional arrangement for the Bird Feeding Home is not known publicly | Jain community |

(continued)

**Table 11.1** (continued)

| S. No. | Action point | Background | Potential implementing agencies |
|---|---|---|---|
| 4 | Medical care of sick and injured cranes | Several cranes get injured and ill, but there is no health-care system in place except whatever indigenous efforts made by the local people | Veterinary Hospital at Phalodi |
| 5 | Scientific study | No scientific study on ecology of the cranes in and around Kheechan could be found. There is no knowledge of the benefits of cranes to local people | Jodhpur University<br>Zoological Survey of India, Wildlife Institute of India, BNHS |
| 6 | Ecotourism—development and management | (a) State tourism department is indifferent to the potential of Kheechan as a natural history site<br>(b) There is need of ecotourism literature/online information on Kheechan and Demoiselle Crane to guide visitors when to go, where to go, how to watch the birds, what to do, and what not to do<br>(c) No infrastructure<br>(d) Proper sign boards are not there<br>(e) There is no site specific ecotourism plan<br>(f) There are no trained guides | State tourism department<br>Village *panchayat*<br>Marwar Crane Foundation<br>Wildlife Institute of India<br>WWF India |
| 7 | Kheechan and Demoiselle Crane fair (between January and February) | (a) The tourist visits depend on the guidance of tour operators, not all of whom are well versed with the birds and ecotourism guidelines | State tourism department<br>Village *panchayat* |
| 8 | Maintenance of *status quo* of important areas used by cranes | There are certain threats which can come under developmental pressures and encroachment | Revenue department<br>Forest department |
| 9 | Plantations | The village common land, river banks, and catchment areas of ponds are getting denuded of trees<br>There is a decrease in density as well number of species | NGOs, horticulture department, village *panchayat*<br>WWF India |

Villagers at Kheechan, too, have similar or rather more love and compassion toward wildlife. It has been a cultural and religious practice of most of the communities at Kheechan to start the day with putting out grains for birds to feed on, according to one's capacity. It has also been a practice to commit certain quantity of grain for birds if a tragedy or a celebration happens in the family.

The practice of feeding birds has been further reinforced due to the presence of the Jain community here which has nonviolence as one of their religious tenets. The Jain community has been at the forefront in the feeding of birds. They manage the Pakshi Chugga Ghar (Bird Feeding Home), where around INR 100.00,00 worth of grain is fed to birds every year, in the recent past.

The need for doing this project arose because these cultural values are getting diluted or dying in many parts of the country. Furthermore, increasing population as well as the greed of man is putting pressure on the land. There is ever increasing encroachment. There is, thus, a need of supplementing/supporting conservation management by the people. Secondly, people at Kheechan hardly know about ecology of the Demoiselle Crane. The information/knowledge background would help them to better appreciate the work they are doing.

Implementation of the project created a feeling in the village and among the local stakeholders that there is much more to the Demoiselle Crane than ritualistic feeding of the birds as a religious practice. The capacity building document complied under the project was circulated among community leaders, NGOs, academicians, local administration, forest department, etc. It fulfills the basic need for information and is being used as a ready reference.

The survey among the villagers, to cull out the history of the crane at Kheechan, revealed that the Demoiselle Crane used to visit in very small numbers (maximum 150, as indicated by one interviewee) until the 1970s.

It was with the introduction of artificial feeding of cranes as a religious practice by an old couple that their numbers started increasing. From 100s in the 1970s, it became 1,000s in 1990s and 11,505 (±10%) in the migration season of 2004–2005.

Crane count and tourism survey, as well as the WWF India's report on the project, provides a baseline from which scientists can build further research. One of the authors, who has been living in the village at the bird feeding site for more than 25 years, has not come across any scientist working here on the crane. Certainly, there is a need for more research, as at global level not many crane scientists and conservationists were updated about the migration of Demoiselle Crane to Rajasthan, let alone Kheechan, as is evident from "The Cranes, Status Survey and Conservation Action Plan, Demoiselle Crane" [2].

To take the process of supplementing conservation management of Demoiselle Crane at Kheechan further, a 10-point action plan has been prepared. The action plan preparation went through the process of drafting based on observations, stakeholder interactions, and survey among the villagers. There was a formal consultation with village communities at a mammoth meeting. One-to-one consultations with government officials, NGOs, and village leaders too were held.

The action plan largely focuses on institutionalization of the management of the Bird Feeding Home, protection of the catchment area of the ponds, and ensuring water availability by linking them to other water sources nearby; ecotourism; village political body may declare Kheechan a "voluntary community crane conservation area" and form simple rules to regulate tourism and restrict anticonservation land use; scientific studies; arrangement for medicinal treatment for ill and injured cranes; popularizing Kheechan by organizing annual fairs; and sensible land use.

Now, the identified stakeholders should initiate the identified actions to support the conservation management at Kheechan in a sensitive manner. Of course, one has to be cautious so as not to disturb or interfere with the communities' ongoing work. Please see Chaps. 2 and 3 from *Faunal Heritage of Rajasthan: Ecology and General Background of Vertebrates*, Vol. 1; B. K. Sharma et al. (eds.), 2013 and Chaps. 14 and 18 from this volume for more pictures.

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# Chapter 12
# Distribution of Sarus Crane *Grus antigone antigone* in Rajasthan and People's Participation in the Protection of its Breeding Sites

**Jatinder Kaur, Anil K. Nair, and B.C. Choudhary**

**Abstract** The chapter describes the history, species distribution, and nesting sites of Sarus Cranes in Rajasthan. The Sarus Crane, once a common bird of rural areas, is now confined to the patches of the rural landscapes. Kota district in southeast and eastern Rajasthan is the only urban township in the country where breeding pairs of Sarus Crane can still be found in the village Ummedganj located 12 km away from the city. The cranes coexist with the rural landscape owing to the religious beliefs associated with it, but present day modernization has brought the focus to economic value which has resulted in the decline of the bird from rural areas. The nests and eggs are being destroyed for various reasons and a need to save the cranes has been realized. By creating awareness and involving farmers and youth, their conservation efforts have already resulted in an increase in the survival rate of the Sarus Cranes in Kota district. Protection groups were formed during the year 2004–2005 as a part of the awareness program run by the authors. The program resulted in the fledging of 18 chicks from 28 nests which was nil during the summer breeding season before the initiation of the project. This awareness and education program in Kota district has proved that involvement of the rural community outside the protected areas is very important to save the breeding habitat and population of Sarus Cranes in the wild in addition to assisting in more scientific studies on their ecology.

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## Introduction

### *Species Account*

Of the 15 species of cranes found in the world today, six are found in India and the Sarus Crane (*Grus antigone*) is the only resident species. Over their entire distribution range, Sarus Cranes utilize natural and man-made wetlands, and are well-known for their ability to live in association with human habitation [1, 2]. In India, people have attributed religious and cultural values to protect Sarus and other cranes.

### *Historical Account*

The Sarus Crane has been documented right from the historical times to pair for life [3] and this feature has made them a symbol of fertility in some parts of northern India. The beginning of Chap. 2 of the famous epic *Ramayana* begins with the author Valmiki's observation of a hunter killing a pair of "*kraunch*" and its mate giving a "heart-rendering distress call" [4]. For a long time, the identity of the bird was in doubt and different opinions on the identity of the bird ranging from curlews to herons to cranes have been given in the literature. Recent investigations have proven without any doubt that the "*kraunch*" was indeed the Sarus Crane [4]. Detailed accounts of pair bonding and nidification can be found in the personal notes of Emperor Jahangir dating back to the seventeenth century [3].

## Distribution of Sarus Crane in India

The Sarus Crane has been recorded from all over the northern and central states of India and present Bangladesh [1, 2]. Historical records indicate that their distribution used to extend from the eastern part of the Indus River in Pakistan to the western limits of the state of Assam through West Bengal and from the Kashmir Valley in the north to the west of the Godavari Delta in the southern part of the subcontinent [5–10]. The Sarus Crane has been seen at the height of 3,500 ft in the Kashmir Valley, and in the Dhauladhar Range of the lesser Himalayas in Dharmsala [7, 11]. Presently outside India and Nepal, the Sarus is a rare visitor to Pakistan and probably extinct in Bangladesh [10, 12, 13]. The fringe areas (areas beyond which the Sarus does not occur) include "Bhandara and Chandrapur districts of Maharashtra; Rewa, Chhatarpur, and Gwalior in MP; regions east of Allahabad in UP; Hissar and Panipat in Haryana; Jodhpur in Rajasthan; and Surat and Valsad in Gujarat" [1]. It is believed to have disappeared from Punjab, Bihar, and West Bengal in recent years (Fig. 12.1). A subspecies was recently recorded in the Dibru-Saikhowa Wildlife Sanctuary, Assam [14] and this sighting constituted a range extension for the subspecies by nearly 500 km to the east.

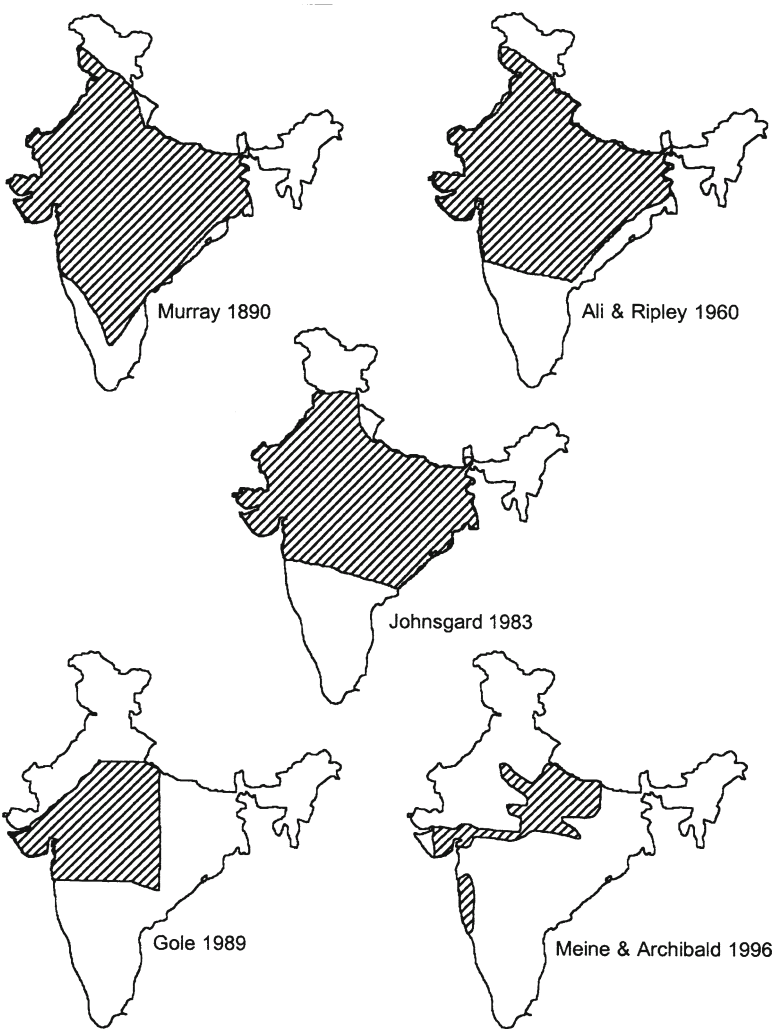


**Fig. 12.1** A shrinkage distribution map of Sarus Crane in India

A study in 1998–1999 suggested a decline in the distribution range [1]. However, countrywide studies showed that the present distribution range of the Sarus Crane is reduced from its historic range, but not to the extent that was surmised [15–18]. Previous reviews showed that distribution of the Sarus varied with season, but later surveys indicate that though there is a seasonal migration from dry areas, Sarus Cranes are mostly resident, and distribution range remains nearly the same throughout the year [16, 18]. From the distribution range of the Sarus Crane as projected after the 1998–1999 in a countrywide survey by Wildlife Institute of India, it can be seen that major populations are now restricted to the belt of eastern and central

Gujarat, southeastern Rajasthan, and central and southwestern Uttar Pradesh. The fringe areas can be defined as follows from the survey report of Wildlife Institute of India:

1. Khatua district in Jammu & Kashmir (32°29′N) forms the northern most region, where Sarus Cranes are recorded in the country. This is weakly continuous with populations in districts of Himachal Pradesh, such as Kangra.
2. Sarus Cranes are well distributed in the *terais* of Uttar Pradesh and their northern most limit in the state was recorded to be at Meerut (29°15′ N). The eastern most record in Uttar Pradesh was in Mau (83°20′ E). Another population, partly discontinuous, to the north comprises the districts of Hisar, Gurgaon, Rohtak, and Panipat in Haryana.
3. Sarus populations were seen in Kutch district of Gujarat (69°34′ N). This forms the western most region of Sarus Crane distribution in the country. The western border extends across Rajasthan state covering Jalor, Pali, and Jodhpur districts.
4. Maharashtra is the southernmost state and, Chandrapur district (20°12′ N) is the southernmost point of Sarus Crane occurrence which extends to the northeast into Raipur district of Chhattisgarh.
5. The eastern most record of Sarus Cranes was from Koochbihar district in West Bengal (89°44′ E). This is, however, Choudhury's record of Sarus Cranes in Assam [14] (95°35′ E) which would, still, form the eastern most occurrence of Sarus Cranes in the country. These sightings are not continuous with the rest of the distribution range as no Sarus Cranes have been sighted at Bihar in the recent years.

The range of the Sarus Crane appears to have extended significantly to the north and marginally to the west [2] (Fig. 12.1). No extensions, however, have been recorded in the south. From the 1998–1989 survey of Wildlife Institute of India [18], no significant difference in distribution was noticed except for the few Cranes from West Bengal (Fig. 12.2). There were, however, significant differences in number of Sarus Cranes sighted between the summer and winter seasons. Sarus Cranes are reported to be mostly resident and their distribution range also remains nearly the same throughout the year [15, 16, 18]. However, in recent surveys conducted in India, both countrywide and local, seasonal migration of Sarus to wet areas from dry areas has been recorded [15, 17, 24]. The overall population status of Indian Sarus Crane has already been determined during the past one and a half year, i.e., from March 1997 to August 1999, through an exhaustive summer season and winter season survey and a very elaborative participatory Sarus Count in June 1999 [27] and continued till the years 2000 and 2002.

## Birdlife and Sarus Crane in Rajasthan

Rajasthan birdlife has been well documented and the Sarus Crane in the state has been recorded since long, with the first known behavioral observations on the species from the Keoladeo Ghana National Park [19]. Sarus Crane in the state has

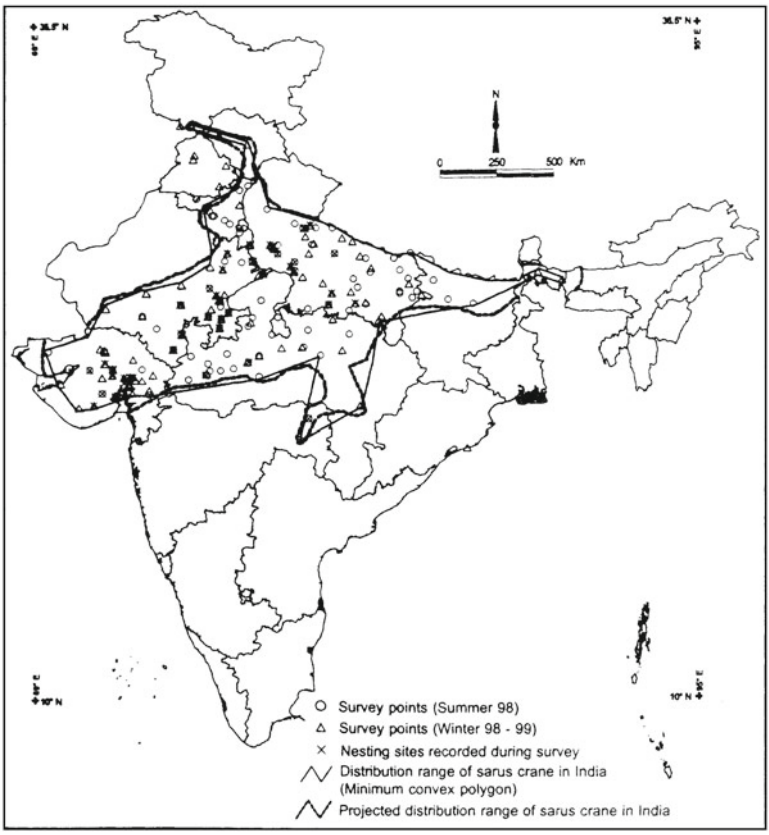


**Fig. 12.2** Distribution range of Sarus Crane (*Grus antigone*) in India

received increasing attention in the past couple of decades, and several works describing local distribution and breeding ecology have made their way to be noticed largely by the BNHS in Keoladeo National Park [20, 21]. The other major work on Sarus in the state has been carried out by the Hadoti Naturalist Society based in Kota and most of their work had been in wetlands around Kota district. Their pioneering work in the state has confirmed eastern Rajasthan in general and the districts of Kota, Bundi, Baran, and Jhalawar to be one of the most densely Sarus-populated areas in the state [22, 23] and these are the only sources of information available from the state where this study conducted some of its intensive investigations.

During the detailed survey conducted by the Wildlife Institute of India in 1998–1999, in 21 districts of the state, 618 individuals of Sarus Cranes were counted of which 253 were counted in the summer and 366 in the winter. Few districts in southeast Rajasthan (namely, Bundi, Kota, Bharatpur, Baran, Jhalawar, and Dhoulpur) and southern Rajasthan (namely, Chittourgarh, Bhilwara, and Banswara) accounted for more than 80% of the species population in the state (Fig. 12.3). The local abundance

**Fig. 12.3** Sarus Cranes *Grus antigone* at River Kalisindh, District Kota. (*Courtesy: Dr. Jatinder Kaur*)

**Fig. 12.4** A pair of Sarus Crane *Grus antigone* with a tiny chick at the nest. (*Courtesy: Mr. Brijmohan Malav*)

of Sarus Crane during both seasons showed that Kota and Tonk were the two districts to record higher counts in summer while other districts showed higher Sarus Crane abundance during the winter period of the survey. More breeding pairs were recorded in winter (29.4%) as compared to summer (20.18%). More families were observed with a juvenile, each in winter ($n=9$) [24] (Fig. 12.4). Districts of

Bhilwara and Banswara have well-knit network of small-medium ponds and large-medium irrigation dams but no intensive study has been done in this part of the state which possesses a viable population of cranes after Kota (Jatinder and Anil Nair; pers. obsv.).

## Methods

The study was conducted for a period of one year but the field work was carried out from February 2007 to May 2008 and our aim was to conduct an awareness program for the Sarus Crane with the involvement of local communities and NGO's. Field visits to important Sarus Crane nesting sites were made every week in all the three districts during the breeding season. The color pamphlets, stickers, and posters in local language were printed for distribution in schools, villages, Government agencies, and local and national NGOs who are working for the conservation of the wildlife. The printed matter helped us to obtain more information from people about Sarus Crane nesting sites and juveniles. People provided the information by making the phone calls and personal visits.

Audio-visual shows and lectures were arranged to explain the breeding biology of the species. Field visits were made for school children, staying close to nearby breeding sites and they were shown the nest. A quiz competition was conducted after the shows, and the prizes were given to the winners. During the field visits and awareness programs, villagers voluntarily came forward to form a rural village Sarus protection group in all the three districts. An award ceremony was organized to felicitate the villagers who dedicatedly worked for the conservation of the species.

## Results and Discussion

The villagers and farmers were instrumental in protecting adult Sarus Cranes from poaching and were responsible for the successful fledging of 80 hatchlings from 62 nests during the wet season of the year 2007–2008 and 19 successful fledglings from 14 nests in the dry season (Table 12.1).

**Table 12.1** Nesting by Sarus Crane during dry (second nesting) and wet season (first nesting) in three districts of semiarid tract of Rajasthan

| | 2007 | 2007 | 2008 | |
|---|---|---|---|---|
| Nesting by Sarus Crane | Dry | Wet | Dry | Total |
| Kota study site | 10 | 33 | 3 | 46 |
| Bundi | 1 | 11 | 0 | 12 |
| Baran | 3 | 18 | 0 | 21 |
| Total | 14 | 62 | 3 | 79 |

## Breeding Success

In dry season of 2007 (Feb–May), a total of 14 nests were observed and most of the nest had two eggs ($n=11$, 78.57%), while only 21.4.2% ($n=3$) of the nests had one egg. For the first time, three juveniles were recorded during the dry season nesting in one of the wetlands. A total of three nests were sighted during 2008 dry season. One pair renested after egg stealing took place.

In wet season of 2007, 62 nests were observed in three districts, while in Kota district a total of 33 nests were sighted, most of the nests had two eggs ($n=27$, 81.81%), and 15.15% ($n=5$) of the nest had one egg each. In one nest three eggs were observed but due to flooding the nest was drowned. Four pairs of Sarus Crane renested after the nests got drowned due to flooding.

A total of 11 nests, in 2007 wet season, were observed in Bundi district and most of the nests had two eggs ($n=9$, 81.81%) and one nest (9.0% $n=1$) had one egg. One pair had abandoned the nest without laying eggs. In Baran district, a total of 18 nests were sighted and most of the nests had two eggs ($n=13$, 72.22%) and $n=5$ had one egg each ($n=5$, 27.77%). One pair renested again after crow destroyed the eggs (Tables 12.2, 12.3 and 12.4).

**Table 12.2** Breeding success of Sarus Crane in three districts during dry Season 2007–2008

| | Nest ($n=14$) | Eggs ($n=25$) |
|---|---|---|
| Hatching success | 14 (100%) | 25 (100%) |
| Fledging success | 12 (85%) | 19 (76%) |

**Table 12.3** Breeding success of Sarus Crane in Kota district during wet season 2007–2008

| | Nest ($n=33$) | Eggs ($n=62$) |
|---|---|---|
| Hatching success | 29 (87.87%) | 47 (75%) |
| Fledging success | 25 (75%) | 43 (69%) |

**Table 12.4** Breeding success of Sarus Crane in Baran district during wet season 2007–2008

| | Nest ($n=18$) | Eggs ($n=31$) |
|---|---|---|
| Hatching success | 17 (94.44%) | 30 (97%) |
| Fledging success | 16 (88.88%) | 23 (74%) |

## Awareness Programs

Based on the studies in 2000–2002 and 2004–2005, to encourage the participation of local people [25] regarding Sarus Crane conservation in Kota district, we extended further work by covering other two additional districts, namely, Bundi and Baran. Five thousand color pamphlets, 3,000 posters, and 2,000 stickers were printed for the distribution, which helped us to obtain more information of the nesting sites and Sarus Crane with juveniles. This kind of educational tool was effective in gathering the information from a wider area and from people who cannot reach directly by any other means [26].

The audio-visual shows, lectures, and a short documentary film on the Sarus Crane showing the nesting season, habitat, threats, and development of the chicks were undertaken. By doing this, misconceptions regarding the cranes, such as, stealing of egg for the egg shells for the treatment of health problem and destruction of crop were removed. These kinds of shows made awareness among villagers and school children regarding the importance of the wetlands and the species. School children residing closer to the breeding sites were taken to the fields to make them practically learn about the protection of the nests and chicks (Fig. 12.5).

**Fig. 12.5** Lecture in progress at a local school for creating awareness among the young minds regarding conservation of Sarus Crane. (*Courtesy: Dr. Jatinder Kaur*)

During our slide shows, people were made aware about Sarus Cranes. Villagers from Kherli informed us that a lot of birds are lying dead in the River Kalisindh. We visited the site and identified the dead birds like Ruddy Shellduck (*Tedorna ferruginea*). The cause of the deaths was found to be the pesticide. Similarly, on the way to Kalisindh River, a family of four Sarus Cranes was also found to be killed by pesticide. State agriculture department needs to increase an awareness among the farmers regarding the use of pesticides. Three deaths of Sarus Cranes were reported due to electrocution. The insulated cable wire should be used to reduce the mortality of large bird such as Sarus Crane.

## Recognition Award to Villagers

During the field visits and awareness programs, local community came forward to form a Rural Village Sarus Protection Group. They ensured that ponds and wetlands used by Sarus Crane for the nesting shall not be disturbed. The individuals gave the information of sighting of the ringed cranes banded in year 2000–2002. A total of 40 Protection Groups, 17 from Kota, three from Baran, and ten from Baran districts were made, who protected the eggs and juveniles from poaching and predation. These grass-root enthusiasts were honored with certificates and T-Shirts and two individuals were recognized by giving away binoculars. The recognition award ceremony was successful due to the active participation of Shri B.C. Choudhry from Wildlife Institute of India, Dehra Dun, Shri Bharat Singh, President, Hadoti Naturalist Society, Kota, and Shri Hada from the state irrigation department gave away the awards to participants from all the three districts on 19 April 2008.

## Conclusion

The more protection groups and education and awareness programs will be required in other Sarus breeding areas in the state. This active network will facilitate improved conservation of the species by reestablishing a bond between farmers and nature. The awareness and education programs have proved that the involvement of the rural community outside the protected area is very important to save the breeding habitat of the Sarus Crane. The involvement of different government agencies and NGO's for a prolonged period is necessary to restore the religious beliefs and to understand the mechanism required to develop the available natural resources for the betterment of the community and the Sarus Crane which have so far coexisted with each other peacefully. Please see Chap. 2 from *Faunal Heritage of Rajasthan: Ecology and General Background of Vertebrates*, Vol. 1; B. K. Sharma et al. (eds.), 2013 for more pictures.

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# Chapter 13
# Conservation Prospects of Smooth-coated Otter *Lutrogale perspicillata* (Geoffroy Saint-Hilaire, 1826) in Rajasthan

**Asghar Nawab**

**Abstract** This chapter attempts to elucidate conservation ecology of Smooth-coated Otter *Lutrogale perspicillata* through a review based on past studies in Rajasthan. Otters are semiaquatic members of the Mustelidae family, and their presence serves as an important biological indicator of wetland quality. Of the five species of otters reported from Asia, three species, namely, Eurasian Otter *Lutra lutra*, Smooth-coated Otter *Lutrogale perspicillata* and the Small-clawed Otter *Aonyx cinereus*, are found in India. The Smooth-coated Otter is the largest and the most common of Asian otters; being distributed throughout India, *L. perspicillata* prefers habitats such as large rivers, lakes and swamps and tends to compete for resources with *A. cinereus* and *L. lutra* when all the three species occur sympatrically. The species is listed as Vulnerable (VU) by the IUCN and is in Appendix II of the CITES and Schedule II (Part II) of the Wildlife (Protection) Amendment Act, 2006. Studies on otters are scanty, and the only known distribution of the species in Rajasthan has been recorded from the "World Heritage site", Keoladeo National Park [Bharatpur] and the National Chambal Sanctuary [Kota]. While some measure of research has been established, the distributional records are largely subjective or are based on chance observations, and as a result, there exists no concrete database for monitoring the population trends of this species. Conservation issues and need for the protection of fauna have been discussed in this chapter.

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## Introduction

Otters are obligately tied to aquatic environments and occupy littoral areas of both freshwater and marine habitats throughout much of the world [1]. They are classified under Lutrinae, one of the subfamilies that belong to the Mustelidae, which also includes the Mustelinae (Weasels and Minks), Melinae (Badgers), Mellivorinae (Honey-badger), Taxidiinae (American Badger) and Mephitinae (Skunks) [2]. Phylogenetically, the otter family tree dates back to the Miocene Era, with otter-like forms represented by genus *Mionictis*, inhabiting the earth as many as 20 Ma ago. Of the 13 species of otters worldwide, the Sea Otter *Enhydra lutris* and Marine Otter *Lutra felina* are restricted to marine environments, the rest 11 inhabit mostly freshwater habitats [3]. Four species of otters are reported from Asia [4]: Hairy-nosed Otter *Lutra sumatrana*, Eurasian Otter *L. lutra,* Smooth-coated Otter *Lutrogale perspicillata* and Small-clawed Otter *Aonyx cinereus*. Of these, the last three are found in India [5–8].

They are small carnivorous mammals and are generally nocturnal and piscivorous in their habits. Otters are suitable indicators of the health of a wetland ecosystem and are sensitive to its degradation, along the food chain [9]. At a high trophic level, they are early victims of poisoning of the food chain with pollutants such as chlorinated hydrocarbon pesticides, heavy metals and organochlorines such as PCBs [10]. Research on otters in Asia dates back to 1988 when the first International Symposium on Asian otters was held in India [11]. Information on the state of otter populations and their habitats in India is scanty, and only a few comprehensive ecological studies on Smooth-coated Otter are available [8, 12, 13]. A few short-term studies have also been conducted [14–18]. Increasingly, otters are being used as a symbol for the survival of healthy aquatic environment, and programmes to conserve otters have gained momentum [19]. WWF-India strives to look into the future of otter conservation efforts in India, so as to provide a strong base in order to facilitate future conservation management of these species.

Studies on otters are scanty, and the only known distribution of the species in Rajasthan has been recorded from the Keoladeo National Park and the National Chambal Sanctuary.

## Keoladeo National Park

Keoladeo National Park sprawls over an area of 29 km$^2$. In 1981, it was declared a Ramsar Site and was upgraded to a national park. Later, in 1985, it was acknowledged as a World Heritage site and an Important Bird Area [20]. One of the richest bird areas of the world, the park supports more than 350 bird species [21]. Other notable wild denizens include Golden Jackal *Canis aureus*, Jungle Cat *Felis chaus*, Fishing Cat *Prionailurus viverrina* and Striped Hyaena *Hyaena hyaena*. Blackbuck

*Antilope cervicapra* and the Siberian Crane *Leucogeranus leucogeranus* have become extinct in recent years. The Smooth-coated Otter *Lutrogale perspicillata* is also found in small numbers. Among reptiles, the Rock Python *Python molurus* is quite common [20]. The flora of the park has been studied extensively [22]. Major threats to the wetland system arise from the paucity of water, illegal grazing and the dependence of neighbouring villages on the park. The growth of *Paspalum* and *Prosopis chilensis* threatens the local vegetation [20].

## National Chambal Sanctuary

The Chambal Wildlife Sanctuary lies in the three states: Rajasthan, Madhya Pradesh and Uttar Pradesh, stretching from Kota in Rajasthan to the confluence of Chambal and Yamuna Rivers in Uttar Pradesh, extending 600 km and encompassing a total area of 63,500 ha. The River Chambal is a perennial, clear and fast-flowing river originating in the Vindhya Hill Range; within the sanctuary, it flows through areas of deeply eroded alluvium, rock beds, sandbanks and gravel bars along with steep banks and bends [23]. The river averages 400 m in width and 1–26 m in depth. During the monsoon season, the water level rises 10–15 m and often spreads 500 m from the either bank. Maximum and minimum discharges of the river recorded are 54,500 $m^3$/s and 27,000 $m^3$/s, respectively [24]. This sanctuary was established to rehabilitate the Gharial. Research and conservation management has also benefited other aquatic species such as the Smooth-coated Otter *Lutrogale perspicillata*, Marsh Crocodile *Crocodylus palustris*, Gangetic Dolphin *Platanista gangetica* and several species of turtles.

The Smooth-coated Otter is distributed throughout southern Asia [5, 25, 49] (Fig. 13.1). Two subspecies have been reported from India [5], that is, *Lutrogale p. perspicillata* in north-east and southern India and *Lutrogale perspicillata sindica* in north and north-western India. In India, the Smooth-coated Otter has the widest distribution in the south from the Himalayas, and in most of the range, it is sympatric with the Small-clawed Otter *Aonyx cinereus* and sometimes also with European Otter *L. lutra* [26]. The Smooth-coated Otter are under Schedule II (Part II) of the Indian Wildlife (Protection) Amendment Act, 2006, listed as Vulnerable by IUCN [27] and included in the Appendix II of the CITES.

The species essentially prefers rivers in plains at low elevations (Fig. 13.2). In the Indian subcontinent, they have adapted to live in the north-western desert, the dry zone of central India and the Deccan Plateau [28]. In general, they occur along the large rivers and lakes and in mangrove forests along the coast and estuaries and even use rice fields for foraging [26, 29]. When occupying saltwater areas, Smooth-coated Otters require freshwater nearby [30, 31]. Along the larger perennial waterbodies in India, they show preference for rocky and sandy stretches in all the seasons, since these stretches provide sites for denning and grooming (Fig. 13.3). River stretches with vegetation on the bank side are favoured, as they provide escape

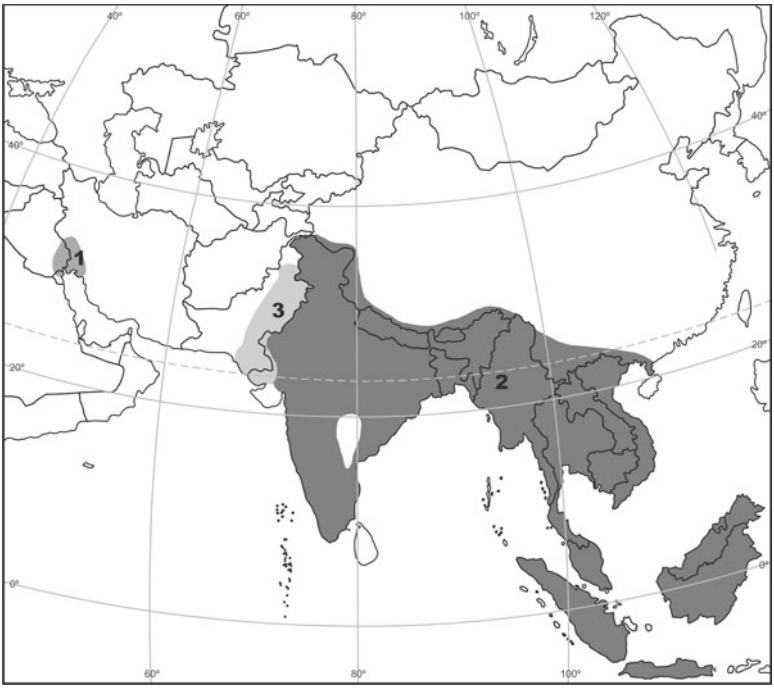


**Fig. 13.1** Distribution of Smooth-coated Otter *Lutrogale perspicillata* in Asia. *1. L. p. maxwelli*, *2. L. p. perspicillata* and *3. L. p. sindica.* (*Source: Hwang & Larivie`re (2005) and Kruuk* (*2006*))

**Fig. 13.2** A group of Smooth-coated Otter *Lutrogale perspicillata* resting under the sun (*Courtesy: Anoop K.R, IFS*)

**Fig. 13.3** Natural rock crevices provide a safe refuge to otters from their predators and often used as den sites

cover while travelling or foraging [8]. In Chambal River, it was found that an adult female with cubs defended a home range of 5.5 km, while the home range for an adult male was estimated 17 km, and the home range of the adult male overlapped extensively with that of several female home ranges [32]. However, studies conducted on Corbett Tiger Reserve, North India [8], recorded smaller home ranges of Smooth-coated Otters, suggesting that otters tend to adapt in their available environment, restricting their movements in patchy and disturbed sites, if the former offers them a suitable habitat.

The Smooth-coated Otter has generally been described as fish specialist. In ponds of Keoladeo NP, 96% of 152 spraints of Smooth-coated Otter contained fish [14]. It has been established that in the Chambal River, otter diet consists mainly of fish [12]. Seven fish species with a mean size of 16 cm were recorded and considered as the "principal diet". Otters are strong swimmers and hunt in groups [31], preferring shallow and placid waters [8]. When fishing, they travel in a V-formation [33]. Most foraging activity occurs in water, and the small fish are swallowed whole [33], but large fish are taken to shore [34]. Spraint sites of Smooth-coated Otter occur on small rocks, sandbanks and large boulders, 1–3 m above water level, and these sites often smell of rotting fish [8, 35] (Fig. 13.4). These animals have been recorded to roll and rub on grassy areas, especially after defecation [36]. When groups of Smooth-coated Otter forage, the commotion may attract birds [33, 35]. However, these interactions may be detrimental to otters because birds attempt to steal fish [33]. In Chambal, Gharial *Gavialis gangeticus*, Mugger *Crocodylus palustris* and Gangetic River Dolphin *Platanista gangetica* live in the same habitat as otters: hence, dietary

**Fig. 13.4** Females of Smooth-coated Otter, when pregnant, start digging dens along river banks and later litter and wean their young ones at these sites

**Fig. 13.5** An otter spraint site

overlap and large-scale interspecific competition are obvious, at least with respect to fish. Further studies on resource partitioning would help understand the level of competition among these sympatric species.

In captivity, Smooth-coated Otters are known to attain sexual maturity at the age of 22 months, and they mate during August to November. Males are polygamous, mating with up to four females [37], and copulation occurs in water, lasting <1 min, followed by prolonged playful bouts between partners [38, 39]. The gestation period varies from 60 to 62 days [37, 38, 40], and a litter of 2–5 pups is born. Smooth-coated Otters often dig their own breeding dens [30, 39] (Fig. 13.5), and a mated pair maintains a small family group with up to four offsprings from the previous seasons [28, 30]. Captive studies suggest that the longest life span of the Smooth-coated Otters is around 20 years and 5 months [41].

## Conservation Implications

### *Otters are not a Priority Species: Lack of Scientific Database*

Otters and their wetland habitats have received considerable attention in the western hemisphere, both from the scientific community and the general public. However, their status in the wetlands of Asia has remained largely unnoticed in many of the range states, despite the presence of four species of otters in the region. Otters have a poor image in Asia, and natural populations have been extirpated through the exploitation of both the animal and its habitat. In India, otters, in general, are becoming increasingly rare outside national parks and wildlife sanctuaries and are threatened in many areas. Most of the distributional records are largely subjective or are based on chance observations, and hence, surveys are incomplete and results inconclusive, and consequently no concrete database exists for monitoring population trends [42].

### *Loss of Habitat: Changing Land Use Practices lead to Fragmentation of Otter Habitats*

Developmental activities, such as construction of dams, adversely affect otter population due to the reduction of water flow downstream denying access to prey and den sites [43]. Changes in prey dynamics has been recorded, as a consequence of waterway obstruction, such as less diversity and small biomass of prey in impoundment upstream of dams due to less nutrient availability and reduction in prey due to blocked migratory routes [44]. Otters also require undisturbed bank side cover for their survival. The depletion of sand from banks decreases the number of sites where otters can groom and bask [8, 45].

### *Excessive Resource Extraction: Depletion of Prey Species*

Otters are often in direct conflict with fishermen who view them as vermin or competitors for fish and kill them [26]. Unimpeded fishing practices using destructive methods, such as dynamiting "ghan" or hammering and use of ichthyotoxic plants to poison fish, are the major threats for otters. This leads to indiscriminate killing of a large number of fish (juvenile as well as broodfish) that adversely affects the population of fish as well as water quality of the rivers [8].

### *Poaching: Otters Dressed to Kill*

Wildlife conservation efforts in India and concern about illegal wildlife trade have largely been concentrated on large fauna such as tigers, leopards, elephants and rhino amidst much public outcry to protect these species. In spite of the general awareness of the trade in wildlife and its derivatives in India, there is a little information on the extent and prevalence of illegal trade in otter skins and consequently the threats to the species. All the three Indian species, namely, Eurasian Otter, Smooth-coated Otter and Small-clawed Otter, have been recorded in trade. Nomadic hunting tribes such as *Gilhara*, *Badiya* and *Jogis* are known to regularly kill otters for their skin and flesh [46, 47]. Seizure figures of wildlife offences in the country reveal that 20–30% of the fur trade comprises of otter skins. The main markets are Kanpur, Lucknow, Kota, Kolkata, Bengaluru and Delhi. The otter fur trade, which is practised in many parts of the world, routes out via Nepal and Tibet to importing countries [48]. Please see Chap. 2 from *Faunal Heritage of Rajasthan: Ecology and General Background of Vertebrates*, Vol. 1; B. K. Sharma et al (eds.) 2013.

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# Chapter 14
# Role of Local People and Community Conservation in Rajasthan

**Neema Pathak and Ashish Kothari**

**Abstract** This chapter describes sacred spaces, protected populations of species, catchment and reserve resource forests, village wetlands, grasslands, institutional dynamics of the conservational efforts, and recommendations for conservation of ecosystems and wildlife in Rajasthan. The last few decades have seen considerable decimation by modern hunting and by "development" projects and processes. Community conservation, today in Rajasthan, has been described in the form of continuation of some traditional practices, e.g., *orans* or sacred groves, protection of species like Blackbuck and conservation of migratory species such as Demoiselle Crane and other waterfowls, regeneration and protection of forests in catchment areas linked to decentralized water harvesting, new protection of heronries or other wildlife congregations, conservation of wetlands with wildlife values, and resistance and protest against destructive activity such as mining. The authors have discussed issues related to limitations of such practices, such as the lack of tenurial security. Since many community conservation initiatives are being implemented on the government land and an aggressive policy of industrialization is being pursued, the need for initiatives of identification, documentation, recognition, and respect for such Community Conserved Areas (CCAs) has been stressed upon.

## Introduction

As one traverses the length and breadth of the country, it is quite common to come across numerous signs and sites depicting the peaceful coexistence of humans and the biodiversity. This is partly due to traditions of tolerance toward the wild and partly because of conscious efforts of people living around these sites to protect the

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wild for religious reasons, traditions, sustainable use, and ecological value. Yet, most discussions on wildlife and biodiversity conservation focus only on officially designated protected areas. This ignores the fact that the oldest form of conservation in the world is what communities have traditionally practiced. Indeed, the most ancient protected areas are the sites that have been kept away from the majority of human disturbance by communities themselves, as in the case of sacred groves. In addition to the above-mentioned widespread community practices of protecting particular species of plants and animals, water catchment forests, village wetlands, and other elements of nature, there is a significant body of conservation initiatives that needs attention and support.

At the international level, and in many countries, these are now being recognized as indigenous reserves, bio-cultural heritage sites, and community reserves. Collectively, they are referred as Indigenous and Community Conserved Areas (ICCAs). Since, the World Parks Congress of 2003 (at which 4,000 conservation scientists and practitioners gathered), the widespread occurrence of ICCAs is increasingly being realized. At the seventh Conference of Parties of the Convention on Biological Diversity (CBD) in 2004, a programme of work on protected areas was formulated, and this, too, included the recognition of ICCAs as a specific action point for all countries to take up [1].

In India, since the term "indigenous" is not officially recognized, the more commonly used terminology for these initiatives is Community Conserved Areas or CCAs which number in thousands here [2]. Largely "hidden" and ignored by professional conservationist till recently, their spread and contribution to biodiversity and wildlife conservation is now becoming clearer. A number of NGOs have been documenting CCAs of various kinds, and policy pronouncements by the government have indicated support for their recognition and backing.

## Community Conservation in Rajasthan [3]

For a variety of reasons, Rajasthan perhaps has one of India's most widespread traditions of community conservation. There is a need to be careful in using relatively scarce natural resources, such as water and forests, and there were strong cultural traditions espousing respect and tolerance for wildlife by the *Bishnoi* community which were (and remain) inspirational. Rulers through the ages also imposed restrictions on the use of resources. In the recent years, committed government officials and NGOs have also been a catalyst.

The following main kinds of initiatives can be discerned:

1. Sacred spaces including forest groves
2. Protected populations of particular species

3. Forest conservation as catchments or for essential resources
4. Village wetlands conserved for waterbirds and regulated water use
5. Grasslands traditionally managed for regulated harvest

## *Sacred Spaces*

Several kinds of sacred spaces, mostly on forest or pasture land, have characterized the state. *Mandir* or *dev vans* or *banis* have been associated with particular temples and deities, often strictly protected. *Kakar banis* are the forests marking the boundary between two villages, often sanctified by religious belief. Then, there are the *orans*, sacred pastures or woodlands used primarily for grazing, with protected tree species like *khejadi* (*Prosopis cineraria*). One statewide survey by the NGO CECOEDECON [4] listed 690 sacred groves, but it is likely that this is an underreporting. Studies in a number of them have shown significant biodiversity value, though there has also been serious degradation in recent years.

Pandey and Singh [3] studied the *mandir vans* (*dev vans*) or *banis* of Kota and Udaipur. They divided sacred groves of the southern Aravalli Ranges and Vindhyachal Ranges into three major categories. The first type of sacred groves was developed and managed by tribes and is located in forests, near streams, or on hills. The second type was devoted to Shankara (the Hindu God). These are located in watershed areas. The third type consists of single trees like Banyan (*Ficus benghalensis*) and Peepal (*Ficus religiosa*). In many of these, communities continue to have strong ties with the grove and devise protection and management strategies, while in others, this link has broken down, and relationship is restricted to certain religious activities being held inside sacred groves. These groves are threatened by indifference of the state agencies and, in some instance, by the local people, encroachments, construction activities, and so on.

## *Protected Populations of Species*

A number of floral and faunal species received special conservation treatment by communities in Rajasthan. Since ancient times, species considered sacred have been protected from all forms of threats including hunting. The *khejadi* tree is zealously protected across the western part of the state. Not surprising, given its high value for communities, it enriches soil nitrogen and provides fodder, and during drought and famine, the bark is mixed with flour for consumption. The story of Blackbuck (*Antilope cervicapra*) and Chinkara or Indian Gazelle (*Gazella bennettii*) protection by *Bishnois* is well known (including their role in getting Salman Khan caught after his infamous hunting episode), so we will not recount it here. Also highlighted in the recent times has been the tale of Khichan, a settlement near Jodhpur that has, for decades, been harboring a wintering population of several thousand Demoiselle

**Fig. 14.1** Demoiselle Cranes at Khichan village – one of the key examples of community conservation in Rajasthan (*Courtesy: Dr. Asad R. Rahmani*)

Cranes (*Anthropoides virgo*). The cranes (locally called *kuraj*) all congregate in a large enclosed area within the settlement twice a day, to feed on grains spread out for them by the villagers, and then move out to surrounding fields and wetlands for other food (Fig. 14.1). Reportedly, the village (with some contribution from visitors) spends several hundred thousand rupees each season, to provide the grain. A *Kuraj Sanrakshan Vikas Sansthan* has been set up for the purpose [5].

## *Catchment and Resource Reserve Forests*

The scarcity of water has prompted many villages to conserve forests that cloak catchments of streams and reservoirs. While this has been a traditional practice in some areas, there is an urgent need to revive or create such practices where the catchments have degraded in recent times. In Alwar, for instance, through the initiative of the NGO naming Tarun Bharat Sangh, several hundred villages have ensured their own water security through *johads* (check dams) and other water harvesting measures, and the regeneration and protection of catchment forests to safeguard these measures (Fig. 14.3). Wildlife and biodiversity have benefited immensely. A couple of villages, Bhaonta and Kolyalat, in the upper reaches of the Arvari River,


**Fig. 14.2** Villagers at Bhaonta-Kolyala at the entrance of people's Wildlife Sanctuary (Dist. Alwar, Rajasthan) (*Courtesy: Ashish Kothari*)

**Fig. 14.3** Terrain of Bhairondev people's sanctuary at Bhaonta-Kolyala village of Alwar district in Rajasthan (*Courtesy: Farhad Vania*)

**Fig. 14.4** Barnakawas villagers with *johad* and conserved forests (*Courtesy: Ashish Kothari*)

have even declared the Bhairondev Abhyaranya, or people's sanctuary, to protect deer, leopards, and other wildlife that has made a comeback in their catchment forest [6] (Fig. 14.3, 14.4, 14.5, and 14.6). About 80 villages around Arvari have come together to form what they call Arvari *Sansad* (the Arvari Parliament), realizing that water, forests, and wildlife along the river cannot be saved by just a handful of villages. These villages hold regular meetings to discuss issues related to water and wildlife conservation. In the Kailadevi area (buffer zone of the Ranthambhore Tiger Reserve), practices such as *kulhadi bandh panchayat* (ban on using axes inside forests) have helped conserve forest patches that were otherwise getting degraded; unfortunately in recent times, this has been undermined by government imposition of externally funded eco-development committees [7]. Regeneration of forests has also been a key initiative of several dozen villages in the Udaipur area of southern Rajasthan, facilitated by the NGO named Seva Mandir (Personal Communication with Vivek, Seva Mandir, 2010). The community in many of these has also been able to persuade their own members to vacate encroachments on common land, in some cases by providing alternatives. A special annual award, instituted under the Umed Mal Lodha Memorial Trust, is given to the villages with the best natural resource management and conservation record.

Typically these forests are not strictly protected, but are subjected to continued use for grazing or fodder collection, medicinal plant harvesting, and other uses. However, strong regulations in many villages, comprising oral as well as written (as in Bhaonta-Kolyala), have helped to limit the use, therefore allowing considerable wildlife and biodiversity value to flourish.

**Fig. 14.5** Aravalli Hills at Bherodeo Lok-sanchiri Bhanota, Alwar (*Courtesy: Ashish Kothari*)

**Fig. 14.6** Sariska Wildlife Sanctuary (*Courtesy: Ashish Kothari*)

Interestingly, there are many sites where the cultural and spiritual tradition of sacred spaces overlaps with the more "economic" motivation of protecting watersheds. In Kota, Bundi, Jhalawar, and Tonk districts, *dev bani* (god's grove) was maintained for the belief that the local deity would protect the community's *talabs* (water body) and other water harvesting structures [3].

## *Village Wetlands*

Rajasthan has a diversity of ancient water harvesting and storage practices, to which more recent harvesting moves have been added, such as in Alwar district. Some of the surface wetlands are critical for waterbirds and other fauna. An interesting example of protection recently surfaced at Udpuria village, near Kota. Spurred by a local NGO, the Hadoti Naturalists' Society, villagers have started protecting a recently established colony of Painted Storks (*Mycteria leucocephala*) on their two hectares wetland [8].

## *Grasslands*

Experts like Asad Rahmani have recorded that traditional pastures (*beed*) managed by pastoralist families or communities have in the past been strongholds of species like the bustards and floricans; some such *beeds* remain intact though increasingly getting threatened (personal communication with Dr. AR Rahmani). The seasonal patterns of grazing or fodder-cutting and leaving the area vacant to regenerate periodically have contributed to this phenomenon. More recently, NGOs like "Seva Mandir" has helped communities to regenerate degraded pastures, primarily for livelihood purposes but at the same time has resulted in greater potential for wildlife conservation.

Another traditional system of conservation by communities is related to *orans*. *Orans* are sacred patches of pasturelands devoted to a deity or temple. Historically, *orans* were developed by local rulers or landlords to protect the common lands of the villages. In the arid regions of Rajasthan, livelihood has traditionally been based on animal husbandry, and protection of such common grazing lands was important to ensure fodder availability. The king or *jagirdar* of the area, therefore, allotted some portion of common lands to a temple. Religious sanctity of the *oran* as well as the fear of the *jagirdar* ensured that *orans* remained protected. *Orans* are important components in the recharge of the aquifers in the desert where every single drop of water is precious. In most *orans*, particularly in western Rajasthan, the dominant tree, *khejadi*, is worshipped for its immense ecological value. Many rules were developed to ensure protection of *orans* such as banning commercial use, restricted lopping (allowed only in times of fodder scarcity), and open to all castes and classes of society. Those failing to obey the rules were punished by making them contribute grains toward the local *chabutara* (a platform meant for feeding birds) and were

also fined a sum of money. *Orans* also provided a space for adjacent villages to discuss socioreligious, economic, and cultural issues and also to resolve personal grievances. It is not surprising; therefore, that Sariska National Park has been carved out of 12 *orans* in that area [5].

In recent times, however, *orans* have suffered due to lack of understanding about their ecological and social value, and hence, an indifferent attitude by the relevant authorities. Politics within *panchayats* (under whose jurisdiction they fall) has also contributed to their degradation. There are few examples, however, where the local people have come forward to revive conservation of *orans*. They have protested encroachments by outsiders as well as members of their own community and have even filed court cases such as Para village in Barmer district [9, 10]. In recent times a group of people and communities engaged in issues related to governance of *orans* have come together to form "*Oran* Forum" to lobby for a more effective management of *orans* in the state [11].

## Institutional Dynamics

It is vital to understand the institutional dynamics that have led to sustained CCAs. The range of management institutions is bewildering, temple authorities managing sacred spaces, forest protection committees specially set up by villages, entire *gram sabhas* (village assemblies) assuming the responsibility for conservation, joint forest management committees established with the support of government, and so on. In most cases there are customary or new rules set by the community on its own or in consultation with NGOs and government agencies. These are often unwritten but not necessarily any less effective than the more formal written rules.

It appears that more successful initiatives have been the ones started by villagers themselves, where a long-term process has been allowed to play itself out initiated by outsiders, especially as part of time-bound projects, the results are mixed. The Sacred Grove Conservation Program launched by the Udaipur forest division in 1992 resulted in some excellent cases of conservation (including the declaration of some new sacred forests). But, there were also notable failures at many sites, and in number of other externally driven projects, community initiatives have simply not sustained after the project period often because of their dependence on external funds and motivators depending on those funds.

## Threats

It would be a major mistake to assume either that CCAs are the panacea for Rajasthan's wildlife or that they are free of problems. Indeed, they face a series of threats that are common to CCAs in India as a whole. These include:

*Traditional Inequities*: Sociopolitical inequities that characterize traditional society continue to influence decision-making and management, often causing divisions within a community and thereby affecting conservation and distribution of the benefits arising from conservation. In most parts of Rajasthan, the traditional prejudice against women is also very evident from near absence of women in the decision-making process, including those related to community conservation.

*Insecure Tenure*: Since the colonial and Post-Independence takeover of common lands by the state, CCAs mostly contain government lands or a congregate of government, private, and community lands. There is a serious lack of tenurial security over such areas for the local community, often leading to a decrease in commitment for conservation or inability to protect CCAs against outside threats and pressures on which the community has no legal authority.

*Developmental Threats*: With the state and central government keen to take the state to a process of rapid economic growth, many CCAs and their surroundings have been threatened with mining, industrialization, takeover for activities like Special Economic Zones, and so on. This could be the single largest category of threats to CCAs, which in the year 2010 has been very evident from the state government granting permission for mining in the sensitive Aravalli mountains despite a stay order from the court of law [12].

*Lack of Recognition and Support*: Barring a few initiatives such as those by the *Bishnois*, most community conservation efforts remain neglected by the government and by the media. NGOs have increasingly stepped to document and support them, but even their abilities and commitments are limited.

*Governance Indifference*: While there are many references to the sites and species that are being conserved or protected by people, much of this is a de facto status. In most cases these sites fall under the jurisdiction of the local *panchayats* or revenue or forest departments. Indifference from these agencies toward the effective management of these sites, lack of support in times of need, and lack of understanding about the social and ecological importance of these sites lead to a number of plans, schemes, development activities that are directly threatening to these or inaction that indirectly threatens them. At places where the local people and governance structure are very strong, such indifference can sometimes be defeated, but in most situations, it can lead to negative impact on the efforts of the people.

## Recommendations

Community conservation initiatives in Rajasthan, both traditional and new, need urgent support. In particular, the following steps are imperative:

*Documentation*: A full inventory of CCAs and studies on their sociopolitical dynamics, wildlife and biodiversity values, economic and social benefits, and threats is

strongly needed. Such documentation should also include areas which have a high potential and demand from local communities for initiating CCAs or where such initiatives may have existed in the past and have a potential of being revived.

*Legal and Policy Backing*: A clear policy statement from the state government is needed, to recognize and support CCAs and legal backing under relevant laws such as the Wildlife (Protection) Amendment Act, 2006, ("Community Reserves"), the Biological Diversity Act ("Heritage sites"), the Scheduled Tribes and Other Forest-dwellers Rights Act 2006 ("Community Forests"), and the Environment Protection Act 1996 ("Ecologically Sensitive Areas"). Even seemingly unrelated laws such as the *panchayat* legislation, and *Gramdan* Act, could be effective in providing backing. In all cases, however, the legal measures need to be sensitive to local institutional and ecological diversity, rather than impose uniform rules and institutional structures as has been attempted in the Wildlife Act's provision for community reserves and conservation reserves in many states. If the state can frame appropriate rules under the Biological Diversity Act, the provision for declaring biodiversity heritage sites could be very useful in providing the flexibility needed to cover diverse ground situations. In fact "Community Forestry Resource" under Section 3 (1) i and 5 and Rule 4e of the Forest Rights Act, 2006 mentioned above is an extremely useful space for supporting CCAs which has hardly been used so far. Both state agencies and NGOs need to give much more attention to this provision. However, many communities may desire a supportive role of the department in helping them discharge their authority and responsibilities, particularly when faced with some threats. This needs capacity building among the various line agencies including forest department, to effectively play this role.

*Social Recognition*: Under the current development paradigm, the local communities, their efforts, knowledge systems, and technological innovations remain unappreciated and unrecognized. Decades of lack of recognition and endorsement have instilled a feeling of inferiority among local knowledge holders and innovators. Often the conservation efforts draw attention of the national and global community toward the local communities leading to social recognition of their efforts. Awareness of CCAs among the state's population, especially its urban citizens, can be provided through the media and other means. Initiatives, such as, the Umed Mal Lodha Trust's Award can also be very helpful in motivating communities.

*Building Capacity*: Communities today have to face a series of threats and challenges including that of providing livelihoods to its younger generations while sustaining their interest in conservation. Facilitating the building of capacity for this is crucial. A number of initiatives for the above measures are already underway in Rajasthan. But much more needs to be done, if we are to help communities sustain and spread even more widely, the enormously important task of conserving wildlife and biodiversity that they have been performing for centuries.

*Landscape Approach*: It must be kept in mind that these areas do not exist in isolation and are influenced by various social and political forces and land-use practices in the surrounding areas. Allowing resource-intensive activities in the surrounding

areas could put more pressure on the biodiversity of the area to be protected or act in contradiction to conservation objectives. It is extremely important to orient regional planning toward the ecological and cultural dimensions of an area, including community conservation efforts. A community's wish to conserve a certain area needs to be respected and reflected in the regional planning. Even if the community has not overtly opposed any action impacting traditionally conserved sites, utmost attention should be paid before any development activities are taken up here. The example of Arvari *Sansad*, which aims to be the primary decision-making body for the entire basin, becomes very important in this regard. The *sansad* is based on the principle that a holistic landscape approach will need to be taken for the conservation and use of the catchment. Members of the *sansad* believe that decisions made by individual villages are, often, restricted to the interests of their own villages and may not adequately take care of the eco-region as a whole.

*Governance and Decision-Making*: Good governance is increasingly being seen as an important factor in ensuring the success of any conservation effort. Governance is about power, relationships, and accountability. It, thus, has major influence on the achievement of management objectives and the sharing of relevant responsibilities, rights, costs, and benefits. In order to support the existing CCAs in Rajasthan and revive the ones which are coming down under various threats and pressures mentioned above, it is important to identify where such sites exist and organize consultations with those who have a direct relationship or dependence in these. This will help work out an all inclusive, participatory, and locally acceptable system of governance. Such consultations need to be an integral part of any decision-making process related to CCAs. In many areas, local capacities may not be enough to ensure effective management, in these cases capacity building programs would be crucial.

*Creating Support Structures:* Most conserving communities have expressed a desire for a supralocal supportive body for constant support, guidance, capacity building programs, and as an information and experience sharing forum. This could be in the form of landscape level federations of the CCAs themselves, such as the ones in the state of Orissa [13] or multi-representative bodies created in complete consultation with the concerned communities. Please see Chaps. 3 and 4 from *Faunal Heritage of Rajasthan: Ecology and General Background of Vertebrates*, Vol. 1; B. K. Sharma et al. (eds.), 2013 and Chaps. 15, 17 and 19 from this volume for more relevant details and pictures.

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# Chapter 15
# The Revival Model for Common Property Reserves in the Thar Desert of Rajasthan with Special Reference to their Faunal Components

**P.L. Kankane**

**Abstract** Conservation threats such as poaching and change in land-use pattern have fragmented wildlife habitat to such an extent that, nowadays, the distribution map of animal-loving human communities has become the distribution map of wild animals. *Oran* (the term for common property in Rajasthan) is an age-old system of creating common property reserves at village level for sustainable use of wild fauna and flora even before enactment of the Wildlife (Protection) Amendment Act, 2006. This chapter signifies the revival and management of wasteland, *orans,* and *gauchers* for the success of any conservation program in the Thar Desert because it offers habitat favorable for abundance of native fauna like Chinkara (*Gazella bennettii*), Blackbuck (*Antilope cervicapra*), Desert Fox (*Vulpes vulpes*) and Desert Cat (*Felis silvestris*). According to one of the studies (KRAPAVIS), there are about 1,100 major *orans* spread out in an area of more than 100,000 ha in this region. The issue of revival and management of o*rans*, *gauchers,* and wasteland which requires understanding of micro-, meso-, and macrofauna of soil, the resident species of fauna, their dietary habits, and food preferences and the identification of plant species with high moisture contents have been discussed. Non-vegetative requirements and man-animal relations have been shown to be the vital aspects for the successful and continued survival of fauna in these common property reserves.

## Introduction

Though land is a scarce resource in India in terms of its per capita availability, but in the recent past, the Thar Desert was considered as the "land bank" of the country because about 46% of it was considered as "wasteland." This categorization together

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with the nonavailability of surface and groundwater, offers a favorable habitat for abundance of native fauna like Chinkara (*Gazella bennettii*), Nilgai (*Antilope cervicapra*), Desert Fox (*Vulpes vulpes pussilla*) and Desert Cat (*Felis silvestris*). These animals were abundant in the recent past. However, poaching and gradual change in land use pattern have fragmented their habitat to such an extent that, nowadays, the distribution map of animal-loving human communities has become the distribution map of wild animals. In order to protect desert biodiversity, the Government of Rajasthan has declared two protected areas, namely, Desert National Park (proposed) and Tal Chhaper Sanctuary under the Indian Wildlife (Protection) Amendment Act, 2006. They together constitute about 1.5% of the total area of the Thar Desert. However, even before enactment of the above act, there was an age-old well-established system of creating reserves at village level, for sustainable use of wild fauna and flora known as *orans* (the term for common property in Rajasthan). They were the collective efforts of local people to protect plants and animals by giving the designated area an identity under tradition. Throughout the desert, this unique tradition has given almost every village a protected area, offering conducive environment to animals by providing them food and shelter. According to one of the studies, KRAPAVIS (*Krishi Avam Paristhitiki Vikas Sansthan* -the term for Agriculture and Ecological Development Institute in Hindi), there are about 1,100 major *orans* spread out in an area of more than 100,000 ha in this region. However, in the recent past, due to pressure from livestock and illegal poaching of wood and animals, most of these oases in the desert have now become scarce. Nevertheless, these together embrace more number and variety of wildlife than in protected areas. Hence, revival and effective management of such habitation (*orans* and wasteland) hold the key to any successful conservation program in the region.

## The *Orans*

The creation of *orans* (the term for common property in Rajasthan) in the Thar Desert of Rajasthan is an amazing step by local communities to protect the area around their village where livestock grazing and wood cutting is banned or restricted in time and space. This is to conserve natural resources and watershed to face the vagaries of nature during adverse conditions. *Orans* were the oases offering conducive environment to a number of animals by providing them food and shelter. However, in recent past, due to pressure from livestock, poaching of wood and animals, and absence of strong legislations to legally and constitutionally uphold the community's right to own and manage these *orans*, most of these oases are now scars on the landscape. Satellite data suggests that there has been an increase in intensity of cultivation across the region, and more and more fallow and marginal land is being brought under plow, so much that 39% increase has been registered in net sown area during the last five decades, at the cost of 25% decline in fallow land. As more and more marginal lands are being brought under plow, grazing lands are also shrinking.

Unfortunately, the present distribution of *orans* in the Thar is not available in public domain. Though an attempt has been made by National Remote Sensing Agency, Hyderabad, to map out the wasteland of the country (1:50,000 scale), *orans* are not categorized as such and are probably merged under some bigger category of wasteland in the report [1]. Moreover, such maps are not freely available.

## The Controlling Factors

Interdependence of plants and animals is well-known because the vegetation directly or indirectly influences the life of all animals. It has recently been established [2] that the socioeconomic and religious aspects of human beings play a vital role in determining the vegetation complex in the human-dominated landscape, as well as the variety of animals that are found in his domain. Accordingly, in any model for vegetative revival of degraded land, man and animals have to be given their due importance to make it viable.

### *Meso- and Macrofauna*

While examining the faunal component of the *orans*, requirements of larger vertebrates are always the first to attract one's attention. Nevertheless, equally important are the meso- and macrofauna present in the soil, which promote fertility as well as create food base for other animals, especially reptiles, birds, and small mammals. Therefore, let us first discuss about the importance of inconspicuous soil fauna as well as their diversity.

The soil divided into aerial and moisture phases offers large number of microhabitats. In addition, the occurrence of mutual relationship between macro- and microorganisms increases the niche space and, thus, increases possibility of harboring more number of species. Various animal groups are there to occupy these microhabitats, and their activities have significant effects on soil organic matter dynamics, the organization and structure of soil. This, in turn, affects sustainable growth of plants and their varieties. According to one of the studies, nearly 80–100% of the fields in several pockets of the arid zone were severely deficient in boron, zinc, and sulfur, in addition to the macronutrients such as nitrogen and phosphorus. In nature, such activity is taken care by soil fauna by the process of selective ingestion of organic and mineral particles, mixing of soil and organic matter, and excavation of galleries and chambers accumulated over time. This has a dramatic impact on the morphology and function of the soil. Yet another important attribute of soil is aggregation or organization of particles in micro to centimeter aggregates. This is largely dependent on the activities of invertebrates (meso- and macrofauna) that produce such aggregates as organic fecal pellet or other species that further split them into smaller units when they excavate or feed on these large formations. The earthworms and termites owing to their huge ingestion rates play an important role in the process.

In addition, soil provides a variety of microhabitats to aquatic microfauna living in water-filled spaces and surface films covering soil particles and terrestrial elements. Our present knowledge of the soil fauna of the Thar Desert is very limited, and such information is not available specifically for *orans* except for Protozoa (52) (number of species given in brackets), Nematodes (197), Rotifera (8), Annelida (26), Arachnida, (Acarina 10), Chilopoda (8), Collembola (6), Orthoptera (40), Dermaptera (7), Dictyoptera (20), Diptera (80), Coleoptera, Scarabaeidae (85), Isoptera (34), Hymenoptera, Formicidae (35), Mollusca (24), Amphibia (8), Reptilia (44), Insectivora (4), and Rodentia (18), we are yet to explore species of the most of the other groups [2–4].

## *Other Fauna*

The majority of food items ingested by desert-dwelling animals depend on the moisture requirements imposed by usually low moisture and high temperature regimes of the desert. Based on this requirement, the desert-dwelling animals can be categorized in two forms, one that needs morphological adaptation of their stomach to absorb metabolic water while the other that does not. Thus, certain types of foods, such as herbaceous material and insects, are superior to the others because of the moisture they provided (Table 15.1) [5].

This is the only reason why Chinkara *Gazella bennettii,* a dominant species of the desert, survives in the arid areas of Rajasthan where for miles there is no drinking water, while another antelope Nilgai *Boselaphus tragocamelus,* usually concentrates around irrigated cultivation fields and gradually penetrates into the desert along with availability of water through Indira Gandhi Canal Project (IGNP). Therefore, this kind of information could be an important input while planning vegetative revival of *orans*.

The food habits are another important consideration, as far as the survival of desert animals is concerned. Based on primary and known dietary habits of these animals, a table was compiled (Table 15.2) [6], and a close examination of this table leads to the conclusion that desert animals are often opportunistic in their feeding habit. Most often, they use those dietary items which are the most abundant, and if the prey exhibits seasonal or diurnal activity pattern, the consumers may mirror this trait. Thus, as a part of strategy, both environmental constraints and temporal patterns of availability of appropriate food force the desert animals to adjust their seasonal and diurnal activity patterns and their dietary preference accordingly (Tables 15.3, 15.4, and 15.5) [5]. For instance, rodents are active late in the night during the hottest part of the summer and earlier during the winter, and the Chinkara feeds in the night when the greatest amount of hygroscopic water is available. These modifications in diet and foraging behavior allow many species to survive during unfavorable circumstances and later allow them to reap the advantages of seasonal bursts of productivity and diversity. Some more information on feeding habits of desert animals is available on hedgehog [7], mammals [8], and bats [9].

**Table 15.1** Water contents of some feeding stuff preferred by Chinkara *Gazella bennettii* in the Thar Desert [5]

| Plant species | Part | Moisture (%) |
|---|---|---|
| *Zizyphus nummularia* | Leaves(young) | 86 |
| *Calotropis procera* | Leaves | 80 |
| *Prosopis cineraria* | Pods(unripe) | 78 |
| *Salvadora persica* | Fruits | 77 |
| *Capparis decidua* | Fruits | 74 |
| *Dipterygium glaucum* | Root | 74 |
| *Capparis decidua* | Flowers | 73 |
| *Maytenus emarginata* | Leaves | 72 |
| *Calligonum polygonoides* | Shoots | 71 |
| *Capparis decidua* | Shoots | 71 |
| *Salvadora persica* | Leaves | 71 |
| *Dipterygium glaucum* | Root bark | 69 |
| *Prosopis cineraria* | Leaves(young) | 68 |
| *Zizyphus nummularia* | Leaves | 67 |
| *Prosopis cineraria* | Leaves (old) | 64 |
| *Acacia tortilis* | Leaves | 61 |
| *Acacia tortilis* | Pods(unripe) | 61 |
| *Balanites aegyptiaca* | Leaves | 61 |
| *Maytenus emarginata* | Leaves (old) | 59 |
| *Tecomella undulata* | Leaves | 58 |
| *Crotalaria burhia* | Shoots | 46 |

These are some of the considerations required to be taken care of while developing any plan for vegetative revival and predictable animal activities in such *oran*. On the other hand, there are animals such as a few species of rodents and Nilgai that have acquired the status of pest in some parts of the Thar Desert. The available information on their food preferences (Tables 15.6 and 15.7) [10] can be used for controlling their population by altering the selection of food plants.

## *Non-vegetative Support*

There are a few mammals (such as Chinkara) whose non-vegetation requirements have to be kept in mind because of their minimum home range requirements. Therefore, a due consideration is to be given to total area of *orans* taken for vegetative revival. It should be big enough to fulfill home range requirements of these animals. While reviving and developing the degraded habitat of *orans,* provision for likely introduction of species, such as Gray Wolf and Wild Ass in Sanchore Block in Barmer district together with the requirements of prey birds likely to visit such *orans*, should be taken into consideration in the revival model. This provision is important for balanced and sustainable growth of the area. Moreover, species-specific habitat such as existing cliffs, overhangs which are natural projections,

**Table 15.2** Primary (P) and known (K) dietary habits of desert animals of different deserts [6]

| Animal groups | | | Herbivore | Granivore | Omnivore | Insectivore | Carnivore | Detritivore | Scavenger | Cannibalistic |
|---|---|---|---|---|---|---|---|---|---|---|
| Nematoda | | | P | | | | | K | | |
| Mollusca | Gastropoda (snails) | | P | | K | | | K | | |
| Arthropoda | Arachnid | Acarina (mites) | K | K | K | P | K | K | K | |
| Arthropoda | Arachnid | Scorpionidae | | | | P | K | | | K |
| Arthropoda | Arachnid | Pseudoscorpionidae | | | | P | K | | | K |
| Arthropoda | Arachnid | Solifugidae | | | | P | K | | | K |
| Arthropoda | Arachnid | Araneida | | | | P | K | | | K |
| Arthropoda | Arachnid | Chilopoda (centipedes) | P | | | | K | | | K |
| Arthropoda | Arachnid | Diplopoda (millipeds) | P | K | | | | | | |
| Arthropoda | Insecta | | P | | | | | | | |
| Chordata | Amphibia | | P | | | P | K | | | K |
| Chordata | Reptilia | Chelonia (turtles) | P | | | K | K | | | |
| Chordata | Reptilia | Squamata (lizards) | K | K | K | P | K | | K | K |
| Chordata | Reptilia | Squamata (snakes) | | | | K | P | | | K |
| Chordata | Aves | | K | K | K | P | K | | K | |
| Chordata | Mammalia | Lagomorpha (rabbits) | P | K | | K | | | | |
| Chordata | Mammalia | Rodentia | P | K | K | K | K | | | |
| Chordata | Mammalia | Carnivora (canidae) | | | K | | P | | K | |
| Chordata | Mammalia | Carnivora (felidae) | | | | | P | | | |
| Chordata | Mammalia | Artiodactyla | P | | | | | | | |
| Chordata | Mammalia | Insectivora | | | | P | K | | | |
| Chordata | Mammalia | Primates | P | | K | | | | | |
| Chordata | Mammalia | Chiroptera | K | | | P | K | | | |
| Chordata | Mammalia | Edentata | K | | K | P | | | | |

**Table 15.3** Plant species consumed as food by Nilgai *Boselaphus tragocamelus* [5]

| Plant species | Part | Winter | Summer | Moisture contents |
|---|---|---|---|---|
| *Pennisetum typhoides/americanum* | | Yes | Yes | NA |
| *Vigna aconitifolia* | | Yes | | NA |
| *Cyamopsis tetragonoloba* | | | | NA |
| *Medicago sativa* | | Yes | | NA |
| *Triticum aestivum* | | Yes | Yes | NA |
| *Ricinus communis* | | | Yes | NA |
| *Tephrosia purpurea* | Flower | | Yes | NA |
| *Aerva persica* | | | | NA |
| *Zizyphus nummularia* | Leaves | | | 86% |
| *Acacia nilotica* | Pods | | | NA |
| *Prosopis cineraria* | Pods | | | 78% |
| *Prosopis juliflora* | Pods | | | NA |
| *Calotropis procera* | Leaves | | | 80% |

**Table 15.4** Seasonal variation in consumption of plant species by Chinkara *Gazella bennettii* [5]

| Plant species | Part | Winter | Summer | Moisture contents |
|---|---|---|---|---|
| *Maytenus emarginata* | | | Yes | 72% |
| *Zizyphus nummularia* | | Yes | Yes | 86% |
| *Eleusine compressa* | | | Yes | NA |
| *Heliotropium* spp. | | | Yes | 68% |
| *Prosopis cineraria* | Pods | | Yes | 78% |
| *Crotalaria burhia* | | Yes | | 46% |
| *Tecomella undulata* | Flowers | Yes | | 58% |

**Table 15.5** Seasonal variation in consumption of plant species by Blackbuck *Antilope cervicapra* [5]

| Plant species | Part | Winter | Summer | Moisture contents |
|---|---|---|---|---|
| *Cynodon dactylon* | | Yes | Yes | NA |
| *Desmostachya bipinnata* | | Yes | Yes | NA |
| *Dactyloctenium aegyptium* | | Yes | | NA |
| *Eleusine compressa* | | Yes | | NA |
| *Mollugo* spp. | | Yes | Yes | NA |
| *Prosopis cineraria* | Pods | | Yes | 78% |
| *Prosopis juliflora* | Pods | | Yes | NA |

**Table 15.6** Preference of intake of seeds of grasses by gerbils [10]

| Seed species | *Meriones hurrianae* | *Tatera indica* | *Gerbillus gleadowi* |
|---|---|---|---|
| *Perotis hordeiformis* | 7 | 4 | 1 |
| *Eragrostis ciliaris* | 6 | 4 | 5 |
| *Erianthus munja* | 5 | 4 | 6 |
| *Cenchrus ciliaris* | 4 | 3 | 3 |
| *Lasiurus sindicus* | 3 | 4 | 4 |
| *Cenchrus setigerus* | 3 | 1 | 2 |
| *Dichanthium annulatum* | 2 | 2 | 3 |
| *Panicum antidotale* | 1 | | 3 |

**Table 15.7** Preference of intake of seeds of tree and shrubs by gerbils [10]

| Seed species | *Meriones hurrianae* | *Tatera indica* | *Gerbillus gleadowi* |
|---|---|---|---|
| *Acacia arabica* | 7 | 4 | 4 |
| *Acacia tortilis* | 7 | 4 | 3 |
| *Azadirachta indica* | 7 | 3 | 7 |
| *Acacia senegal* | 7 | 3 | 3 |
| *Prosopis spicigera* | 6 | 3 | 4 |
| *Parkinsonia aculeata* | 5 | 2 | 5 |
| *Aerva tomentosa* | 4 | 4 | 5 |
| *Prosopis juliflora* | 4 | 2 | 5 |
| *Albizia lebbeck* | 4 | 2 | 2 |
| *Calligonum polygonoides* | 3 | 5 | 6 |
| *Tecomella undulata* | 3 | 3 | 5 |
| *Zizyphus nummularia* | 2 | 1 | 1 |
| *Ricinus communis* | 1 | 2 | |

outcroppings normally used by prey birds, dens, burrows, tree hollows, and water bodies should not only be maintained, but adequate provisions may be kept in the plan to create them further.

## Recommendations

1. In spite of their uniqueness, the *orans, gaucher,* and groves could not attract attention of scientists, foresters, and policymakers. Therefore, all the existing *orans* in the Thar Desert should be systematically surveyed, demarcated, and mapped.
2. In the revenue records, *orans* were categorized under "culturable wasteland" and were often the target for land use change especially in absence of any law to protect them. Hence, enactment of legislations is immediately required for their legal protection.
3. All the *orans* should be surveyed for their biological wealth on priority basis so that whatever remains is not lost with time. Each *oran* should have a working plan developed in collaboration with local communities.
4. Some *orans* can be declared as community or conservation reserves with the involvement of local people.

Please see Chaps. 3 and 4 from *Faunal Heritage of Rajasthan: Ecology and General Background of Vertebrates*, Vol. 1; B. K. Sharma et al. (eds.), 2013 and Chaps. 14 and 19 from this volume for more information on community conservation in Rajasthan.

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# Chapter 16
# Resource Dependency and Socio-economic Profile of Local Communities in Sariska Tiger Reserve, Rajasthan

**Tanushree Srivastava, K. Sankar, Qamar Qureshi, and P.R. Sinha**

**Abstract** This chapter presents a data analysis of the study conducted between February and August 2008 to assess the socioeconomic status and resource dependency of ten villages located in the notified national park, i.e., core zone I of Sariska Tiger Reserve (STR). Data pertaining to the collection of forest products, livestock holding, demographic details, source of income, and education level was collected using a structured questionnaire, achieving a sampling effort of 45–84%, varying in different villages. Literacy-rate reported for the villages is 24% which is quite low and mostly restricted to a primary level of education. Average annual household income reported for the villages is 29,600 INR, of which a major part (89.4%) is contributed by milk sales followed by agriculture, daily wage labor, and goat selling (10.6%). High dependency of local people on forest products is observed, having an annual harvest of 496 tonnes and 2,300 tonnes of fuel wood and fodder, respectively, for all the ten villages. The fuel wood has a high commercial value of 2,609,000 INR and fodder has a value of 3,040,000 INR. The livestock owned by the local communities in the entire national park comprises of 2,643 buffaloes, 896 cattle, 6,160 goats, and 234 sheep. The observed high dependency of the local people in Sariska

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is attributed to the lack of alternatives and accessibility to essential commodities. It is suggested to make provision for alternative livelihood sources, economic incentives through benefit sharing from tourism, compensation for the loss of livestock killed by the predators and to the local people, and community-based conservation programs. Raising plantations with indigenous tree and shrub species along with palatable grasses in the buffer zone of STR to reduce pressures on core zone I and relocation of the villages from core zone I have been suggested for the availability of more space to wild animals.

## Introduction

Protected areas (PAs) all over the world are established to protect the faunal and floral biodiversity of the areas concerned. The PA network in India has helped to conserve a significant part of biodiversity, but simultaneously these areas are also reported to coincide with the areas of human settlements having communities living in and around these areas and showing high dependence on the natural forest resources to meet their daily livelihood requirements. However, the effectiveness of this system is increasingly under strain due to the unsustainable resource demand of the local communities as well as development pressures [1]. In India, nearly five million people live inside the protected areas (PAs), and another 147 million depend on the resources that these PAs provide [2]. According to a survey carried out in mid-1980s, over 65% of protected areas in India are characterized by human settlements. Rural population in the Indian subcontinent depends heavily on forest resources [3] and despite laws that prohibit hunting, fishing, fodder and fuelwood collection, and livestock grazing, the practice continues in most of the PAs [2, 4–6]. An ideal example of such areas is represented by Sariska Tiger Reserve (STR), one of the most potential and important Tiger Reserves in the country.

## Study Area

Sariska Tiger Reserve, situated in the Aravalli Hills of Rajasthan state in Central India, is the third largest protected area among the 93 protected areas situated in the semiarid biogeographic zone of India [7] (Fig. 16.1). The area extends between 76°17′–76°34′ N latitudes and 27°05′–27°33′ S longitudes part of district Alwar in Rajasthan. The entire tiger reserve spread over an area of 881 km², is divided into a core zone (497 $km^2$) and a buffer zone (384 $km^2$). The core zone is further divided into three zones, i.e., core zones I, II, and III where core zone I with an area of 273.8 $km^2$ is the notified national park since its declaration in 1982.

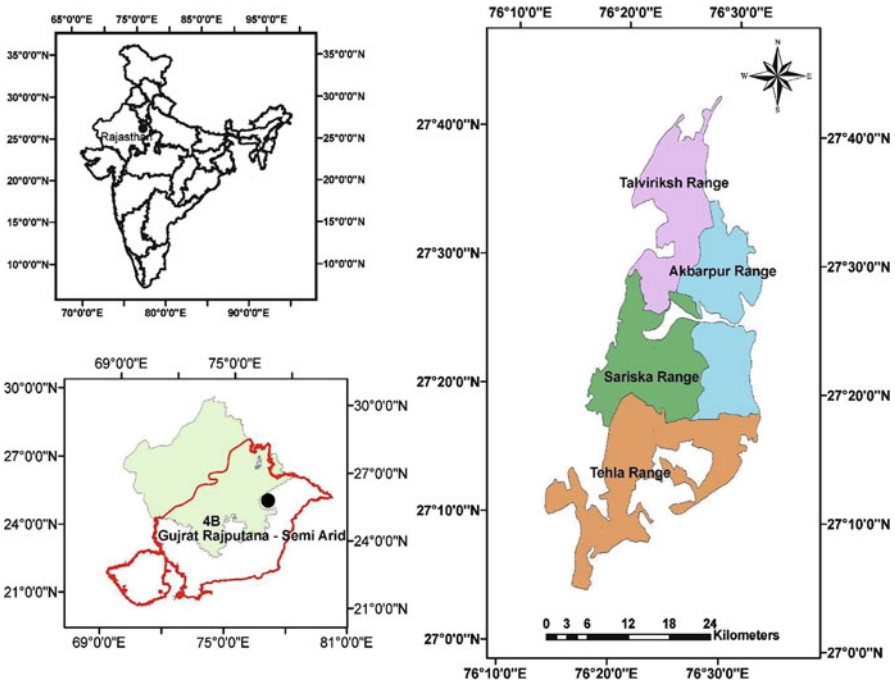


**Fig. 16.1** Location and administrative boundary of Sariska Tiger Reserve

## Villages in Sariska Tiger Reserve

There are 32 villages located within the tiger reserve. Of these, ten villages are located in the national park area, i.e., core zone I of the tiger reserve (Fig. 16.2). Some of these villages like Kankwari, Rekhamala, Dabli, and Deori are among the oldest villages in the reserve of which Kankwari is said to be at least a thousand years old. These villages are inhabited by *Bhagvatas, Minas* and *Rajputs* in the past and currently by *Gujjars* and *Minas* largely, with a few *Brahmins*. Village Deori, too, has very old temples dating back 1820 AD. Thus, it can be concluded that the national park villages with their present inhabitants are at least 100 years old and since then are dependent on the resources provided by these forests for their livelihood requirements [8].

The relocation of these villages is due since 1982. However, in 1976–1977, an attempt to use relocation as a tool in the PA management in case of Sariska Tiger Reserve was made in a more organized way, when the relocation of two villages, Karankawas and Kiraska, was carried out. The sites identified for the relocation of these villages were not very far from the tiger reserve, and the lands allocated to the villagers were present at three different places, namely, Bandipul, Dhulawa, and Sirawas. Although, this initial attempt to relocate fully fledged villages could not

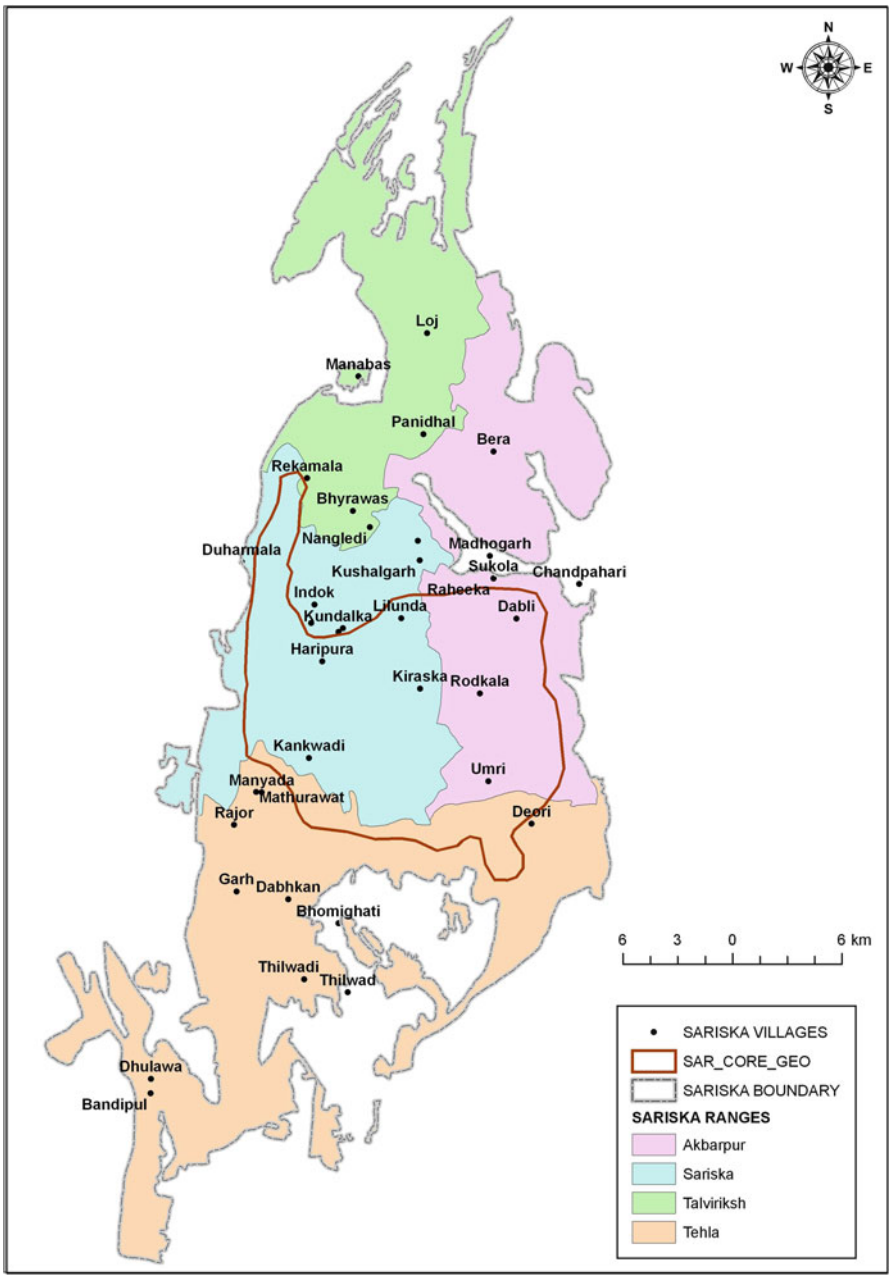


**Fig. 16.2** Location of different villages in core zone I, i.e., Sariska National Park and the entire tiger reserve

achieve due success and several people who had been relocated returned to resettle at places close to an existing village Kundalka where they established a separate hamlet named Chhota Kundalka. A remarkable success was achieved in relocating the village, Bhagani, to a new site in November 2007 [9].

The local people inhabiting the villages in Sariska largely belong to the *Gujjar* community and mostly practice animal husbandry as their main source of income in addition to agriculture practiced by the two revenue villages (Deori and Dabli) in the national park.

The present study undertaken from February to August 2008 aimed to assess the resource use by the resident human population and their attitude toward the conservation of these resources along with its implications for the protected area. Attempts were made to understand the complexities of the relocation process in Sariska National Park and project the perspectives, aspirations, and attitude of people facing imminent displacement. Also, the socioeconomic, political, and ecological contexts of relocation were examined, and perhaps most critically, it was tried to generate the baseline data on socioeconomic status, livelihoods, and economy of the villages in the national park.

## Methodology

A structured questionnaire [8, 10–13] was used to collect data pertaining to the current study. A survey was conducted achieving a sampling effort of 45–85% varying among different villages. A detailed data collection was done for all the ten villages located in the national park area, and households to be sampled from each village were randomly selected. Both close- and open-ended questions were administered to 275 households, out of the total 521 households present in these villages, thus achieving an overall sampling effort of 53% for the entire national park (Table 16.1).

**Table 16.1** Number of households surveyed and percent sampling achieved among the villages of Sariska National Park

| Village | Range | Beat | Total number of households | Number of households surveyed | % Households sampled |
|---|---|---|---|---|---|
| Umri | Akbarpur | Umri | 50 | 30 | 60 |
| Haripura | Sariska | Haripura | 35 | 29 | 83 |
| Kankwari | Sariska | Kankwari | 91 | 48 | 53 |
| Kiraska | Sariska | Kiraska | 111 | 50 | 45 |
| Sukola | Akbarpur | Sukola | 30 | 24 | 80 |
| Dabli | Akbarpur | Dabli | 46 | 24 | 53 |
| Rekhamala | Talvriksh | Rekhamala | 35 | 21 | 60 |
| Lilunda | Sariska | Bhartari | 20 | 17 | 85 |
| Deori | Tehla | Deori | 65 | 33 | 51 |
| Rotkala | Akbarpur | Rotkala | 38 | 20 | 53 |

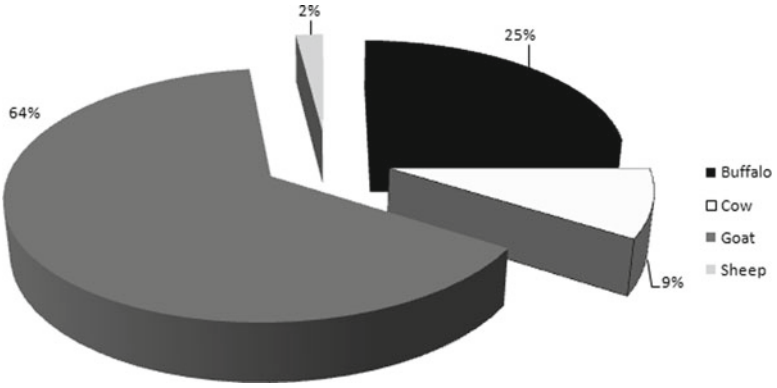


**Fig. 16.3** Percent occurrence of different livestock species among the villages of Sariska National Park

The questionnaire was designed in a way to collect information on the dependency of the households on forest produce; the kind of forest produce they harvest as fuelwood, fodder, and non-timber forest products; and the extent of their dependency on these forest resources. The socioeconomic and demographic variables measured were members in the family, level of education, primary occupation, livestock holding, level of income, gender, age, land ownership, and quality and quantity of forest product and non-timber forest product collection for each household sampled, and lastly, some specially designed questions were administered in order to get an overview of the local people's attitudes in the national park and their views toward conservation.

## Results

### *Human Population*

Out of all the ten villages sampled, the smallest village Lilunda was found to have 20 households whereas Kiraska, the largest village, with 111 households (Table 16.1 and Fig. 16.3). However, the observed sex-ratio among the villages was 77 females per 100 males with the highest (98 females per 100 males) exhibited by village Haripura and the lowest found in Dabli (66 females per 100 males) (Table 16.2). Also, a high child to female ratio of 1.9:1 exhibited by the population represents a high growth trend in the population. The ratio was found to be the highest in village Rotkala (300 children per 100 females) and the lowest in Rekhamala (141 children per 100 females) from all the sampled households.

**Table 16.2** Demographic details for the villages of Sariska National Park

| Village | Households surveyed | Total population | Population <14 year | Population >14 year | Population >50 year | Sex-ratio (# of females/100 males) |
|---|---|---|---|---|---|---|
| Umri | 30 | 225 | 70 | 129 | 26 | 82.93 |
| Haripura | 19 | 121 | 51 | 52 | 18 | 98.36 |
| Kankwari | 48 | 273 | 90 | 156 | 27 | 71.70 |
| Kiraska | 50 | 237 | 90 | 119 | 28 | 88.10 |
| Sukola | 24 | 169 | 65 | 88 | 16 | 69.00 |
| Dabli | 24 | 214 | 83 | 103 | 28 | 65.89 |
| Rekhamala | 21 | 73 | 24 | 38 | 11 | 82.50 |
| Lilunda | 17 | 101 | 46 | 43 | 12 | 71.19 |
| Deori | 33 | 182 | 82 | 77 | 23 | 73.33 |
| Rotkala | 20 | 91 | 42 | 33 | 16 | 78.43 |

**Table 16.3** Reported literacy-rate among the villages of Sariska National Park

| Villages | % Overall literacy | % Literate children | % Literate adults |
|---|---|---|---|
| Umri | 22.7 | 78.4 | 21.6 |
| Haripura | 33.9 | 61.0 | 39.0 |
| Kankwari | 30.4 | 90.3 | 9.6 |
| Kiraska | 28.3 | 61.2 | 38.8 |
| Sukola | 23.1 | 71.8 | 28.2 |
| Dabli | 14.5 | 64.5 | 35.5 |
| Rekhamala | 34.2 | 76.0 | 24.0 |
| Lilunda | 2.0 | 100.0 | 0.0 |
| Deori | 41.8 | 79.0 | 21.1 |
| Rotkala | 0.0 | 0.0 | 0.0 |
| Overall | 24.6 | 74.7 | 25.3 |

The villages reported to have a low overall literacy rate of 24.6%, whereas the highest literacy was reported in Deori (42%) and the lowest in Rotkala (2%) (Table 16.3). A previous study [8] reported village Lilunda to have 0% literacy rate which according to the present study reached up to 2%. However, literacy-rate reported among the children was appreciably high as compared to that for adults. Out of the whole literate population, 75% were children, whereas remaining 25% comprised of the adult population. Highest percentage of educated children (83%) was reported by village Kankwari, whereas the highest percentage (23%) of literate adults was recorded in Haripura (Table 16.3).

## *Livestock Population*

The estimated overall livestock population for the entire national park was 9,933 which are comprised of 2,643 buffaloes, 896 cows, 6,160 goats, and 234 sheep.

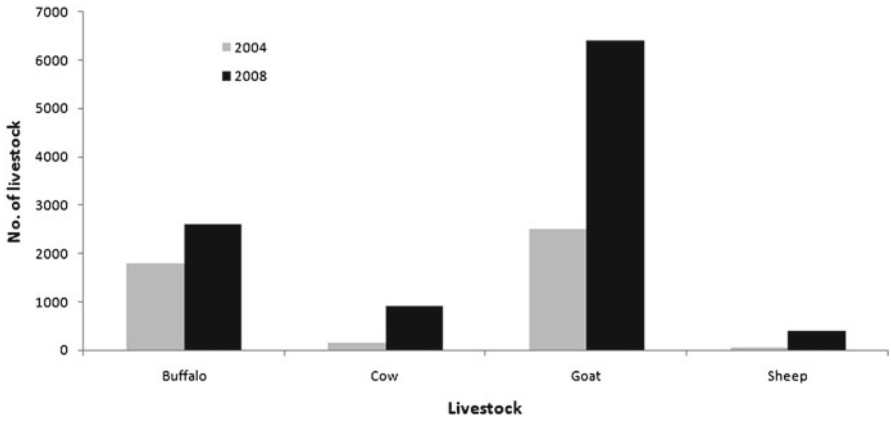


**Fig. 16.4** Observed difference in the total livestock population from 2004 to 2008 in the villages of Sariska National Park

Umri had the maximum number of buffaloes (407) and Lilunda had the least number (105), whereas Kankwari owned the largest number of goats (1,082) and Rekhamala had the least number of goats (241). Of the total livestock holding by the villagers, 62% were goats, 27% buffaloes, 9% cattle, and 2% sheep (Figs. 16.4 and 16.5). Maximum livestock number was reported from Dabli (1,082) and the lowest from Rekhamala (408). The livestock population in the national park has shown a considerable increase in the last four years, i.e., from 2004 [8] to 2008, where the increase in the number of cattle and sheep is much higher as compared to buffalo and goat (Fig. 16.6). The estimated increase in the overall livestock number was 129%.

## *Resource Dependency*

The indigenous tree species of the entire national park as well as the tiger reserve play an important and integral role in the lives of the villagers residing in the park. The economic survival of majority of the households is highly dependent upon the forests and rain [8]. Fuelwood is the major forest product collected by all the villagers and is the primary source of domestic energy for almost all the households. Out of the various plant species collected by the local people for fuelwood, *Anogeissus pendula* was found to be the most preferred tree species, constituting to 95% of the total fuelwood collected followed by *Acacia leucophloea* and *Ziziphus mauritiana* forming the remaining smaller percentage (Table 16.4). In addition to *Anogeissus pendula* and *Ziziphus mauritiana*, *Phoenix sylvestris* and *Butea monosperma* were also lopped heavily for stall feeding livestock, i.e., the buffaloes, cows, and goats (Figs. 16.7 and 16.8). As a result of the same, *Ziziphus mauritiana*, which is known to be an important fodder plant for wild ungulates, is not able to flower and fruit near the villages Kiraska and Kankwari [14].

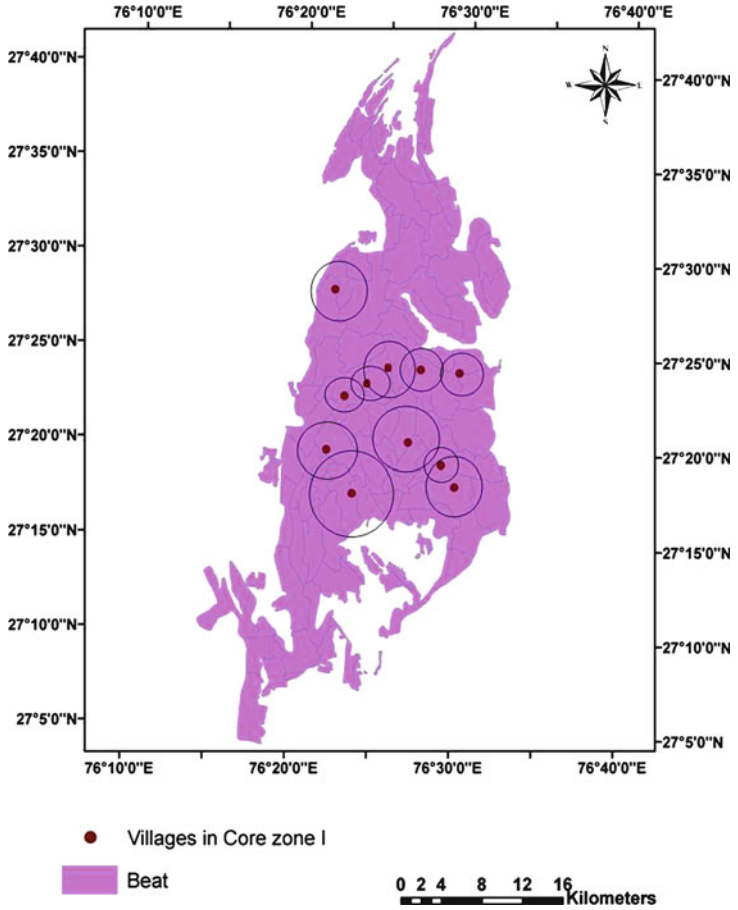


**Fig. 16.5** Location of villages with buffer of mean grazing distance in Sariska National Park, i.e., core zone I (based on questionnaire survey)

Our estimates suggest a total of 345 headloads of fuelwood per day to be extracted by all the ten villages located within the national park area. Each headload weighing about 40 kg, the total figure, thus generated comes to be approximately 13,800 kg per day combined for the villages in the national park. Maximum resource extraction was reported from Kiraska while the minimum from Lilunda being directly proportional to the number of households within these villages. For the exploitation of fodder, each headload weighs about 45 kg, and the estimated figure was 73,100 kg per day for all the households present in the ten villages of the national park (Table 16.5).

As the market value for a single headload of fuelwood and fodder was reported to be approximately 20 INR and 5 INR, respectively, the cost of the total annual exploitation was 2,609,000 INR and 3,040,000 INR for fuelwood and fodder, respectively, for the entire national park area (Table 16.5).

**Fig. 16.6** Animal husbandry is the major source of income for the local people in Sariska

**Table 16.4** List of plant species exploited by the local communities inhabiting the villages located in Sariska National Park

| Fuelwood | Grass species* | Non-timber forest product (NTFP) and fodder* |
|---|---|---|
| *Anogeissus pendula* (95%)<br>*Acacia leucophloea & Ziziphus mauritiana* (5%) | *Apluda mutica* > *Heteropogon contortus* > *Chloris dolichostachya* | *Butea monosperma* > *Acacia leucophloea* > *Acacia catechu, Ziziphus mauritiana, Ziziphus nummularia* > *Phoenix sylvestris* > *Capparis decidua* |

*The species are in accordance to the descending order of their use

## *Sources of Livelihood for the Local People*

As discussed earlier, a major part (87%) of the local communities inhabiting the villages in Sariska National Park belong to the *Gujjar* community. The communities being traditionally pastoralists rely mainly on the sales of dairy products, i.e., milk, *mawa*, and *ghee*, to earn their livelihoods and major proportion (89.4%) of their annual income comes from milk sales. Total milk produced among all the households sampled was 2,028 l per day in summer out of which about 1,413.5 l (70%) is sold from all the villages daily. During monsoon, when the per day milk yield is reported to be the highest as compared to other seasons like in summer when the same is reported to be extremely low, the villagers earn and save money for the

**Fig. 16.7** Lady with fodder: *Butea monosperma*, an important fodder for buffaloes

**Fig. 16.8** Grass extraction by local people in Sariska

**Table 16.5** Details of fuelwood and fodder exploitation and their commercial value among the villages of Sariska National Park

| Attributes | Fuelwood | Fodder |
|---|---|---|
| Quantity exploited daily (tonnes) | 14.0 | 73.0 |
| Economic value for daily exploitation (INR) | 7,300.00 | 8,400.00 |
| Quantity exploited annually (tonnes) | 5,000.00 | 23,000.00 |
| Economic value for annual exploitation (INR) | 2,609,000.00 | 3,040,000.00 |

whole year. The profit gained by selling milk is not of a good extent as the villagers were paid low prices by the local dealers. However, people living in more inaccessible villages like Kiraska, Dabli, Sukola, Rekhamala, Lilunda, and Rotkala largely sell *ghee* and *mawa* instead of milk.

In addition to milk sales, daily wage labor mostly outside the villages, agriculture, and goat selling contributed to the remaining 10.6% annual household income. Goats, found to be the most abundant livestock in the park, are largely kept for selling. On an average, 20–25% of goats owned by the inhabitants are sold from every village per year. Goats are sold at the rate of 500–700 INR per individual to the butchers outside the tiger reserve. During summer, some villagers exchange their buffaloes with goats as goats are easy to maintain being browsers and provide instant cash and commodities.

Among the ten villages, only two revenue villages, i.e., Deori and Dabli, were found to earn from crop cultivation as they owned some land in the national park where they are allowed to practice agriculture. However, none of the villagers reported to work as daily wage laborers either inside or at places nearby the tiger reserve, but some of the inhabitants visited places like Delhi, Bhiwadi, and Jaipur to work as drivers, daily wage laborers, and waiters.

## General Awareness and Attitude Toward Environment and Conservation

The inhabitants of these villages are well acquainted with their surroundings and showed a positive attitude toward conservation. More than 75% of the respondents had a clear idea of tiger extermination from the area, and a much higher percentage, i.e., 88%, of the respondents, considered the disappearance of tigers as a sad happening. As whether tigers should be reintroduced or not, maximum number of the inhabitants (98%) were found willing to welcome the move of the forest department and concerned authorities to bring the tigers back in Sariska. However, when asked about their willingness to relocate, 58% of the respondents were readily willing to relocate, whereas the other 40% were ready to relocate if assured to be provided with attractive packages including land, money, and accessibility to other basic amenities. Most of the inhabitants (97%) reported for no assistance being provided by

the government authorities in these villages, and also 79% respondents reported the forest department to be indifferent to them in restricting them from forest resource collection and charging fines on them for their livestock grazing in the forest land. Human–leopard conflict was almost negligible with less than 1% of the inhabitants responding positively, and also only 13% of the respondents reported of the livestock depredation by leopard.

## Discussion

### *Human Population*

The estimated sex-ratio when compared with the national average, i.e., 93 females per 100 males, was found to be low in all the sampled villages except in Haripura with 98 females per 100 males. But, the population exhibits a highly growing trend as evident by the number of children being almost twice to that of the female numbers in the population with one village having the number of children to be even three times to that of the females. The literacy-rate reported by these villages was in accordance with their accessibility to primary and secondary schools location, i.e., within a village or at nearby places. The low literacy-rate reported in these villages could be attributed to their unawareness toward the importance of education primarily because of their traditional ways of earning livelihoods like milk selling and daily labor and also to the lack of basic amenities like proper road network. However, the reason for higher percentage of literate children population (only up to primary level) can undoubtedly be the provision of primary schools by the government authorities known as *Prathamik Baudhshalas*. However, they have almost negligible access to secondary schools or colleges. This results in the education among the masses to be restricted up to primary level.

### *Livestock Population and Distance Covered for Grazing*

The entire livestock population (9,933 individuals) is found to be totally dependent on the forests for grazing and browsing. An average distance of $3.3 \pm 0.3$ (SE) km has been reported by the villagers to be covered by their livestock population in the tiger reserve with the longest distance traveled from village Rekhamala (4.5 km) and the shortest from Deori, i.e., 1.5 km (Fig. 16.9). Thus, the estimated area left relatively undisturbed for wildlife is less than 15% in the entire national park. However, the high increase recorded in the livestock number suggests that the scenario in the near future is going to be unmanageable if it continues in the same manner.

**Fig. 16.9** Village Kankwari which is due for relocation in Sariska

## *Resource Dependency*

Extensively large amount of fuelwood and fodder being extracted from the reserve may result in quick depletion and degradation of the forest resources in the near future. Long-term use of the Sariska forests for grazing, fodder collection, and firewood removal by local residents has been reported as the primary cause for degradation and biodiversity loss [8]. Extensive forest degradation in certain regions suggests that the intensive use of forests for sustenance and consumption is no longer viable [15]. Non-timber forest product extraction contributes significantly to local household income in tropical regions and has been viewed as preferable to conversion to other land uses when it is sustainable. However, non-sustainable resource extraction can have deleterious consequences for biodiversity and affect the livelihoods of the users [15]. Also, the extraction of non-timber forest products is an important activity practiced by all the villagers to feed their livestock.

High commercial value possessed by the fodder and fuelwood exploited in the local level market includes the input costs being provided by the forest department and the state government for the maintenance of the tiger reserve from time to time. Therefore, the cost of production from common resources increases and their outputs decrease [16]. Sustainable extraction can be achieved only under particular conditions of low population density, simple technology, localized resources, and

limited possibilities of expansion [17–20]. Collection for subsistence livelihoods could be a major driver of deforestation, although the relationship between deforestation and wealth is not straightforward [21, 22]. Deforestation has multiple scalable causes that differ geographically [23, 24], suggesting that policy might have to be site and case centric to be effective.

## *Sources of Livelihood for the Local People*

The local residents mainly depend on the sales of dairy products, i.e., milk, *mawa*, *ghee*, etc., to earn their livelihoods. Lower profits gained by the villagers through milk selling are because it is not sold directly in the larger markets, but to the dealer in the village itself. However, the sales of *ghee* and *mawa* instead of milk by the inhabitants of Kiraska, Dabli, Sukola, Rekhamala, Lilunda, and Rotkala can largely be attributed to the lack of roads for the vehicles to ply on, thus resulting in their inability to walk down daily to sell milk. The local people, apart from a smaller percentage, generally do not prefer to work outside. The fact can primarily be attributed to the illiteracy prevailing among the communities due to which they do not get work outside other than as daily wage laborers being paid with a meager amounts of 2,500–3,000 INR per month and also the inhabitants reported to have nobody to look after their family in their absence, most of them having young children, land, and cattle. Also, in villages like Sukola, Dabli, and Rekhamala, the inaccessibility to roads due to which they have to walk about 7–8 km even to visit a doctor seems to be the major factor responsible for the same and makes them to survive in extremely miserable conditions.

Almost negligible income generated through agricultural practices can undoubtedly be attributed to the lack of land holdings with the villagers except some inhabitants in the revenue villages, i.e., Dabli and Deori. People from Kiraska also reported to own land around their village in the earlier times and are now not being allowed to cultivate by the forest department. The major crops grown in the area are wheat, oat, barley, and vegetables where out of the total yield, sometimes half or even less than that is sold and the rest is kept for their own consumption.

All the families raising goats in the study area reported to sell goats once or twice a year. Goat herds are commonly doubled in a year and, thus, considered to be the most prized assets for relatively better-off households [25]. Therefore, for the villagers, possessing goats and sheep is an alternative in times of drought and hunger. Poor households largely rely on goats as their maintenance costs are comparatively low. According to Rathore [26], the market in arid areas has been described as favoring the herder, and good prices are usually available for most small holders except during drought years when desperation sales allow the buyer to set the price. Even then, goat sales are one of the few avenues of access to capital. Throughout the year, goats provide the steadiest and most reliable source of income for nonspecialist households. This is especially significant in a region where failures in monsoon rainfall are common and agricultural production is highly risky [25]. Also, goats are

much hardier and able to subsist on browse species. Additionally goats require next to no medical attention or commercial fodder in comparison to larger livestock [8].

Limited accessibility to roads, extremely low literacy-rate, and long-time-followed traditional ways of earning finally leave the local communities with no alternate options to earn their livelihoods except the ones discussed above.

## General Awareness and Attitude toward Environment and its Conservation

The study revealed that the concept of conservation is well-supported in the area, even when the inhabitants are highly dependent on the park resources for their sustenance. Most of the inhabitants were found having fairly good knowledge about their surrounding environment and were ready to play an active role for its conservation. Some people, in fact, said that tigers play an important role in the grazing economy through their depredations on livestock as tigers tend to kill out the weaker individuals from the stock. Almost all the inhabitants believed that the presence of tigers in the area kept their livestock healthy as the killing of one individual by the tiger from the stock stopped the spread of diseases among their entire livestock population. Alves [27] also reports a local folk proverb: "*The tiger and the cow must drink from the same pool*" and a common belief that "*because of the tiger*, *the buffalo is not sick too often*," reflecting the perceived importance of the tiger in the grazing economy. Also, the respondents were really keen and willing regarding tiger reintroduction and responded through facts which showed their positive and caring attitude toward environment and conservation. They said that tigers are *king of the Jungle*, it is their home, and they should definitely live in their natural habitats. They said that tigers safeguard the forests from resource exploitation as people are afraid of going into the interiors of the forest for fuelwood and fodder collection.

The response regarding relocation of villages varied with the level of education, accessibility to the essential commodities, and sources to earn livelihood. The respondents were found to be under the dilemma regarding the deals and promises made by the forest department to be fair and fulfilling, but also the miserable conditions of most of the villages made them readily willing to relocate. After the successful relocation of Bhagani, the forest department is now preparing the blueprint for the relocation of Kankwari, Umri, Haripura, and Kiraska in the near future. The inhabitants of Sukola, Duarmala, Rekhamala, and Dabli showed positive response toward the relocation plan provided they are dealt fairly and shifted outside Sariska with a good deal to people (land for cultivation, money, house, water, electricity, and easy accessibility to a nearby town to avail banking, medication, and educational facilities). Some people also demanded legal papers for the land given for which they were also ready to sign a bond for not selling it for the next 20 years. It seems that other villages would also follow the relocation path if similar deal is given to them like the one offered to Bhagani villagers and their requirements are fulfilled to satisfactory levels. This could be due to the reason that Haripura is located close

to well-established human habitations (forest department headquarters and Bhartari) and also the Alwar–Thanagazi and Alwar–Tehla main roads.

The future of Sariska lies in successful relocation of the remaining ten villages from the notified area of the national park (core zone I), which, in turn, will provide a disturbance-free habitat for the wild ungulates and their predators.

## Recommendations

Large-scale development of plantations, pastures, and forests is required in the buffer zone of Sariska and beyond to reduce pressures on the national park plant biomass. Positive interactions have to be inculcated between peripheral villages and reserve management via substantial compensatory mechanisms, such as for loss of access to forest resources and compensation for injuries and crop-raiding by wild animals. Comanagement of forests involving local people and institutions and restoration of their rights may help to resolve conflicts related to resource use and lead to a better management of natural resources. It is said that introducing "real" people-oriented management approaches is the way to achieve long-term biodiversity; thus, more site-specific and human-faced park management policies are needed, particularly provision of tangible benefits and alternative livelihoods for the affected population [12]. To achieve success in fulfilling the above-mentioned goals, the implementation of eco-development programs with the involvement of NGOs is recommended.

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# Chapter 17
# Nature Reverence does not mean Conservation in Tribal Rajasthan: Culture, Cognition, and Personal and Collective Commitments to the Environment

**Jeffrey G. Snodgrass, Satish Kumar Sharma, and Michael G. Lacy**

**Abstract** We discuss why nature reverence and pro-environmental *thinking* among indigenous peoples inhabiting a Wildlife Sanctuary in southern Rajasthan does not translate into more actual conservation *practice*. We point to the way that the post-Independence dispossession of these peoples from their lands has resulted in a failure of institutional organization and collective action. Lacking locally meaningful institutions for monitoring and policing forest resource use, even individuals personally committed to conservation lose the will to behave responsibly with regard to their forests. We use this discussion to refine a cognitive anthropological framework of the environment that prioritizes both individual commitment and social organization and that attempts to understand how local beliefs and values intersect with, and are constrained by political contexts.

## Introduction

Our research indicates that indigenous peoples living in and near the Phulwari Ki Nal Wildlife Sanctuary (Fig. 17.1) in southern Rajasthan (Udaipur district) deeply revere nature. For example, the indigenous *Bhils*, who are the focus of the present

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**Fig. 17.1** Phulwari Ki Nal's distinctive rock outcroppings

research, worship *Magra Baoji*[1]—the living mountain parent, who is believed to possess rock bones, river blood, and tree and moss hair. They empathize with this sentient mountain, believing that he not only thinks and reasons and indeed is smarter than humans but also feels pain due to damage caused by mines, clear-cuts, and pollution. In order to protect their mountain god from suffering, most all our informants vehemently condemn any and all actions that threaten or harm the woods and wildlife surrounding their homes.

[1] *Magra* means mountain in local tribal dialects, and *baoji*, though widely used to refer to deities and spirits, is more generally "a term of respect also used for elders who possessed supernatural knowledge" [1].

We also learned, however, that these same indigenous peoples do not generally practice conservation. Inhabitants of this wildlife sanctuary not only overhunt bushmeat, they overharvest medicinal herbs, overgraze their lands, and over-tap gum trees. They illicitly cut bamboo and timber, carelessly use fire when smoking out bees for honey hidden in tree stumps, gather too many headloads of wood and grass for animal fodder and fuelwood, and illegally encroach on lands earmarked for wild animals. Wild animals seen to threaten one's well-being—leopards that can devour domesticated herd animals, hyaena that gobble up corn on the stalk, and the deadly Russell's Viper (*Daboia russelii*)—sometimes can be harassed, harmed, or even killed with seemingly little remorse.

In this chapter, we describe the environmental thought and practice of our tribal Bhil respondents. More particularly, we address why it is that the nature reverence and pro-environmental *thinking* of our informants does not translate into more actual conservation *practice*. It is tempting to simply say that indigenous peoples living in and around this wildlife sanctuary do not *really* demonstrate pro-environmental thought. Or, perhaps, our interviews elicit cultural ideals that are rarely pursued or that merely reveal what informants think that we the researchers want to hear. We do not feel, however, that this is the case. Interviews and observations conducted over 4 years, which culminated in a 238-person survey administered in fall 2005, demonstrate indigenous reverence and respect for their woods and wildlife.

Instead, we point to a lack of meaningful institutions that organize individuals in these communities for collective action—in this case, for defending their forests against abuse and overuse by both insiders and outsiders to the community. Lacking locally meaningful institutions for monitoring and policing forest resource use, even committed individuals who, as we will show, cognitively "model" the forest as a sacred ancestor lose the will to behave responsibly (in their own terms) in regard to their forests. This lack of institutional infrastructure helps to explain both why the forests in this sanctuary continue to degrade and also why environmentally conscious individuals fail to act on their best intentions. Individual restraint in these contexts, after all, means that conscientious individuals get less of a valuable resource than those who fail to exercise such restraint.

In our research, we complement ethnographic methods and perspectives with techniques and theories drawn from the subdiscipline of cognitive anthropology and particularly from the "cultural models" literature [2–6]. We use such cognitive anthropological perspectives and theories to uncover the form and content of tribal conservation thought, for example, our informants' widespread cultural "modeling" of the forested mountain as a sacred being. However, we found that cognitive anthropological perspectives, as currently framed to explain environmental issues, were only partially able to illuminate the disconnection between our informants' deep love and affection for their mountains and their failure to actively defend and conserve their natural resources. We thus present in this chapter an alternate cognitive anthropological perspective, which we think better accounts for these disconnections between pro-environmental thinking and practice. In particular, we expand cognitive anthropological notions of "culture" to include what we, following D'Andrade [7], call not only its personally "internalized" but also its collectively held "institutional" dimensions.

## The Cognitive Anthropology of the Environment: Relevant Theories and Methods

Cognitive anthropology is the subfield of anthropology concerned with the analysis of human *thought*: as one influential scholar in this anthropological subdiscipline puts it, "the cognitive anthropologist studies how people in social groups conceive and think about the objects and events which make up their world—including everything from physical objects like wild plants to abstract events like social justice" [2, 8]. In both the design and analysis of our research, we draw in particular on what cognitive anthropologists call "cultural models." Psychologists, linguists, and philosophers have devoted considerable attention to the study of *schemas* (or *schemata*)—simple cognitive elements or prototypes which help individuals organize and process information in relationship to their social and natural environments—as well as to *models* or *frames*, understood to be more complex concatenations of schemas, which help individuals understand the world around them and attribute meaning and significance to events and experiences [9–17]. Building on such insights, cognitive anthropologists analyze *cultural* models and frames—as opposed to idiosyncratic or *personal* models—in the sense of abstract and simplified mental representations of the world that are both *socially transmitted* and *widely shared* within a group [2–7, 18–20]. As understood in this literature, cultural models provide a structure through which novel ideas can be generated and novel observations given meaning, thus allowing for constrained creativity and innovation within the structures provided by tradition.

Of particular interest for our research is a growing body of anthropological theories and perspectives as a starting point to understand *environment*-related processes.[2] Cognitive anthropologists have been busy documenting human thought in relationship to the environment for decades now.[3] Early classic work in the cognitive anthropology of the environment focused on the manner in which the natural world, and particularly plants but also animals, were named and classified by local peoples; the form and content of these classification systems were read to provide deeper insights into both local knowledge, values, priorities, and economies as well as into panhuman potentials [27, 28]. These early ethnobiological studies developed into in-depth analyses of ethnobotanical and ethnopharmacological knowledge, focusing on the manner in which plant uses for treating human illnesses were conceptualized by usually indigenous peoples inhabiting small-scale, relatively isolated, low-technology societies with deep historical ties to particular environments [29].[4]

[2] See [21–26] for our own work in this regard.

[3] For a survey of this work, see Kempton [8].

[4] The description and analysis of traditional ethnobiological knowledge systems—and mainly ethnobotanical and ethnozoological knowledge—is still a vibrant project within cognitive anthropology, as demonstrated by the contemporary societies and journals devoted to this topic. See, for example, the *Journal of Ethnobiology* produced by the Society of Ethnobiology and also the International Society of Ethnobiology.

More recently, cognitive anthropologists working within the "cultural models" tradition have been interested to document cross-cultural understandings of the environment and ecosystems. In part, this is a descriptive project in which cognitive anthropologists describe the form and content of underlying and shared conceptual models, often referred to as "traditional ecological knowledge" (TEK), related to nature and natural resources [30]. But many of these researchers attempt to document the manner in which these models actually structure active and inferential thinking in regard to the natural world and, in some cases, the need for conservation. Thus, for example, Atran and Medin [31, 32] document the manner in which Mayan Indians conceptualize the natural world as a *house* or *household* in contrast to Americans' frequent understanding of nature as an *organism* much like the human *body* [8, 33]. Such models, in turn, lead to culture-specific predictions or inferences about the natural world: Americans think of nature as having constituent *organs* (species) that are each necessary to the survival of the organism as a whole (ecosystem), a system that like a precariously balanced *house of cards* can be easily tumbled down in a *chain reaction* with the loss of a single vital organ; by contrast, Mayans think of the various *rooms* (species) of the house as a whole (ecosystem) being vitally linked to each other but not in any essential way as in the case of a human body; such a system of thought, Atran and Medin [31] argue, can lead to beliefs in a hardier and more resilient nature given that the various rooms of the house are somewhat interchangeable and can serve the functions of the others if necessary [34, 35].

Responding to a call within cognitive anthropology to move beyond a study of mere abstract thinking about the environment and the need for conservation to the way that thought connects to actual *behavior*, contemporary cognitive anthropologists of the environment have begun to examine how cultural models of nature lead to environmentally significant actions.[5] Thus, for example, Kempton *et al*. [33] elegantly illuminate the manner in which belief- and value-based identities such as belonging to the Sierra Club or Earth First can, for example, make one more or less likely to *act* in ways that conserve natural resources: voting for an environmentally friendly Green party, donating to an environmental NGO, recycling, and so forth. Likewise, other researchers point to the manner in which understandings, knowledge, and "cognized models" of the natural world structure actual resource management and utilization in non-Western contexts [31, 32, 37–39].

Methodologically, cognitive anthropologists working within the cultural models tradition often document the form and content of cognitive models with a methodological suite of statistical routines (and indeed what some consider a theory in its own right) known as "cultural consensus analysis" [40–43]. Dressler *et al*. [45],

[5] This follows the more prosaic, yet nevertheless important and time-intensive, agenda of documenting the wide range of cultural models found within America and elsewhere. On this change in research agenda, see D'Andrade [2, 7]; D'Andrade and Strauss [36]; Hutchins [20]; Kempton [8]; Strauss and Quinn [6].

whose procedures for eliciting shared models of a "successful Brazilian" provided inspiration in our own research, expand upon the consensus process:

> In cultural consensus analysis, agreement among a set of informants (and in many applications a small set, e.g., around 30, is sufficient) is evaluated by first collecting their responses to a fixed set of questions that sample knowledge of a domain. Then a kind of statistical thought experiment is conducted in which a model of a single set of "culturally best" responses is proposed, and the degree to which each informant's responses match that aggregate model is evaluated. If, overall, there is a relatively high degree of correspondence between each informant's set of responses and the hypothesized culturally best model, then it can be said that there is consensus regarding that knowledge, and further, it is reasonable to infer that each individual is using the same or a very similar model.

Sets of statements with high consensus and thus high sharing are presumed to be, under the tenets of this theoretical model, potentially *cultural* in nature. Or, more technically (and to help with the interpretation of our research results reported below), first, the cultural consensus analyst factors an informant-by-informant correlation matrix, which demonstrates associations of each respondent with every other respondent on the survey items in question. A first factor *answer key* is derived from weighted means of informant competency. This answer key or sheet serves as the culturally agreed upon best model for the tested domain. Each respondent also receives an individual *competence score*, identifying their relative agreement with the culturally agreed upon correct responses or answer key. By convention, if the eigenvalue ratio of the first to the second factor of the factored matrix is greater than 3:1, or in other words, if the first answer key explains three times more variability than the second most applicable answer key, than there is evidence of high cultural consensus—and thus of a single culture. Where the eigenvalue ratio is less than 3, again by convention, researchers see evidence of a lack of consensual culture.

## Setting

Our research unfolded in the Phulwari Ki Nal ( "Abode of Flowers") Wildlife Sanctuary—a dry tropical deciduous forest reserve of 511 km$^2$, which sits in the southern portion of the Aravalli Mountain Range in Udaipur district near the Rajasthani town of Kotra. Before Indian Independence in 1947, this area was a hunting reserve of the erstwhile rulers of the princely kingdoms of Bhumat and Mewar. In 1983, the area was declared a state wildlife sanctuary in accordance with the 1972 Wildlife Protection Act, as well as the 1980 Rajasthan Forest Conservation Act.

In contrast to American practice, indigenous persons in India—referred to as *Adivasis* (literally "first inhabitants" or "natives"), *janjatis* (often translated as "tribals"), and "Scheduled Tribes" (an official state designation)[6]—continue to

[6] They are "scheduled," along with India's low status and formally untouchable caste communities, for government aid programs aiming to alleviate poverty and "backwardness."


**Fig. 17.2** Drs. J. G. Snodgrass and S. K. Sharma (center) with *Bhils*

inhabit many of India's protected and reserved forests, parks, and wildlife sanctuaries. In the case of Phulwari Ki Nal, there are 134 villages within the sanctuary [46]. Many of these villages are occupied by members of the *Bhil* tribe (Fig. 17.2), the dominant population in the area (about 75% of the area's population), the third largest tribal group in India, and the focus of this chapter.

Tribals in the area depend heavily on the forest for their economic survival, though in law, no one is allowed to take, as we were told, "even a single blade of grass" from within the sanctuary's boundaries. Our typical respondent visits forests usually just a few 100 m from their homes every third day—though at least one family member typically travels there daily—leaving early in the morning with domesticated animals and returning after four to five hours of work. Most *Adivasis* describe themselves as heavily reliant on forest produce such as wild herbs (referred to as *jadi buti* or "roots and herbs"), fruits, vegetables, gum, honey, and the flowers and fruits of the *mahua* trees (the flowers of this tree, *Madhuca indica*, are brewed into alcohol, the fruits made into edible oil). They also gather "headloads" of grass and wood, used or sold as animal fodder and fuelwood. Despite our informants' economic reliance on the forest, and in part because of the prestige attached to farming and the ownership of domesticated animals in dominant Hindu society, most of our respondents also own farmland and domesticated herd animals.

Many tribals work part of the year for the Rajasthan Forest Department (RFD). Some are hired to harvest bamboo, hardwoods, and other forest products under state contracts, while others help RFD officials track and count the sanctuary's leopards and other wildlife. Most are able to earn some income, if they desire, planting


**Fig. 17.3** A *Bhil* home found within Phulwari Ki Nal

saplings, maintaining nurseries, or building the RFD's many dams (or smaller *anicuts* and "check dams"), watering holes for wildlife, roads, and stone fences (meant to keep grazing animals from devouring newly planted trees).

In spite of their many sources of income, forest- and non-forest-related, our informants are generally poor. 94.1% of our sample inhabits *kachcha* ("crude" or "unfinished") houses constructed entirely of forest products lacking in mortar or cement, which they make and maintain themselves (Fig. 17.3). 43% of our sample hold below poverty line (BPL) cards, which allow them to buy grain and other essentials at deeply discounted prices from government stores.

## Research Methods

The lead author, Jeffrey Snodgrass, who has conducted research in Udaipur among formerly untouchable communities since the early 1990s,[7] performed the ethnographic interviews and observations in tribal villages near protected forests.

[7] See, for example, Snodgrass [44].

He usually spent 10–12 h each day intermingling with tribals and RFD employees in village and forest contexts and then sleeping nights in RFD outposts (*nakkas*) located near tribal villages or in the villages themselves.

This ethnography and informal interviewing, which took place in the summers of 2003–2006, as well as in autumn 2005, provided insights necessary to develop and meaningfully interpret a 190-item survey used to assess our informants' relationship to nature. Our survey methods were influenced by social psychological studies of environmental thought and practice.[8] However, many statements included in our survey were direct quotes of widely recurring ideas taken from our qualitative interviews. These included statements related to religious experience and nature reverence, understandings about the mind and personhood of mountains and animals, knowledge of plants and trees, economic dependence on the jungle, and the necessity of wildlife sanctuaries. We were also interested to understand our informants' relationship to the RFD and its policies. We thus collected statements that deviated in their descriptive language and categories of thought from local views and perspectives held by our informants—this included standard demographic data like age, gender, education, tribal affiliation, and land ownership—and also statements about conservation and wildlife management that were closer to the perspectives and language of the RFD and local NGOs than to tribals themselves.

The final survey was written in Hindi and, after multiple field tests, administered orally in local Rajasthani dialects by six master's students in sociology from Bhupal Nobles' PG College (Udaipur, Rajasthan) over a 10-day period in November 2005.[9] As a sampling strategy, we administered the survey to individuals inhabiting 20 tribal villages located in or near the proposed ecological core of the Phulwari Ki Nal. This assured that we elicited responses from persons who, in the RFD's opinion, would be most critical to the conservation of the sanctuary's key areas. We distributed the survey to a total of 238 individuals. The response rate to our questionnaire was nearly 100%—largely because we paid informants 20 *rupees* (about 40 US cents), equivalent to a half day's pay for wage laborers, for the 30- to 45-min interview.

## Research Results: Nature Reverence but Not Conservation

### *Survey Results*

Survey items related to our informants' environmental thought and practice are summarized in Table 17.1. Referring to this table, we see that our informants possess a deep and abiding relationship to the natural world. For example, they attribute

[8] For example, studies of the relation between religion and "environmental concern" such as Guth, Green, Kellstedt, and Smidt [47]; Hayes and Marangudakis [48]; and Schultz, Zelezny, and Dalrymple [49].

[9] Interviews were usually conducted in Mewari, a Rajasthani dialect and lingua franca in the area, rather than in Hindi or in the particular Bhili or other tribal dialects spoken in the sanctuary.

**Table 17.1** Environmental thought and practice of the sample as a whole ($N = 238$)

| # | Item | Agree | Neutral | Disagree |
|---|---|---|---|---|
| Nature as a "sacred person" | | | | |
| 1 | The mountain thinks and has opinions like human beings | 71.0 | 4.2 | 24.8 |
| 2 | The mountain is smarter than humans | 65.1 | 5.9 | 28.2 |
| 3 | Mining and the cutting of trees cause the mountain to feel pain | 89.1 | 2.1 | 8.8 |
| 4 | Rivers and ponds feel pain when dirty things pollute them | 84.5 | 3.4 | 12.2 |
| 5 | The jungle is more like my "father and mother" than my property | 88.2 | 0.8 | 10.1 |
| 6 | The mountain god's power is greater on the mountaintop than in the village | 68.9 | 4.6 | 23.9 |
| 7 | The god of the mountain protects the jungle more than farmland | 40.8 | 21.8 | 34.0 |
| 8 | The mountain god prefers visits to mountaintop rather than village shrines | 79.4 | 0.8 | 18.9 |
| Nature as "fragile" | | | | |
| 9 | There are so many different animals in the jungle; if three to four species go extinct, it does not make any difference to the jungle | 40.8[a] | 5.9 | 52.9 |
| 10 | These days wild animals do not have enough space to live | 76.5 | 2.1 | 20.6 |
| 11 | Wild animals need places to live where there are no villages or human habitations | 76.5 | 11.8 | 11.3 |
| 12 | New human settlements near the jungle have led to a decline in animal populations | 85.3 | 1.7 | 12.2 |
| 13 | Taking gum from trees makes them stronger | 10.2[a] | .8 | 88.7 |
| 14 | Human overuse of certain forests of Gujarat has led to their disappearance | 89.5 | 2.1 | 8.4 |
| 15 | Daily use of the jungle and too much human dependency on the jungle compromise the forest's beauty | 85.3 | 2.9 | 11.8 |
| 16 | Sometimes I fear that our forests too may decline or disappear | 89.5 | 1.7 | 8.4 |
| 17 | In order to restore damaged sections of the jungle, it is necessary to close them off to human and domesticated animal use | 81.5 | 3.4 | 15.1 |
| 18 | We do not need to save/protect those wild animals that do damage to human crops and domesticated animals | 34.5[a] | .8 | 63.9 |
| 19 | We need more guards in order to effectively protect our forests | 62.2 | 2.1 | 35.7 |
| 20 | The government should further increase fines for those individuals who illegally cut trees from the forest | 90.3 | .4 | 9.2 |
| 21 | The government should allow more farming in this game sanctuary | 73.9 | 5.0 | 20.6 |
| (Reported) conservation practice | | | | |
| | How often have you . . . ? | Frequently | Sometimes | Never |
| 22 | Reported a forest crime to the RFD | 3.4 | 14.3 | 82.4 |
| 23 | Stopped someone from illegally cutting trees | 9.2 | 26.9 | 63.9 |
| 24 | Participated in a FPC meeting | 3.8 | 16.8 | 79.4 |

[a]Items marked with an asterisk are reverse scored so that a lower number indicates more environmental understanding or a closer relationship to the forest

sentience to rocks, rivers, and mountains, which they revere and empathize with (items 1–4). The vast majority of our sample consider the jungle a "father and mother" (*ma-bap*) rather than their property (*sampati*) (item 5). Likewise, they locate their spiritual center in mountain shrines surrounded by forests: the god of the mountain (*Magra Baoji*) is typically our informants' central deity. He in turn is seen to have the greatest power in his mountain as opposed to village shrines (item 6), he is also seen to protect the jungle more than the village (item 7), and he prefers that believers make the difficult trek to his mountain abode rather than simply paying homage to village shrines (item 8).

Tribals also understand the behaviors of animals and the interconnection of animal species, tending to disagree with the idea that a loss of species does not impact the jungle as a whole (item 9). They realize that human activity and expansion have compromised the needs of wildlife as well as the beauty and even continued existence of the forest (items 10–16). They thus demonstrate a commitment to closing off wild spaces and protecting wildlife (items 17–18), calling for more guards to patrol their forests and voicing support for raising fines for illegally harvesting timber (items 19–20). Still, our respondents do not feel that their own farming overly compromises the forest's survivability, supporting the idea that the government should allow more farming in the sanctuary (item 21).

Further, our cultural consensus analysis shows a large degree of sharing on three interrelated tribal "models" or "frames" of nature, suggesting that certain pro-environmental patterns of thought might be widely shared and thus in some sense *cultural*. For example, we performed cultural consensus analysis on a number of interrelated survey items (1–8) connected to ideas about the mountain's powers and ability to think and feel like a human person, to document a potential cultural model or frame of the mountain as *sacred person* or *ancestor*. A cultural consensus analysis of these items (using UCINET) gave a first to second eigenvalue ratio of 5.16 and an average individual competence score of 0.73. As there were likewise no negative competence scores, these results demonstrate that our *Bhil* respondents, according to the tenets of consensus procedures and theory, share the understanding that the mountain is a *sacred person* whose powers are particularly strong on the forested mountaintop itself (as opposed to in the village, where these gods also have shrines).

Likewise, we performed consensus on another set of survey responses, which we also considered potentially interrelated, this time concerning ideas about how human activity might negatively impact a potentially vulnerable natural web of interconnected species (items 9–21). Here, too, we found a high degree of cultural sharing, with a first to second eigenvalue ratio of 9.38, an average competence score of 0.73, and no negative values. We might interpret this to show environmental concern and awareness of the potentially negative impacts of human activity on nature. However, in the cultural models' consensus framework, we think this also potentially reveals an underlying cognitive model of the mountain, with its interconnected species, as somehow *fragile* and *vulnerable*.

Finally, we performed consensus on all the combined items in the two previously described models, to trace potentially cultural sharing on local understandings of the mountain as a *fragile parent*, perhaps an *elderly or ailing parent*, now needing

care and protection. This gave us a first to second eigenvalue ratio of 11.86 to 1, an average competence score of 0.74, and no negative values, again pointing to the manner this "fusion" model is shared among our Bhil informants and thus potentially cultural in nature.

Despite broad consensus on a number of pro-environmental *thought* items, reported conservation *practice* was less commonly reported among our informants: only 17.7% claim to have reported forest crimes to the RFD, 36.1% to have themselves actually have stopped such a crime, and 20.6% to have participated in a FPC meeting (Table 17.1: items 22 to 24). When it comes to actually *participating* in pro-environmental *practices*—rather than just demonstrating environmental *awareness*, reporting a commitment to conservation *values*, or even reporting that one supports such action in the *abstract*—our informants demonstrate a much lower commitment to actual conservation action.

## *Ethnographic Interviews and Observations*

We might refer to the pro-environmental thinking revealed by our survey as pointing to a Bhil *cultural* consciousness in the way that these understandings are shared by a large percentage of our sample. Indeed, our ethnographic interviews and observations (as during transect walks through forests accompanied by tribals) revealed that our informants possessed a deep affection for, and feeling of kinship with, the mountain. Our informants clearly enjoy spending time in the jungle as well as observing wildlife and indeed say they would not be "true" tribals without their forests. Similarly, our Adivasi informants lament even the loss of a few species and even say they favor protecting predatory species that harm their livestock.

As in our survey, our interviewees consistently presented the mountain surrounding their homes as a sacred *person* of a kind. This person, *Magra Baoji*, possessed similar attributes as human persons. The rocks were his *bones*, the rivers and ponds his *blood*, and the trees, mosses, and grass his *hair*. Likewise, he was seen to possess a *mind* and a *soul* and thus could *think* and *reason*, as well as feel *pain*, *love*, and *longing*. All of our interviewees considered the mountain more like a *parent* than their property, and they revered the living mountain as a *god* with *powers* that are not generally accessible to human beings. Likewise, tribal individuals also pay their respects to a multitude of lesser nature spirits seen to animate their land's ponds, rock formations, and grasses.

This personification of nature as a community of *living beings* clarifies our informants' proclamations, recurrent in these interviews, that the mountain and the forest have even more of a right than humans to live and flourish. As a family member but also a parent, the mountain is perceived to have an "intrinsic right" [50] to flourish and avoid unnecessary suffering. The Hindu religion demands filial loyalty to parents. In framing mountains as parental figures, local animism channels such filial sentiments toward a living, breathing, and personified nature. A similar line of reasoning is found in the way our informants speak of wild animals such as leopards.

Our informants often express the idea that forest-dwelling plants and animals are the *offspring* and *children* of the living mountain and thus have as much a right to exist as human beings.

This returns us to the issue of the relationship between tribal identity and nature conservation, which we define following Smith and Wishnie [51] as actions or practices consciously designed to prevent or mitigate resource overharvesting or environmental damage. It is true that *Bhils* do tend to protect and tend the trees and species that are economically valuable to them. For example, *mahua* trees, which yield not only fruits but flowers from which a local liquor is distilled, are especially well treated. These are inherited from one's father and are considered an important source of wealth both for one's own consumption as well as for sale in the market. In fact, most fruiting trees—mangoes but also others producing small fruits that are sold by children on the roadside—are not generally cut nor are a variety of religiously significant trees such *banyan*, *peepal*, or others which are either worshipped or provide products such as flowers that are used in the worship of the gods. This is also the case of *tendu* trees whose leaves are harvested for use in rolling *bidi* cigarettes. These are carefully tended and pruned. They also are not cut for timber nor are the six or seven species of trees that produce gum that is used to produce food, medicine, and rubber and that is either consumed locally or sold to Marwari middlemen vendors. Some trees are also seen as ancestors to certain tribal clans in the area, and these too are not cut but instead worshipped.

However, we witnessed a lack of conservation practice in regard to many other contexts and species. For example, tribals have overhunted bushmeat, and especially large game such as deer, which are no longer found in the sanctuary. Instead, they now hunt only small game, rabbits and partridge, though even these are getting scarce.[10] We also saw that *Adivasis* in this area frequently do not wait to harvest several local species of grass found on the mountain until they are head high, which would be an efficient and sustainable way to use this resource, allowing hay to be stored for droughts and lean times. Instead, they send their goats and sheep up into the mountain as soon as the first green shoots appear, despite the efforts of local NGOs to promote more efficient grasslands management. Likewise, local Bhils and others generally realize that certain roots, like *safed musli* (referred to as *desi* or Indian-style Viagra because of its energizing potential; this root is sold at a premium in local markets), should be harvested after the rainy season has ended. This allows the root to meet its maximal size. *Adivasis* know that a small piece of the root should be left in the ground, even replanted if the whole root happens to be extracted. This allows the rhizome to regrow for the following season. Nevertheless, it seems that only a minority of elders follow such rules. Now *safed musli* is almost totally nonexistent in the area.

[10] Spotted Deer (*Chital, Axis axis*), Swamp Deer (*Barasingha, Cervus duvauceli*), Bluebull (*Nilgai, Boselaphus tragocamelus*), and other large mammals are no longer found in the sanctuary due to overhunting and habitat loss; Wild Boar (*Sus scrofa*) and other smaller game animals, such as (*Chinkara, Gazella bennettii*), are only rarely seen.

Perhaps the biggest environmental problem in the area is the illicit harvesting of timber. Some villagers do everything in their power to stop such harvesting by the local timber mafia, though this is oftentimes not the case because, as the lead author was once asked by a local respondent, "What can one man, or a small group, do against such numbers?" Others, however, expressly turn a blind eye to such harvesting, especially when their own out-of-town relatives are involved. Still other Adivasis are directly involved in this illegal activity, sometimes in cahoots with the timber mafia itself or even, we were told, with RFD employees.

Local *Bhils* also set fires in hollows of logs, in an effort to smoke out bees and collect their honey. And these fires sometimes get out of control, burning large sections of jungle. *Bhils* tribals also make vows to their gods that if certain boons are granted then the supplicants would reward their deities with a gift of fire—referred to as a "fire bath" (*agni snan*)—that could leave an entire slope darkened. Our informants, ahead of some Western resource managers, recognize some of the beneficial aspects of fire in regard to forest health. They know, for example, that fires clear out underbrush, allow for resprouting of certain trees, promote berry and fruit production, and in general lead to healthy forests. Nevertheless, it is evident that in their "fire baths" such a promotion of forest health is not uppermost in their minds. These intentionally set fires very often do great damage to the jungle, burning very hot, and local Adivasis know it.

## Discussion: Culture and Institutions in the Cognitive Anthropology of the Environment

Following theorists cited in our literature review, we might reason that Bhil models of the forested mountain as a *sentient person*—as opposed to a Mayan Indians' notion of the natural world as a *house* or *household* or to Americans' understanding of nature as an *organism* much like the human *body*—might also lead them to make culture-specific inferences about natural resources [8, 31–33]. That is, we might explain Bhil reasoning about the natural world, and potentially even their actual conservation practice, in reference to the logic of their cultural models themselves.

In fact, we did find that the *Bhil* tribal reverence for forests and wild animals is premised upon a conceptualization of these spaces and persons as powerful and even terrifying: here, we would note that 88.2% of our sample claim that they are afraid of the jungle and wild animals. In our cognitive interviews, tribal Adivasis told us, reasoning from their ideas of an all-powerful nature, that their primary ethical obligation is *not* to protect these powerful mountain animal deities. Leopard gods protect and sustain humans—*not vice versa*. For the most part, we were told, tribals are not even seen as *able* to defend these supernatural persons. Indeed, taking on such a role can be seen as not only arrogant but possibly a usurpation of divinity's mandate. Instead, tribals' primary obligations in their interactions with mountain and animal gods are to demonstrate reverence and respect with *puja* and sacrificial offerings so that these beings' powers will flow into human lives in order to help them flourish.

In these terms, we can say that tribals develop personal relationships with forest and mountain spirits who they "serve." Leopards, who communicate both their needs and their knowledge of the mountain, are a case in point. Such relationships reveal deep emotional bonds, and even abiding love, between an individual and forest deities. But we should separate such relationships and perceptions from the felt obligation—and even from the perception of the possibility—of a need to *conserve* wildlife or nature more generally. Wild animals certainly have the right in tribal opinions to be protected and even flourish. Still, having the right to be safe and to flourish is different from locating obligations to actively protect and assure that right in the bodies, and also in the *actions*, of these animal deities' tribal servants. Ultimately, our informants reason that the mountain does not need to be protected because it is eminently capable, as a powerful elder and ancestor, of protecting both itself and also its human, animal, and plant offspring (for more on this argument, see Snodgrass *et al.* [23, 24] and Ross *et al.* [21]).

Nevertheless, as we noted in our presentation of our interview data, many tribals suggested to us that deforestation in the area had weakened the mountain god Magra Baosi. He thus could no longer protect and sustain human communities with his gifts of natural munificence. Increased tribal farming and pastoralism in the area, which meant grabbing up sanctuary land for corn fields and pasturage, placed further strain on this mountain parent. These changes have led many Adivasis to reinterpret the previously discussed cultural model, with the mountain parent now understood to be *sick* and *ailing* and thus like a *frail and elderly parent*. Such a revamped model, which as we showed in our consensus analysis is widely shared among our informants, might lead tribals to infer precisely the need for them to actively conserve nature. Within the frame of Hindu filial piety, frail parents and elders, be they human or divine, deserve protection and care. Thus, the internal logic of this new revamped cultural model, which incorporates understanding about a fragile and ailing nature, cannot be used to explain the *lack* of conservation.

In any case, this form of analysis may be on the wrong track, relying as it does on the internal logic of certain salient cultural models rather than the economic, political, and institutional context within which these models are situated. As we saw, tribal *Bhils* damage their environment because of their poverty and thus out of economic necessity: their livelihoods, and indeed most of their economy, are forest-based. Still, we might think that *Bhil* would protect their environment precisely *because* their livelihoods are forest-based. Failure to manage carefully their natural resources, as *Bhil* were aware, would only lead to even greater impoverishment in the future (Fig. 17.4).

Nevertheless, we saw that *Bhil*, though reverent of nature and understanding that conservation would protect their futures, lacked the social and political machinery that might allow for coordinated management of their natural resources. Historically, as our oral histories reveal, local headmen and caste councils acted as agents for the collectivity in regard to land management. They were assigned the duty to resolve disputes related to access and use of forest resources. These agents, who were connected to Rajput feudal regimes, created and policed communal norms. In the area now referred to as Phulwari Ki Nal, we documented innumerable context-bound rules or "action schemas" that defined permissible and impermissible resource use


**Fig. 17.4** Herbalist Kalaji, an individual possessing deep respect for the environment

as well as the sanctions that would be enforced if rules were broken. These rules defined such things as which animals could be hunted in which season; how grass and medicinal roots should be managed and harvested; which trees were totemic and thus never to be touched; how many "headloads" of wood could be taken from a given area; who had the right to gather products as diverse as honey, *mahua* flowers, and gum; and how much exactly is needed to be paid when these myriad rules were transgressed.

However, headmen and caste councils are now largely powerless in the villages of Phulwari. This was the result of the way the British colonial and subsequent independent Indian state distributed tribal lands to the forest department and other governmental agencies to be alternately conserved or "developed" according to a new regime of rules and goals. In these contexts, "development" often meant clear-cutting forests to generate revenue for the state. In oral histories recounted to us by Bhil elders, for example, we learned of how barely 20 years ago their valuable gum trees, under the watch of the RFD, fell to the axe and were burned down to coal.

Tribal forest inhabitants were typically defined as competitors for this now state-owned wealth and thus declared to be trespassers and squatters. Our informants often pointed out that their names were not on the boards demarcating RFD lands. This disempowerment encouraged tribals themselves to take part in, in their words, the "looting" of forests before the state or others did so. As they were not considered even shared owners of these forests, why should they work to protect these lands, they asked us. Indeed, they did not even have the legal right to do so.

It is true that since the early 1980s, the Indian state and the RFD have been trying to win back local support for state-sponsored conservation and forest management. "Social Forestry" and "Joint Forest Management" (JFM) are two examples of these efforts. Still, as we witnessed, these new institutions rarely connect meaningfully with tribal traditions. For example, they do not intersect with the traditional tribal councils (*pancayats*), which played important roles in pre-Independence Rajasthani forest management. In fact, often illiterate and tradition-bound headmen (*patels*) are typically seen by the state and NGOs as inappropriate for these new modern institutions, a stance which many local Adivasis interpret as a sign of the modern state's disrespect, and even disdain, for tribal peoples and their traditions. Tribals thus find these state agendas both illegitimate and disconnected from their own thought, traditions, and institutions. Modern RFD agendas do not institutionalize tribal understandings, and they have thus not won local allegiance.

Likewise, there is such a proliferation of modern institutions for forest management meant to garner local support—Eco-Development Committees (EDCs), Village Forest Management and Protection Committees (VFMPCs), Common Interest Groups (CIGs), Women's Forest Management and Protection Committees (WFMPCs), and many others—that tribals often cannot figure out to whom to devote their attentions and loyalties even when they wish to. Indeed, every new NGO entering a tribal village in the area tends to set up its own, often competing, natural resource management and tribal development committees. To the confusion of the inhabitants of these villages, these councils and committees usually fall into disuse after a given NGO's projects end or funds dry up so that most *Adivasis* do not know the mandates or meeting times of these various bodies nor even if they are still members of them (Fig. 17.5).

As a result, tribal models of an animate *mountain parent*, and indeed of a *frail and ailing mountain parent*, are still widespread among our informants, as our ethnography, survey, and interviews reveal. Though incarnated in individual psyches, pro-environmental models do not get linked to institutions that embody them at the level of collective agreement. Locally legitimate institutions of forest management have largely disappeared from the local landscape, or at least been robbed of real power and authority over natural resources. In these terms, we might say that pro-environmental thought remains, as do tribal councils in many cases—but their institutional *bite* does not. Village-based forest management institutions have fallen into disarray. Collective gatherings related to natural resource management among Phulwari's inhabitants are now infrequent and largely disconnected from the power to enforce rules and sanctions related to the environment. As practical people, our informants act on those conservation commitments that they feel will have real effects and significant outcomes. In the absence of meaningful institutions that


**Fig. 17.5** A collective gathering of *Bhil* discuss the current state of their forests

organize joint defense and management of forest lands, a mad rush for forest resources, even when it goes against one's personal values, beliefs, and commitments, is an entirely understandable course of action. A massive tragedy of the commons is thus not only logical in these situations, it is to be expected.

Our research thus leads us to point to the importance of politics and economics in directing Bhil conservation practice (or its absence). Might this imply that culturally patterned and transmitted thought—that is, "cultural models"—does not matter in these contexts? That is, does the form of analysis we are pursuing here leave room for a *cognitive* anthropology of the environment, interested as it is in socially learned patterns of *thinking* rather than politics and economics pure and simple?

We do see continued importance for cognitive anthropological analysis of environmental thought and practice. But for cognitive anthropological theories and perspectives to remain relevant in our own field site, we argue for a fourfold shift in focus. First, we would emphasize the need to analyze the manner that local models, be they personal or collective, *intersect with* larger regional and even national political structures and forces. Institutions are always most effective when they resonate with locally prevalent beliefs and values—that is, with local patterns of *thinking*, which it still behooves us to document. In this natural resource context, unless new institutions are built that resonate with local beliefs and values, the failure of conservation will continue into the foreseeable future.

Second, cognitive anthropologists, and especially those working within cultural models theory, could usefully devote their considerable skills to illuminating how insiders metaphorically and discursively model *society*, rather than how social actors

directly model *nature*. As we have shown in this chapter, individuals oftentimes do not make decisions about whether to exploit a resource based on the characteristics of the resource itself—not even unique ways by a particular community, for example, as a living and breathing sentient mountain person. Rather, individuals make many, if not most, conservation decisions based on their relationship to institutional forms—and the individuals and the powers associated with these institutions—set up to regulate the resources in question. Whether conservation occurs or not is thus based as much on an individual's successful gathering of information about the social and political world—and the dangers and opportunities associated with specific behaviors—as it is about information about the natural world. We would like to see the analytical skill and precision of cognitive anthropologists of the environment—developed in fine-grained attention to *emic* systems of naming and classification of plants and animals and applied more recently to richer and more complex cultural models of natural phenomena—extended to an analysis of how individuals think about the *social* world. We believe, as in our allusion to *Adivasis*' models of the RFD as an *opponent* or *competitor* for resources, that these insiders' models of the way the world works provide a powerful complement to our own analysis of social processes related to the use and management of natural resources.[11]

Third, cognitive anthropological studies of the environment typically focus on the *is* models about how nature and society are understood to *be*—that is, the mountain is understood to *be* a grandfather or ancestor, healthy and thus giving or ailing and therefore needy. But we have found that specific context-dependent normative models defining how individuals *ought* or *should* behave toward natural resources are even more important than ontological models in unraveling the connection, or disconnection, between pro-environmental thought and behavior. Following D'Andrade's [7] reading of the philosopher John Searle's [52] discussion of institutions, we thus think that even more cognitive anthropological attention should be directed toward "the *collective shoulds* of life, which Searle calls *deontic powers*." We think that norms are also models of a kind and that cognitive anthropologists should devote their energies toward tracing their form and function. In particular, this means reading interview transcripts not only for "cultural models," as classically understood, but also for the way that normative "ought" models get linked in informants' minds to complex arrays of context-dependent rules, action scripts, and sanctions defined and policed by social agents with well-defined powers and duties related to natural resources. Focusing interviews around the topic of specific norms and action scripts related to natural resources forces informants to be more specific in explaining the train of thought that links abstract models and commitments, which can be multifarious and even contradictory, to the particular actions entailed by those commitments.

[11] This reverses the pleas of other environmental and ecological anthropologists to devote *more* attention to nature and ecological processes in their studies of the interactions of human populations with the environment. See, for example, Moran [53].

Fourth, following D'Andrade [7], we would encourage analysts to distinguish between cultural models that are *personally* as opposed to *collectively* held. The former are simply widely agreed to or understood and thus can be studied as they are *epidemiologically* distributed across individuals in a culture, as we have done in our cultural consensus analysis [54, 55]. The latter have both a *normative* and also an *intersubjective* element. To qualify as a "collective" model, people must think that this understanding is the proper, correct, and true idea or model. Likewise, individuals in a collectivity must be aware that *we* all know *this* and *we* know *we* know this.[12]

To put this fourth point another way, examining how models are "internalized" by individuals to form a part of a personal worldview [2, 36, 56]—identifying how some persons find them compelling and motivating, while others do not—does advance our understanding of conservation thought and behavior in Phulwari Ki Nal. However, such methodological individualism, even when examining shared beliefs across multiple individuals, also runs the risk of downplaying the superorganic properties of culture and collectivities. In our collective opinion, paying more attention to models that are *collectively* held (we all know we believe this to be right) and less attention to simple *sharing* and thus the widespread prevalence of certain beliefs (in the aggregate, many people in this culture individually believe this to be right) helps to explain why conservation does not necessarily emerge even when a community, such as those inhabiting Phulwari, consists of a majority of committed individual conservationists.

## Conclusion: Culture Patterns both Individual and Collective Commitment

In an influential series of writings, Shepard Krech [57, 58] suggests that we redefine environmental conservation as "conservation by design." By this, following others (e.g., Smith and Wishnie [51]), he means that *real* conservation should be distinguished from *accidental* conservation, as in Eugene Hunn's [59] example of "epiphenomenal conservation" resulting not from explicit intentions to conserve but rather from low population density, limited technology, or low demand for commodities.

We think Krech's stress on *intentionality*, like other pleas for the ethnographic analysis of systems of "conservation by design," calls out for a greater reliance on the theories and methods of the cognitive sciences to study the relationship between thought and practice in environmental contexts. We thus employ the tools

[12] The phrasing here is taken from a personal communication from Roy D'Andrade. In the same communication, D'Andrade points out that "all collective beliefs and models are shared, but some shared beliefs and models are not collective. Thus, Americans share the idea that other Americans have materialistic values (which is not true). But you don't have to believe *this*, and Americans don't know that other Americans think *this*, so it is not a collective belief."

of cognitive anthropology in our investigations of thought and action of tribal *Adivasis* occupying Phulwari Ki Nal. This entails, among other things, considering not only how people think about nature and the environment but also how they think about the social institutions and norms set up to regulate human interaction with their environments. As we have shown, many times individuals do not choose whether or not to act on an internalized value related to a specific natural resource in question. Rather, they decide whether or not to act on a rule or sanction associated with a social institution set up to regulate a resource that is collectively deemed to be important and worth protecting.

Realizations such as these have meant, for us, bringing our *cognitive* anthropology in line with more mainstream ethnographic approaches to analyzing environmentally significant behavior, influenced as it is by political ecology and the commons literature on collective action that devotes primary attention to the roles political, economic, and social institutions play in regulating human interactions with nature.[13] As we have argued, to more fully explain the disconnect between thought and practice in these indigenous contexts requires that attention be paid to not only the way cultural models are shared across individuals and individual minds (a standard perspective in the current cognitive anthropology of the environment) but also the way culturally normative "ought" models in particular are institutionalized in spaces of collective agreement (an idea D'Andrade borrows from the philosopher John Searle [52]).

In these terms, we think that cognitive anthropologists could usefully borrow from ethnographically and politically informed analyses of natural resource management in postcolonial settings, perspectives which aided our own analysis in this wildlife sanctuary. However, we do not feel that cognitive anthropology needs to merely mimic ethnographic and political approaches to explaining environmental thought and practice. Yes, critical to conservation efforts in this Rajasthani Wildlife Sanctuary are institutional frameworks that provide individuals with a framework to meaningfully act on their deepest commitments, as revealed, for example, by the extensive commons management literature [38]. Still, attention also needs to be paid to the manner our anthropological informants metaphorically *model* these institutions, in this case using a language of *kinship* and *family* to conceptualize both nature and social relations. If these cultural models compel individuals to act in certain ways, a cognitive anthropological framework provides a nuanced language for mapping deep patterns within individual psychology and institutional form. If these cultural models instead represent higher-level representations of experience—a folk sociology and psychology so to speak—exploring such *emic* perspectives provides important alternate points of view to our own and certainly one which the RFD must heed in order for their forest conservation and management initiatives to have any chance of success.

[13] The entire "tragedy of the commons" literature (e.g., McCay and Acheson [38]), not to mention the burgeoning subfield of political ecology more generally (e.g., Robbins [60]), explores the way that institutional lacunae can lead to overexploitation of the environment.

After all, the mere existence of forest management institutions is not enough to ensure successful forest management in these indigenous contexts. The ever-proliferating councils and committees promoted by the RFD and local NGOs, as we have seen, do not garner tribal support. What are needed instead are institutions that *meaningfully* connect with local collectivities and, as importantly, with personal beliefs and values. Successful land management, we believe, demands *both* coordinated social action and *also* individual commitment. It is the interplay between these two levels of culture—the one institutional, social structural, and communal and the other cognitive, psychological, individualistic, and personal—that helps to explain responsible forest management, or its lack, within Phulwari Ki Nal. It is the interaction of these two dimensions of culture, we think, that assures the continuing relevance of a cognitive and psychological anthropology of the environment.

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# Part II
# Ecological and Wildlife Tourism in Rajasthan: The Terra Incognita

# Chapter 18
# Ecotourism in Rajasthan: Prospects and Perspectives

**Shailja Sharma, B.K. Sharma, Seema Kulshreshtha, and Smriti Johri**

**Abstract** This chapter touches upon the newly emerging concepts of ecotourism and heritage tourism. The state harbors a wealth of mesmerizing palaces and forts, World Heritage sites and hotels, vibrant cultural traditions, and fairs and pilgrimage sites which attract a large number of national and international tourists. In addition, the national parks and tiger reserves, world famous heronry, colorful desert, and wildlife sanctuaries located in diverse habitat draw the attention of wildlifers and nature lovers from around the world. Potential ecotourism sites still in wilderness and unexploited by the rapid pace of civilization have been selected and listed district-wise on the basis of forest areas with rich biodiversity, natural scenic beauty, waterfalls and springs, historical buildings, palaces, forts, and temples. In this chapter, authors have mentioned about the proposed activities and value addition being brought through camping and wide publicity as major strategies for developing these ecotourism sites. The prospects in the Hadoti region of southwestern Rajasthan as a potential ecotourism attraction with birding sites and adventure tourism are also

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particularly described. To this end, the emphasis of the government has been on community-based ecotourism, encouraging public–private sector participation, and infrastructural development. The major stakeholders of the plan are forest, tourism, and finance departments of the state government, local communities, private sector, NGOs, and academic institutions. Economic benefits to local people and tribal youth, building public support for conservation, and encouraging conservational efforts are some of the key advantages of ecotourism which are described in the text. The authors have looked into the policies and prospects of wildlife tourism in Rajasthan. The issues and problems related to implementation of the Ecotourism Policy by the government along with the formation of an "Ecotourism Advisory Bureau" also find a prominent place in the chapter.

## Introduction

Ecotourism also known as ecological tourism can be defined as "responsible travel to pristine, fragile, relatively unexploited, and usually protected areas that strive to be low impact." Wildlife tourism and heritage tourism are more or less synonymous to ecotourism. Enjoying the scenic beauty while simultaneously studying and admiring the biological diversity and culture are the usual gains for the tourist while the concerned government department is benefited greatly via revenue addition, a major chunk of which feeds conservation programs. The stated purposes of ecotourism are to foster public awareness of the environment by sensitizing the travelers to nature and empowering local communities and tribes with an aim to minimize the negative impacts of conventional tourism and human activities on the wilderness. In fact, promoting nature conservation while taking care of the cultural integrity of locales should be the key objective of ecotourism so that future generations, too, may have a feel of an "intact" nature. It came into prominence as a strategy for the conservation of biodiversity-rich areas through appreciation, public support, and attention of private sectors. Clearly, at a time when traditional conservation through enforced protection of natural areas was being questioned for its effectiveness and social impact, strategies such as ecotourism offered considerable potential for integrating conservation with development.

Significance of the proposed activities and major strategies for value addition currently being undertaken by the government and World Wide Fund for Nature (WWF—India) toward developing Rajasthan as a major ecotourism destination of India, without altering the natural scaffolding, is paramount. The major stakeholders of the ecotourism sector, namely, the forest, tourism, and finance departments of the state government, local communities and tribes, private sector, NGOs, and academic institutions must join hands to promote benefits to local people via employment generation, building public support, and people's participation for nature conservation in this part of the world. Promoting ecotourism via community-based conservation, people's participation, and rehabilitation of tribes which are otherwise involved in poaching and trade of wild animals, is a necessary step forward. In addition, we also need to look into the policies and prospects of ecotourism in

Rajasthan and issues and problems related to the implementation of ecotourism policy along with the formation of an "Ecotourism Advisory Bureau." The emerging concepts of ecotourism, wildlife tourism, and heritage tourism need to be looked at with a fresh insight in the fast-changing global environmental scenario.

Within a decade, the ecotourism sector in India captured the attention of both the communities and tourism industry. Over the years, now it has been known as the world's biggest industry on the basis of its contribution to the GDP, the number of jobs it generates, and the number of clients it serves. Many of the declining ecosystems provide attraction for tourism development involving wildlife viewing, trekking, river rafting, etc. An estimate shows the extent of wetlands in India to be around 13.1 million ha, and the ecosystem service value with respect to average global value going to the national budget is approximately Rs. 7, 151.08 billion per year including ecotourism which is seven times more than the income from our forests ecosystems.

Tourism over the last decade has emerged as the key sector in the economic development of the state of Rajasthan too. The tourist traffic in the state has been growing at the rate of 9.22%. Rajasthan has a very significant role to play in the Indian tourist scenario as out of 18.8 million foreign tourists visiting India every year, as per Department of Tourism, of the State Government of Rajasthan, in 2010, the state alone attracted 12.7 million while 25 million Indian tourists visited the state (Table 18.1). Two world famous tiger reserve, a national park known for the enchanting avifauna, and the 25 wildlife sanctuaries have been attracting domestic

**Table 18.1** Tourist influx in Rajasthan during last two decades

| S. No. | Year | No. of tourists, Indian | No. of tourists, foreigners | Total |
|---|---|---|---|---|
| 1 | 1971 | 880,694 | 42,500 | 923,194 |
| 2 | 1972 | 902,769 | 48,350 | 951,119 |
| 3 | 1973 | 1,157,959 | 54,611 | 1,212,570 |
| 4 | 1974 | 998,227 | 55,781 | 1,054,008 |
| 5 | 1975 | 1,117,663 | 66,207 | 1,183,870 |
| 6 | 1976 | 1,303,633 | 92,272 | 1,395,905 |
| 7 | 1977 | 1,618,822 | 125,112 | 1,743,934 |
| 8 | 1978 | 2,042,586 | 160,134 | 2,202,720 |
| 9 | 1979 | 2,306,550 | 195,837 | 2,502,387 |
| 10 | 1980 | 2,450,282 | 208,216 | 2,658,498 |
| 11 | 1981 | 2,600,407 | 220,440 | 2,820,847 |
| 12 | 1982 | 2,780,109 | 237,444 | 3,017,553 |
| 13 | 1983 | 2,932,622 | 266,221 | 3,198,843 |
| 14 | 1984 | 3,040,197 | 259,637 | 3,299,834 |
| 15 | 1985 | 3,120,944 | 268,774 | 3,389,718 |
| 16 | 1986 | 3,214,113 | 291,763 | 3,505,876 |
| 17 | 1987 | 3,424,324 | 348,260 | 3,772,584 |
| 18 | 1988 | 3,495,158 | 366,435 | 3,861,593 |
| 19 | 1989 | 3,833,008 | 419,651 | 4,252,659 |
| 20 | 1990 | 3,735,174 | 417,641 | 4,152,815 |

(continued)

**Table 18.1** (continued)

| S. No. | Year | No. of tourists, Indian | No. of tourists, foreigners | Total |
|---|---|---|---|---|
| 21 | 1991 | 4,300,857 | 494,150 | 4,795,007 |
| 22 | 1992 | 5,263,121 | 547,802 | 5,810,923 |
| 23 | 1993 | 5,454,321 | 540,738 | 5,995,059 |
| 24 | 1994 | 4,699,886 | 436,801 | 5,136,687 |
| 25 | 1995 | 5,248,862 | 534,749 | 5,783,611 |
| 26 | 1996 | 5,726,441 | 560,946 | 6,287,387 |
| 27 | 1997 | 6,290,115 | 605,060 | 6,895,175 |
| 28 | 1998 | 6,403,310 | 591,369 | 6,994,679 |
| 29 | 1999 | 6,675,528 | 562,685 | 7,238,213 |
| 30 | 2000 | 7,374,391 | 623,100 | 7,997,491 |
| 31 | 2001 | 7,757,217 | 608,283 | 8,365,500 |
| 32 | 2002 | 8,300,190 | 428,437 | 8,728,627 |
| 33 | 2003 | 12,545,135 | 628,560 | 13,173,695 |
| 34 | 2004 | 16,033,896 | 971,772 | 17,005,668 |
| 35 | 2005 | 18,787,298 | 1,131,164 | 19,918,462 |
| 36 | 2006 | 23,483,287 | 1,220,164 | 24,703,451 |
| 37 | 2007 | 25,920,529 | 1,401,042 | 27,321,571 |
| 38 | 2008 | 28,358,918 | 1,477,646 | 29,836,564 |
| 39 | 2009 | 25,558,691 | 1,073,414 | 26,632,105 |
| 40 | 2010 | 25,543,877 | 1,278,523 | 26,822,400 |

*Source*: Tourism Department, State Government of Rajasthan http//www.rajasthantourism.gov.in/ downloaded on June 23, 2012

and foreign tourists for many decades. Some of the neglected PAs can be revived by regulated and sustainable tourism. In diverse and fragile ecosystems of Rajasthan, growth of ecotourism offers ample opportunities. The state government has got the sanctions for ecotourism development at the major protected areas including Keoladeo, Ranthambhore, Sariska, and Mt. Abu. Biodiversity conservation coupled with sustainable development of ecotourism is the need of hour; however, unchecked tourism-related activities may pose a big threat and must be handled appropriately.

## Rajasthan Ecotourism Policy, 2010

In order to promote ecotourism, sensitize masses, and draw the attention of the central government and NGOs, the state government framed a policy on February 15, 2010, under the guiding principle of various Forest and Environment Protection Acts. Forest activities and ecotourism activities permissible under the policy are trekking, safari, boating and river rafting, bird-watching, overnight camping, etc. For the implementation of the policy, an autonomous "Rajasthan Ecotourism Development Society" under the chairmanship of the Minister, Department of Forest, Government of Rajasthan will be created. It shall find out technical and financial resources from the concerning government departments and NGOs and work for planning, developing, and implementing the projects with the help of Eco-Development Committees (EDC), Joint Forest Management Committees

(JFMC), and local self-help groups for the maximum benefit of locals without posing any threat to the ecotourism sites.

## Existing Ecotourism Hot Spots in Rajasthan

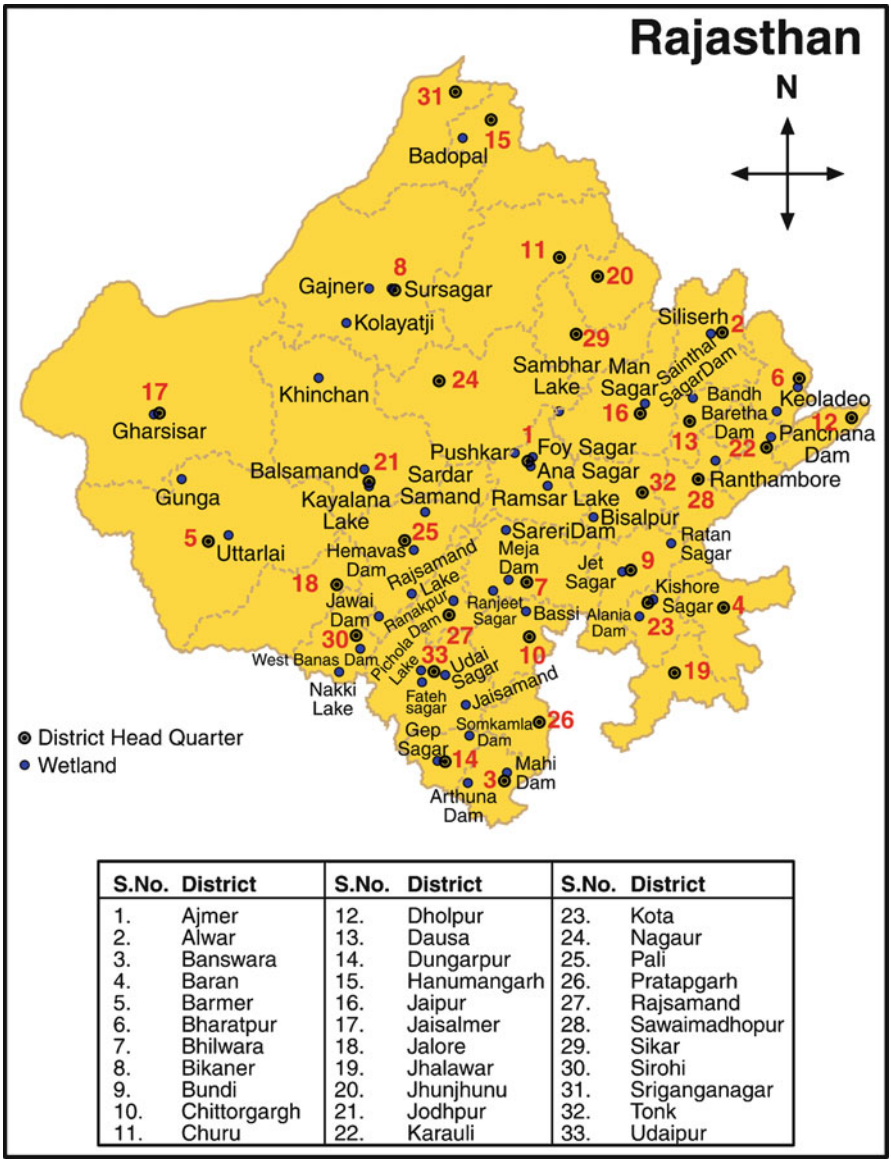
Rajasthan has varied habitats nurturing wonderful wild animals and plants intermingled with interesting medieval culture and history which makes it a truly unique ecotourism destination. Historical places, archaeological sites, palaces, *Shikarbadis* (hunting reserves of the erstwhile Maharajas), temples, etc. are the major attractions of the state. Other natural sites have waterfalls, seasonal springs, ponds, gorges, valleys, rich forests, arboretums, herbal gardens, and nature trails.

At present, there are three national parks, two Ramsar sites, and 25 wildlife sanctuaries (WLS) covering 2.80% of the total geographical area of the state. Ranthambhore and Sariska Tiger Reserves, the world famous heronry of Keoladeo National Park (KNP) and Sambhar Salt Lake having flamingos, attract thousands of tourists. The National Chambal Sanctuary, Tal Chhapar having Blackbuck, Kheechan with the attractive Demoiselle Crane, Desert National Park (DNP), and Kumbhalgarh WLS in Pali and Udaipur are other major tourist attractions of Rajasthan (Fig. 18.1).

The following are the key ecotourism attractions on the basis of tourist arrival in the past few decades:

1. Ranthambhore National Park (RNP), Sawai Madhopur
   An ecological hub for threatened species of plants and animals covering an area of around 1,394 km$^2$, the park has a large expanse of wilderness with more than 402 plant species and six species of the cat family including the Bengal Tiger (Fig. 18.2a), Leopard, Caracal and Jungle Cat besides deer, Crocodile, Monkeys, birds, and several other animals (Fig. 18.2b). RNP with 42 tigers is a cache of wildlife, culture, history, religion, and heart-pounding excitement. The Ranthambhore Fort which was once meant to protect the kings through the battlements now defends the king of the jungle.

   The fort that towers over the forest was occupied for years by Raja Hamir—a Hindu monarch who successfully warded off several assaults by a series of Muslim rulers including Alauddin Khilji in 1301. The army of the Mughal Emperor Akbar was also recorded camping here (1558–1569), and the *Akbarnama* records the menu that the generals were served when they ate under the famous banyan tree, still alive and well at the well-known Jogi Mahal (Fig. 18.2c) amid the dense forest. The park used to be the hunting preserve of the Maharajas of Jaipur, and many tigers were shot here, including an infamous visit in the early 1960s when a tiger was set up to be shot by Queen Elizabeth II. Apart from this, the park displays a variety of magnificent natural landscapes (Fig. 18.2d–f).
2. Keoladeo National Park (KNP), Bharatpur
   A UNESCO World Heritage site, popularly known as “Ghana” and “Bird Paradise” for its 398 bird species, was declared as a national park in the year




| S.No. | District | S.No. | District | S.No. | District |
|---|---|---|---|---|---|
| 1. | Ajmer | 12. | Dholpur | 23. | Kota |
| 2. | Alwar | 13. | Dausa | 24. | Nagaur |
| 3. | Banswara | 14. | Dungarpur | 25. | Pali |
| 4. | Baran | 15. | Hanumangarh | 26. | Pratapgarh |
| 5. | Barmer | 16. | Jaipur | 27. | Rajsamand |
| 6. | Bharatpur | 17. | Jaisalmer | 28. | Sawaimadhopur |
| 7. | Bhilwara | 18. | Jalore | 29. | Sikar |
| 8. | Bikaner | 19. | Jhalawar | 30. | Sirohi |
| 9. | Bundi | 20. | Jhunjhunu | 31. | Sriganganagar |
| 10. | Chittorgargh | 21. | Jodhpur | 32. | Tonk |
| 11. | Churu | 22. | Karauli | 33. | Udaipur |

**Fig. 18.1** A map showing existing and potential ecotourism sites. *Courtesy: Dr. B.K. Sharma*

1981. "Salim Ali Interpretation Centre" has been established in the park. A few globally threatened bird species of KNP are Dalmatian Pelican *Pelecanus crispus*, Gray Pelican *Pelecanus philippensis*, Adjutant Stork *Leptoptilos dubius*, Lesser Adjutant Stork *Leptoptilos javanicus*, Baikal Teal *Anas formosa*, Baer's Pochard *Aythya baeri*, Marbled Teal *Marmaronetta angustirostris*, Cinereous Vulture


**Fig. 18.2** (**a**) Ranthambhore National Park (RNP) and Tiger Reserve is home to Bengal Tiger. *Courtesy: Devendra Bhardwaj.* (**b**) RNP inhabits varieties of faunal species. *Courtesy: Devendra Bhardwaj.* (**c**) Jogi Mahal at RNP, Sawai Madhopur. *Courtesy: Sunil Singhal, Kota.* (**d**) Forest trail at RNP. *Courtesy: Anish Andheria/Sanctuary Asia Photo Library.* (**e**) A panoramic view at RNP. *Courtesy: Anish Andheria/Sanctuary Asia Photo Library.* (**f**) Chital herd at RNP. *Courtesy: Dr. Gobind Sagar Bhardwaj*


**Fig. 18.2** (continued)



**Fig. 18.2** (continued)

*Aegypius monachus*, Imperial Eagle *Aquila heliaca*, and Pallas's Fishing Eagle *Haliaeetus leucoryphus*. Among other animals, the Rock Python is the key attraction of the park (please see Chap. 8 for details).

3. Mount Abu (Abu Hills), Sirohi
   Mount Abu, the Olympus of India—as mentioned by Lt. Col. James Tod [1]—is a place which abounds with legends of the Gods, their strivings with demons and giants, and the miraculous deeds of the *Rishis* and the holy men. The famous naturalist Charles McCann who spent a lot of time at Mount Abu in the 1940s admiringly referred it as "an oasis in the desert" [2, 3]. In the oppressive heat of Rajasthan, not surprisingly, the Britishers developed the area into one of the many "hill stations" over a couple of centuries ago. The Aravalli (meaning the "midrib" in Hindi) is a folded mountain having a multiphased evolutionary history during the Pre-Cambarian period [4]. The present geomorphology of this system is a result of tectonic changes in the northwestern Indian shield [5, 6]. Situated on the border of Rajasthan and Gujarat, this popular ecotourism destination harbors the scenic beauty, water courses, hills, and valleys. Winters can be as cold as −4 °C in Mount Abu, when frost covers the ground and summers can get uncomfortably warm at around 35 °C. Such climatic variation is also a reason for the magnificent diversity encountered in this place, which once even supported the lion. Semievergreen forests occur on the lower slopes of the valleys [7, 8]. Several species of ferns and fern allies also occur at Mt. Abu. In the drier and completely exposed and eroded areas, thorny scrub is common. Along the shady roadsides, moist grassy meadows, and near puddles and fields, herbaceous flora dominates. Interestingly, the maximum number of Bryophytes and Pteridophytes of the state are confined to Mt. Abu. Faunal diversity consists of Sloth Bear, leopard, wild pig, pangolin, and wolf, along with the other common wild animals. Mt. Abu's altitudinal variations have given rise to an impressive avian diversity [9, 10]. Some of the endemic birds to Indian subcontinent like Green Avadavat [11–13] and a few others make it an IBA.

   There is no better way to explore Mount Abu than to walk. The favorite trails are Kulgarh *Nullah* Trail, Tiger Trail, Bailey's Walk, Trevor's Tank (Fig. 18.3) to Mini Nakki Lake trail, the Gurushikhar to Oriya Trek, Gaumukh to Gautam Rishi Trail (6 km), Ganesh Point to Anadra Trail, Arna to Rishikesh Trail, and the famous Sunset Point. Naturalists and tourists visit the world famous Nakki Lake believed to have been scooped out by the fingernails of the God (Fig. 18.4a, b) which still reverberates to the sounds of duck, geese, and waterfowl of all descriptions including Little Grebe *Tachybaptus ruficollis*, Striated Heron *Butorides striatus*, Northern Shoveler *Anas clypeata*, Northern Pintail *Anas acuta*, and Common Pochard *Aythya ferina*. Strange rock formations called Toad, Nun, and Parrot Rocks built above 1,200 sea level are worth-watching. The hill station presents a heavenly view together with the magnificent wetlands (Fig. 18.5) strewn in and around the area. The famous Dilwara temples of Jain faith built around eleventh to thirteenth centuries AD with its extraordinary marble carvings and the *Ohm Shanti Bhawan*—the spiritual University of *Brahma Kumaris* at Mount Abu—are the major pilgrimage centers. Tribal festivities, folk music and

**Fig. 18.3** Trevor's Tank, Mount Abu. *Courtesy: Sonali Singh*

dance in summer (May—June), and winter festivals (December 29–31) make the visit to the hill station a memorable one.

Summer is the important season when large numbers of tourists visit Mt Abu. Gujaratis form a major part of the domestic tourists, and the tourist influx is increasing day by day (Table 18.2).

4. Sariska Tiger Reserve, Alwar
   Rich in wilderness, forts, and temples and endowed with tropical dry deciduous scrub forests, it became controversial in 2005 for losing all the tigers, and now, seven tigers have been relocated from Ranthambhore. Poachers constantly disrupt the peace in this area even today despite all checks and balances imposed by the central and state governments.

5. Desert Wildlife Sanctuary or the Proposed Desert National Park (DNP)
   Representing the typical xeric ecosystem of the hot and mysterious desert, spreading over 3,162 $km^2$ in the Jaisalmer and Barmer districts (Fig. 18.6a–h), it is home to the Critically Endangered state bird of Rajasthan—the Great Indian Bustard—and the beautiful state animal Chinkara. The DNP has Desert Cat, Desert Fox, Monitor Lizards, and hundreds of other species of birds of prey in addition to the unique Akal Wood Fossil Park.

6. Kumbhalgarh WLS
   This famous WLS has got dense forest with a variety of flora and fauna. Sloth Bear and wolf are the key species along with the ancient fort amid the forest as a center of attraction (Fig. 18.7a, b).


**Fig. 18.4** (**a**) A panoramic view of Nakki Lake, Mount Abu. (**b**) Another view of Nakki Lake, Mount Abu. *Courtesy: Devendra Bhardwaj*

**Fig. 18.5** A wetland at Abu Hills

**Table 18.2** Tourist influx at Mount Abu

| Year | Tourist |
|---|---|
| 1991 | 8,24,547 |
| 1992 | 8,48,559 |
| 1993 | 10,13,092 |
| 1994 | 9,19,065 |
| 1995 | 11,42,693 |
| 1996 | 11,16,418 |
| 1997 | 12,40,480 |
| 1998 | 13,78,100 |
| 1999 | 13,19,911 |
| 2000 | 12,68,763 |
| 2001 | 12,71,910 |
| 2002 | 10,81,362 |
| 2003 | 13,12,440 |
| 2004 | 14,81,522 |
| 2005 | 14,29,040 |

*Source*: Tourism department, Mt Abu

## *Wetlands of Rajasthan: Oases in the Desert*

The importance of wetlands has been realized for ages since they are closely associated with all life forms. The origin of human civilizations in the vicinity of water sources, especially rivers, lakes, and marshes, stands a testimony to this statement. The Space Application Centre (SAC, 1998) mapped the wetlands of India


**Fig. 18.6** (**a**) Golden sand of the Thar Desert mesmerizes the tourists. *Courtesy: Tejveer Singh.* (**b**) Sand dune of the Thar. *Courtesy: Devendra Bhardwaj.* (**c**) *Rohida* tree in the desert. *Courtesy: Tejveer Singh.* (**d**) A wetland amid desert. *Courtesy: Devendra Bhardwaj.* (**e**) Demoiselle Cranes at Kheechan are another attraction for the tourist in the desert of Rajasthan. *Courtesy: Sunil Singhal, Kota.* (**f**) A male and female Demoiselle Crane. *Courtesy: Sunil Singhal, Kota.* (**g**) Langurs at human habitations in Jodhpur. *Courtesy: Anil Kumar Chhangani.* (**h**) Gadisar Pond near Sonar Fort at Jaisalmer is famous for its architect. *Courtesy: Devendra Bhardwaj*


**Fig. 18.6** (continued)


**Fig. 18.6** (continued)


**Fig. 18.6** (continued)

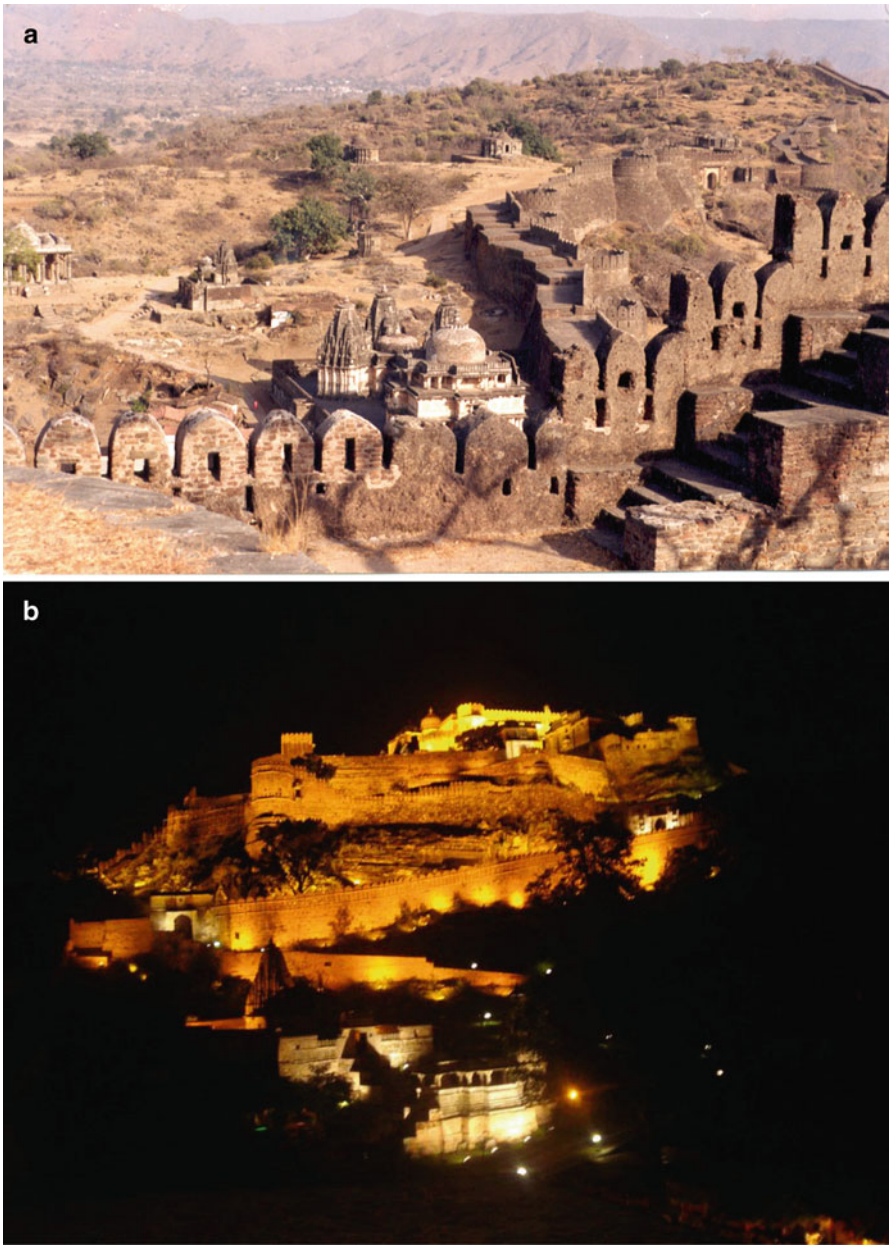



**Fig. 18.7** Kumbhalgarh Fort at Kumbhalgarh Wildlife Sanctuary during daytime (**a**) and night (**b**) *Courtesy (a): Devendra Bhardwaj. Courtesy (b): Sonali Singh*

using remote sensing and documented the extent of wetlands with an estimate of 7.0 million hectares. Rajasthan, in spite of the considerable aridity, is known for a wide variety of wetland ecosystems with their magnificent faunal and floral diversity. In a water scarcity region like Rajasthan, wetlands play an important role in sustainable development. Dependent solely on monsoon, the importance of water conservation in Rajasthan was recognized and practiced even in ancient times. The wetlands were traditionally nurtured and despite the pressures of modern times, have continued to flourish while playing a vital role in maintaining the hydrobiological balance and supporting mankind. In addition, they also make popular ecotourism destinations owing to their natural scenic beauty and associated paraphernalia. There are 123 natural and 931 man-made wetlands in the state of Rajasthan including 44 lakes and ponds and 79 playas, 915 reservoirs, and 16 waterlogged areas. The former three are natural while the latter two are man-made. The major wetlands of Rajasthan include the Ghana and Band Baretha in Bharatpur, Sambhar Lake in Sambhar town, Talab-e-Shahi, Urmila Sagar and Ramsagar in Dholpur, and Siliserh in Alwar. Mansagar Lake (Fig. 18.8) at Jaipur city harbors the beautiful Jal Mahal Palace built around 1734 by Maharaja Sawai Jai Singh-II and once dubbed as an environmental disaster, has now been revived by removing tones of toxic waste and oxygenating it. The other beautiful wetlands of Rajasthan are Chandlai (Fig. 18.9), Chhaparwara, and Ramgarh Lake in Jaipur; Ana Sagar and Foy Sagar in Ajmer Meja and Kareri Dam in Bhilwara; wetlands near Jaipur amid Aravalli (Fig.18.10a–e); the lake complex of Udaipur comprising of Pichola (Fig. 18.11a–e), Fateh Sagar (Fig. 18.12), Jaisamand, Badi Lake (Fig. 18.13), and Lake Jhadol (Fig. 18.14a, b); and the Sardar Samand and Kaylana Lake in Jodhpur. Udaipur, situated in southern Rajasthan, is popularly known as the "Lake City" and "Venice of Rajasthan." The Chittourgarh Fort near Udaipur is also a major tourism attraction (Fig. 18.15) from a historical point of view. All in all, the largest number of wetlands (460) is found in Chittourgarh district of the state followed by Bhilwara (340) and Tonk (334).

## Potential Ecotourism Destinations of Rajasthan

A number of potential ecotourism sites still unexploited by the rapid pace of civilization, having dense forests rich in biota, natural scenic beauty, waterfalls, and ancient monuments including palaces, forts, and temples, have now been identified. Rajasthan also has a number of ecological parks, animal rescue centers, and zoos which can be developed as newer ecotourism destinations. About 126 ecotourism sites have been identified and selected by the Department of Forest, Government of Rajasthan in the proposal for its Ecotourism Policy, 2010 submitted to the National Tourism Advisory Council (Subgroup on Wildlife Tourism). Out of them, the following 29 major ecotourism destinations have been enlisted and found suitable for developing ecotourism facilities (Table 18.3).

**Fig. 18.8** Jaipur, the capital city, also has beautiful lakes, waterbodies, and Aravalli along with many scenic attractions. The picture shows Jal Mahal; once dubbed an environmental disaster, the iconic palace now attracts tourists with its extraordinary beauty. *Courtesy: Devendra Bhardwaj*


**Fig. 18.9** Chandlai—the magnificent lake near Jaipur has flamingos. *Courtesy: Sunil Singhal, Kota*


**Fig. 18.10** Beauty of Aravallis. *Courtesy: Devendra Bhardwaj.* (**a**) A wetland on hilltop near Jaipur. (**b**) Another seasonal wetland near Jhalana forest, Jaipur. (**c**) A waterbody near Jaipur during rains. (**d**) A scenic view of Jaipur city can be seen from the Aravalli. (**e**) Aravalli near Jaipur with slopes and peaks

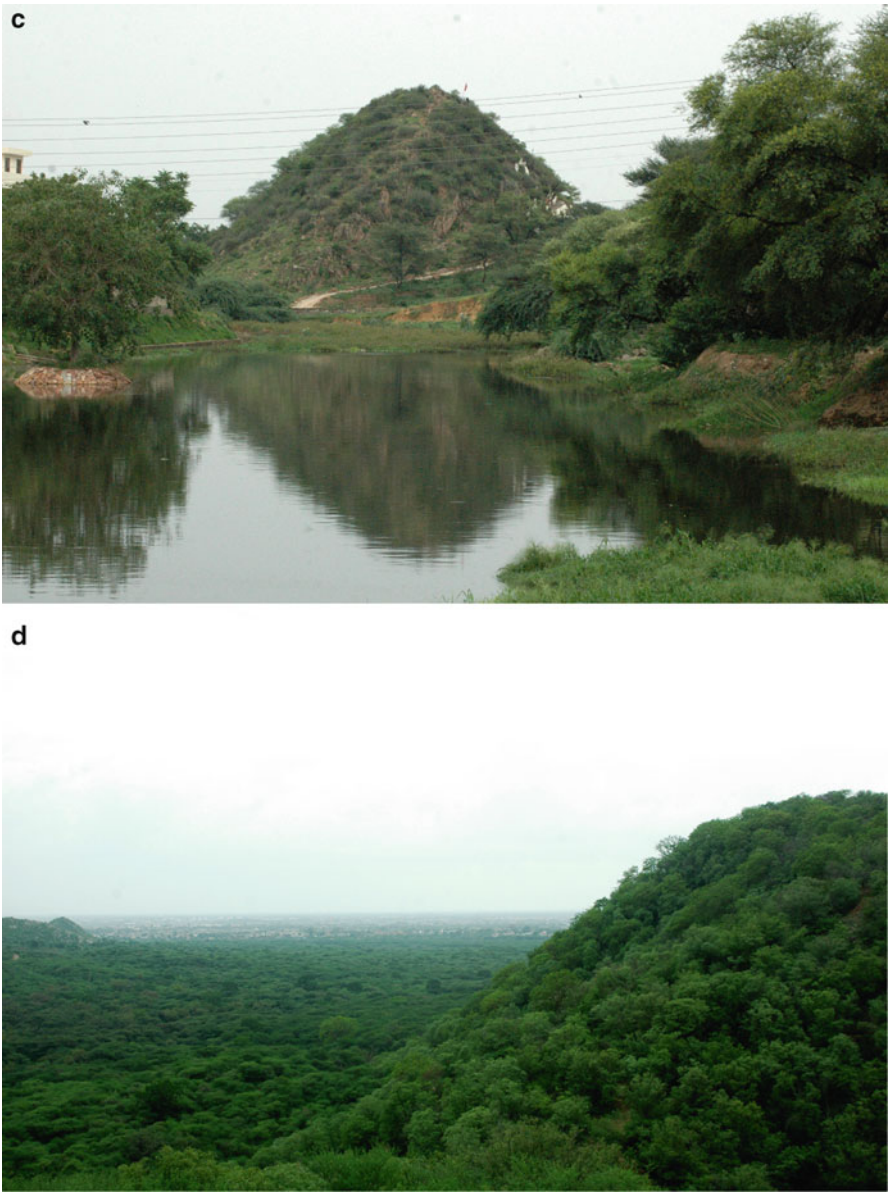



**Fig. 18.10** (continued)


**Fig. 18.10** (continued)


**Fig. 18.11** Pichola Lake, Udaipur. (**a**) View from the roadside, (**b**) City Palace near the lake, (**c**) Nehru Palace amid the lake, and (**d**) view of Lake Palace Hotel in the night and (**e**) Lake Palace during the daytime. *Courtesy: Sonali Singh*



**Fig. 18.11** (continued)



**Fig. 18.11** (continued)

**Fig. 18.12** Fateh Sagar, Udaipur. *Courtesy: Sonali Singh*

**Fig. 18.13** Badi Lake, Udaipur. *Courtesy: Sonali Singh*


**Fig. 18.14** **a** & **b**. Lake Jhadol, Udaipur. *Courtesy: Sonali Singh*

**Fig. 18.15** The historical Chittourgarh Fort has Victory Tower and Meera Temple (seen in this picture) as major tourist attractions in the southern Rajasthan. The Birla Cement Factory can be clearly witnessed in the backdrop. *Courtesy: Sunil Singhal, Kota*

## *Sambhar Salt Lake*

The Sambhar Salt Lake situated in Jaipur, Ajmer, Nagour, and Sikar districts of Rajasthan is a rain-fed playa of the arid zone. Considered as a significant flamingo habitat after the Rann of Kutch in Gujarat, it is one of the largest inland saline wetlands and one of the two Ramsar Sites of Rajasthan. The lake is currently facing many potential threats like illegal salt extraction and rising temperature and above all ignorance by the authorities. Apart from these, unregulated tourism activities continue to be a major cause of concern. A prospective study by the lead authors (Drs. Seema Kulshreshtha & B. K. Sharma) during 2006–2010 aimed at bio-monitoring of the faunal diversity and evaluation of the conservational threats to the lake concluded that, despite continued deforestation, anicut formation in the course of its drainage coupled with an array of other anthropogenic pressures, this wonderful saline ecosystem still holds multidimensional values of being developed as a prospective ecotourism site of the state. The lake also has historical significance being the first capital of *Chauhan* kings who ruled northern India. This famous repository of salt known throughout the world is considered as the blessing of the Goddess Shakambhari whose temple stands tall amid the lake even today, pointing toward its religious value for Hindu tourists. In addition, Naliasar, situated four kilometers

**Table 18.3** Existing and potential ecotourism destinations of Rajasthan

| S. No. | Existing ecotourism destination | Major sites | Remark |
|---|---|---|---|
| 1. | Tribal tourism destinations | Banswara, Dungarpur, Udaipur, Jaisalmer, Shekhawati, and Bishnoi villages | The fascinating world of *Mina*, *Bhil, Garasias, Bishnoi, Gaduliya lohars*, and *Sahariya* tribes in the rustic village trails of Udaipur, Dungarpur, Jaisalmer, and Kota. Discover the enchanting tribal history, legends, tribal crafts, ethnic costumes, traditional jewelry, tribal homes, and tribal music and dance |
| 2. | Rajasthan Desert Safari | Akal Wood Fossil Park, Annual Desert Festival, and Desert National Park | An exciting camel or a jeep safari to the vast expanses of the desert dotted with hundreds of shifting sand-dunes and fascinating medieval cities of Jaisalmer, Bikaner, and Jodhpur, located in the heart of the Thar Desert |
| 3. | Rajasthan eco- and wildlife tours | Lake City Udaipur, salt lakes, IBAs, southern forests, arid zone ,deer and antelopes sightings, Mt. Abu—the only hill station of the state—and Chambal River with crocodiles and dolphins | Tiger reserves, national parks, and varied physiographic regions with a variety of magnificent fauna and flora and protected areas make it an exciting ecotourism destination |
| 4. | Rajasthan Royal Heritage train tours | Royal destinations like Jaipur, Udaipur, Bikaner, and Jodhpur with their famous forts and palaces | The Indian Railways operates some of the most elegant heritage trains of India—the Palace On Wheels, Royal Orient, and the Fairy Queen which take tourists to the cities of the magnificent forts; beautiful palaces; splendid havelis, temples, churches, mosques, and tombs; colorful cultural programs; and festivals on board offering a good insight into the cultural richness of Rajasthan |
| 6. | Royal Wedding Tours | Older *havelis* and palaces turned into heritage hotels make arrangements for charming weddings in traditional Indian style | A royal wedding in Rajasthan recreates a medieval grandeur and regal charm and ambience of the era gone by |
| Potential ecotourism destinations | | | |
| 1. | Jaipur | Jhalana Hills | Excellent trekking routes, World Forestry Arboretum, Jhalana Park |
| | | Nahargarh Biological Park | Biological Park, Tiger and Lion Rescue Centre having 27 tigers, beautiful hills, and valley |
| | | Sambhar Lake | Salt lake with winter-visiting flamingos, salt extraction sites and ancient salt pans, and Shakambhari Temple |
| | | Kukas Dam | Scenic beauty of hills and parks |

(continued)

**Table 18.3** (continued)

| S. No. | Existing ecotourism destination | Major sites | Remark |
|---|---|---|---|
| | | Jamwa Ramgarh WLS | Hunting Tower, dam, lake, and scenic beauty |
| | | Virat Nagar | Historical and archaeological site, religious places |
| | | Naliasar | Archaeological site near Sambhar town, a pond is a good birding site |
| 2. | Alwar | Silisade | Waterfall, forest, and scenic beauty |
| | | Bhangarh Fort | Famous as haunted fort surrounded by dense forest |
| 1. | Dausa | Toda Bheem | Historic site amid thick forest cover |
| | | Kalakho | Dam, water birds, proximity to highway |
| 2. | Bharatpur | Bandh Baretha | Dam, unique vegetation, forest |
| | | Bharatpur Fort | Lie within the city with the walled area, can be further developed |
| 3. | Dholpur | Deohansgarh | Historic place, good forest |
| | | Damoh | Waterfall, picturesque forest |
| | | Talab Shahi | Waterbody, bird-watching place, old architecture near Badi |
| | | Van Vihar | Facing waterbody surrounded by thick forest cover |
| 4. | Karouli | Kailadevi Temple and WLS | Temple in the vicinity of thick forest |
| | | Deogiri Fort | Historic fort amid thick forest |
| | | Udayagiri Fort | Historic fort amid thick forest |
| 5. | Sawai Madhopur | Choth ka Barvada | Temple of Goddess |
| | | Khandar Fort | Historic fort amid thick forest |
| 6. | Bundi | Ramgarh Fort | Historic fort amid thick forest |
| | | Bhelupura | Dam, thick forest |
| | | Bhimlat | Waterfall, dense forest |
| | | Talwas | Lake surrounded by dense forest |
| | | Ajitgarh | Historic fort amid thick forest |
| 7. | Kota | Rawatbhata | Beautiful dam, rose garden, Hydel project, scenic beauty |
| | | Garadia Mahadev Temple | Temple and dense forest |
| 8. | Jhalawar | Gagron Fort | Historic fort amid thick forest |
| | | Jiren Mahadeo | Water stream, religious place amid thick forest |
| | | Band Deora | Archaeologically important, temple amid forest |

| | | | |
|---|---|---|---|
| 9. | Baran | Shahabad Valley | A valley surrounded by forest with centrally located small guest house |
| | | Kunda Khoh | Waterfall, picturesque beauty near Shahabad Fort |
| | | Shergarh Fort | Historic fort amid thick forest |
| | | Sorsan | Great Indian Bustard can be seen here, protected forest |
| 10. | Ajmer | Panch Kund | Deer Park, thick forest near Pushkar |
| | | Udaipur lake | Lake amid forest |
| | | Pitambar ki Gal | Gorge with thick forest |
| | | Ana Sagar | Lake with flamingos and water birds |
| 11. | Bhilwara | Meinal | Waterfall, temple, forest, and a monument |
| | | Hamirgarh | Water tank and a birding site |
| | | Harni Mahadev | Religious place amid forest with water tank |
| 12. | Tonk | Bisalpur | Dam, hills, forest site, scenic beauty |
| | | Shivad | Temple with hills and good scenic beauty |
| 13. | Chittourgarh | Hathini Hodi | Formerly Hunting Tower, forested valley |
| | | Neelia Mahadeo | A religious place with water stream, thick forest |
| | | Bhanwar mata | Temple amid thick forest |
| | | Goautameshwar Temple | Temple amid thick forest |
| 14. | Udaipur | Bagdara | Central water lake with crocodile population amid thick forest |
| | | Ubeshwar Mahadev | Religious place with water stream, forest, and a rest house |
| | | Nal Sandol | Forested valley and a herbal garden |
| | | Kamalnath | Temple on hilltop and trekking route |
| | | Khoria ki Nal | Trekking potential, nursery, small park |
| | | Sei Dam | Dam, water birds |
| | | Banki Farm | Hunting tower, thick forest, nature trail |
| | | Jhameshwar | Temple, spring, dense forest |
| 15. | Rajsamand | Sim mata | Seasonal spring, dense forest |
| | | Dhudheshwar | Temple amid forest |
| | | Desuri ki Nal | Good trekking potential, forested valley, and a variety of fauna |
| | | Ranakpur | Historical and beautiful Jain Temple, thick forest, trail |
| | | Pashupatinath | Famous temple, trekking potential, thick forest |

(continued)

**Table 18.3** (continued)

| S. No. | Existing ecotourism destination | Major sites | Remark |
|---|---|---|---|
| 16. | Banswara | Undavella | Water stream, temple, forested valley |
| | | Tripura Sundari | Bhim Kund, Ram kund, hot and cold spring, religious place, thick forest |
| | | Sharvan Dery | Herbal garden, a reviving forested valley in the back waters of Mahi dam |
| 17. | Dungarpur | Deo Somnath | Nature site and forest |
| | | Vaneshwar | Tribal temple amid forest and predominantly tribal area |
| 18. | Sirohi | Chhipaberry | Herbal garden, forest |
| 19. | Pali | Jawai dam | Birding site |
| | | Muchhala Mahavir | Trekking route, beautiful Jain Temple amid forest |
| 20. | Barmer | Kiradoo | Monument amid forest |
| | | Siwana | Rock climbing, thick forest, picnic spot |
| | | Nakoda | Famous Jain Temple amid forested hills |
| 21. | Jodhpur | Machia | Site chosen for biological park, thick forest |
| | | Traver Tank | Good birding site, water body |
| | | Guda Bishnoi | Famous tribal area for deer conservation |
| 22. | Bikaner | Gajner | Birding site, palace, water tank |
| | | Karni Temple | Only temple with thousands of rats amid forest |
| 23. | Jaisalmer | Akal Wood Fossil Park | A fossil park with surrounding desert |
| | | Sum | Site for sand-dunes |
| | | Khundi | Site for sand-dunes |
| | | Ghantiyli | Site for sand-dunes |
| 24. | Hanumangarh | Pilibanga | Good sitting for flamingos and other birds and archaeological site |
| 25. | Jhunjhunu | Lohargal | Good site, sulfur springs |
| | | Mansa mata | Temple amid forest |
| 26. | Nagour | Bhuwal mata | Temple amid forest |
| 27. | Sikar | Harsha Pahad | Good forested hill, trekking potential |
| | | Gangeshwar Mahadev | Temple amid forest |

away from the main Sambhar town, has great archaeological importance owing to its terracotta figurine and evidences of Kushan and Gupta Periods obtained during geological excavations. Eco-rehabilitation and ecotourism development of this rapidly degrading wetland and its catchment require multidisciplinary approach for sustainable lake basin management, water resource management, and forest management besides looking after the habitat depletion and other potentially deteriorating effects of climate change. The lake offers many pristine sites of tourist interest. Planning organized ecotourism-related activities around the clusters at Sambhar Lake and Sambhar town, trekking on Aravalli Hills surrounding the lake, forest camping, cultural gatherings near salt pans, cycling treks, bird-watching activities, village visits, zoological and botanical tours, nature photography, and hot air ballooning can surely attract large number of foreign tourists in this area. Geopark can also be established in this location for bio-monitoring, for public education, and for creating awareness and generating employment for the local youth. Huge amounts of protein can be extracted from the algae *Spirulina* present in the lake, which can be of immense economic importance and assistance in providing employment to the local youth. The strategies and action plan may include development of facilities for tourists around the lake, capacity building of local communities for meaningful participation in various activities focusing development of ecotourism to ensure sustainable livelihood opportunities, and development of publicity material and marketing of products and services to the larger tourist clientele while building partnerships of all the stakeholders. It is strongly hoped that government–private and public–private partnership would play an important role in this direction. By developing this lake as an ecotourism spot, we can stop this fascinating habitat from sliding into oblivion. It is believed that Sambhar Salt Lake shall make one of the most sought after ecotourism destinations of Rajasthan due to the unique ecosystem which this lake harbors.

In addition, Sajjangarh WLS and its fort (Fig. 18.16), Harsh Parvat Temple of Sikar (Fig. 18.17), and the haunted fort and temple of Bhangarh (Fig. 18.18) are other potential ecotourism destinations which lure the tourist.

An important biodiversity-rich ecotourism zone of Rajasthan encompassing the natural scenic beauty and having dynamic ecotourism prospect is given below as a case study:

## Prospects of Ecotourism in Hadoti Region: A Case Study

Hadoti is the land of *Hada Rajputs*, whose ancestry traces back to the *Chauhan Rajputs* clan. The region was earlier ruled by the *Bhil* and *Mina* tribe, and a small population of them still inhabits the area. Jait Singh Hada, the prince of Bundi, vanquished the *Bhil* chief of Akelgarh and laid the foundation of Kota in 1264 AD on the banks of River Chambal. Kota remained a tutelary of Bundi until 1624 AD, and then Rao Madho Singh received independent charge of the 360 villages from his father Rao Ratan Singh of Bundi. Thus, Kota became an independent state and was accorded recognition by the Mughal Emperor Shah Jahan in 1631 AD; later, Maha Rao Bhim Singh-I's successors ruled the state.

**Fig. 18.16** Sajjangarh Fort is situated in Sajjangarh WLS, Udaipur. *Courtesy: Devendra Bhardwaj*

**Fig. 18.17** Harsh Parvat Temple at Sikar is a pilgrimage and also a beautiful place. *Courtesy: Devendra Bhardwaj*

**Fig. 18.18** Bhangarh Fort is considered the most haunted place in Rajasthan. *Courtesy: Devendra Bhardwaj*

Locally called *pathar* (stony) and *uparmal* (high tableland), the eastern and southeastern part of the state of Rajasthan is known as Hadoti. The plateau lies in the eastern parts along with the Chambal River in the southeast of Mewar Plain and covers greater part of Bhilwara, Bundi, Kota, Baran, and Jhalawar districts. It contains about 9.6% of the total area of Rajasthan. The tableland has a diverse topography consisting of sandy uplands, broad depressions, and level stretches of deep black soil. East of the plateau has a general slope toward Gwalior in Madhya Pradesh state and the catchment of the River Betwa, and to the northeast a rugged terrain along the frontier line of the Chambal in Karouli district. Further northward, the topography opens out into flat plains of Yamuna basin. Most of the part of this region is drained by Chambal River and its tributaries like Kalisindh, Parwan, and Parwati. This plateau is further subdivided into two, namely, Vindhyan Scarpland and Deccan Lava Plateau.

The plateau in this region has *Dhok* and *Salar* trees intermingling with the dry deciduous forests whereas the river valley has evergreen bamboo and moist forest flora. The land adjoining Malwa Plateau and Vindhya Mountain Range in the east have thick *teak* forest. A series of rock-shelters and cave-paintings which are supposedly as old as 25,000 years leaves an indelible mark on one's mind. We find a rare continuity in the history of the region, as a number of excavated mounds have yielded copper, iron and terracotta artifacts, stone jewelry, terracotta beads, red earthenware, seal, and coins, belonging to prehistoric civilization of the mankind.

The region is abound with a diverse fauna, including some of the rare animals like Caracal, Rattle, Gray Wolf, Sambar, and Four-horned Antelope. The avian diversity is phenomenal and includes rare birds like Great Indian Bustard, Lesser Florican, Painted Sandgrouse, Painted Spurfowl, Gagroni Parakeet, Green Pigeon, a variety of migratory flycatchers, bunting, ducks, and geese. The rivers are teemed with Mahseer and other game fishes as well as turtle, Gharial, Mugger and Smooth-coated Otter. The spirit of adventure took the rulers of Hadoti to the jungles, which they loved and protected with zeal. The modern wildlife sanctuaries are actually protected forests of erstwhile rulers of Kota and Bundi states. A number of forest recluses and hunting lodges still provide shelter to a wildlife lover on a vigil at night to watch some rare activities of the forest. The valiance and spirit of adventure of yesteryears gave rise to adventure sports of today. The thrill of being in the forest and in the river valley has attracted many tourists to Hadoti. The adventure of boating, jeep, and horseback safari, water sports, air sports, joy air rides, and trekking on the lonely forest paths have made Hadoti an ideal destination for someone who is an ardent admirer of nature and wildlife tourism.

## *Wildlife Protected Areas of Hadoti*

The districts of Kota, Bundi, Baran, and Jhalawar have five wildlife sanctuaries (WLSs), namely, the Jawahar Sagar, Darrah, National Chambal, Ramgarh Vishdhari and Shergarh Sanctuaries, and the Sorsan Great Indian Bustard Sanctuary (Fig. 18.19). A number of excellent bird-watching sites like Udpuria Bird-Watching Centre are suggested for those who wish to see resident and migratory birds in their natural habitat. Jawahar Sagar and Darrah WLS are excellent for nature education, trekking, bird-watching, butterfly viewing, and studying ferns, orchids, tuberous plants, bryophytes, medicinal plants, shrubs, herbs, grasses, climbers, lianas, and trees. The grasslands of Sorsan, Borawas, Garadia Mahadev, and Abhera villages support the specialized fauna suitable for such habitat. The habitats at Mukundra Hills National Park (Fig. 18.20) and River Chambal (Fig. 18.21a, b) are of great significance from the standpoints of scenic beauty and biodiversity including the gharial, crocodile, otter, and large number of avians. Other birding attractions and wetlands near Kota district of the Hadoti region are Bardha Dam, Alniya Dam, Ranpur *Talab*, Abheda *Talab*, Chandoli River, Chandresal, Ummedganj Reservoir, and Sorsan.

## *Bird-Watching at Hadoti*

The dams, reservoirs, tanks, and rivers of Hadoti offer some excellent bird-watching locations.

Painted Stork Community Reserve of Udpuria is situated only 30 km from Kota (Fig. 18.22). It is a marvel of conservation initiated by the villagers. The storks start

**Fig. 18.19** Blackbucks at the Sorson Sanctuary, Kota. *Courtesy: Sunil Singhal, Kota*

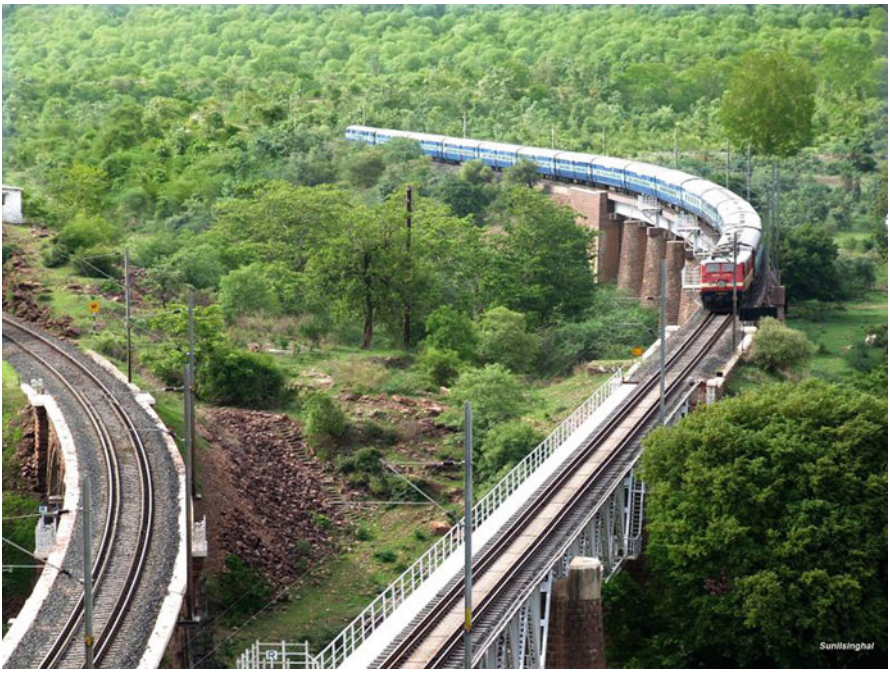



**Fig. 18.20** Mukundra Hills, Kota. *Courtesy: Sunil Singhal, Kota*


**Fig. 18.21** (**a**) River Chambal view at Jawahar Sagar. (**b**) River Chambal meandering through gorges. *Courtesy: Sunil Singhal, Kota*

**Fig. 18.22** Painted Storks at Udpuria Wetland, Kota. *Courtesy: Anil Nair*

arriving in the month of August every year and reside to raise their chick in the friendly atmosphere of Udpuria. The villagers are aware of the requirements of the bird and make sacrifices to make them comfortable. Some trekking routes ideal for bird-watching are Selzer–Chambal providing eight kilometers walk along a stream with crossing over to Kadab ki khal area to watch aquatic birds; Kolipura–Girdharpura, 12 km through Karondi and Kanjhar; Laxmipura–Darrah village through Jhamara and Gaddhe-ka-mala; Shergarh Sanctuary, six kilometers along the Parban River on the right bank; and Jawahar Sagar–Rani Amba, eight kilometers along the Chambal River and atop the hill are good for bird-watching. Grassland trails for bird-watching are Daulatganj–Geparnath, Ahera–Bardhahas trek through a rough terrain, and Garadia Mahadev crossing the limits of Kota city to Dabi. A boat ride of about 26 km at Jawahar Sagar is a bird-watchers' dream run. The motor boats are available from Kota. Kadab ki khal, on the upstream Chambal River, is a great site for bird-watching where the forest department provides boat on hire. Bardha Dam is a medium-sized dam in Bundi district, about 18 km from Kota where thousands of migratory birds gather during winter. Alniya Dam situated 20 km from Kota city is also well-known for its avian diversity.

## *Key Activities for the Promotion of Ecotourism in Hadoti*

For promoting tourism in the WLSs, the following aspects need to be developed so that the visitors get attracted and carry the message of nature conservation. Conducting nature education camps, trekking, wildlife viewing, horse or camel safari, botanical excursions, nature education trails, bird-watching, hiking, participating in cultural events, photography, and mountaineering are a few activities which may attract tourists.

## *Adventure Sports*

There are excellent opportunities for water sports at Chambal River such as boating, water skiing, kayaking, wind-surfing, and water-rafting. The Department of Tourism, State Government of Rajasthan has initiated an Adventure Sports Festival at Kota. The tourists may also enjoy boat rides in Jait Sagar in Bundi and Keshoraipatan. The boat ride from Rangpur to Keshoraipatan in the backdrop of setting sun and the beauty of the Keshav Rai Temple in the foreground is an enthralling experience.

## *Prehistoric Sites*

The cave -shelters and cave- paintings of the prehistoric man from stone, copper, and iron ages have been discovered in Hadoti. A glimpse of the ochre-, green-, red-, and white-colored drawings provides an insight of the social life and the intellect of the early man. 25,000–30,000-year-old rock shelters on the banks of Alniya River have some of the most primitive paintings depicting animal figures, geometrical designs, and hunting scenes. Nalhah, Golpur, and Garadada's large painted shelters offer an opportunity to invade the past through the expressive artwork of early man. The older paintings depict wild animals, human figures, and abstract designs, whereas at some places, village life and agropastoral way of life has been shown. Tiptiya is a recent discovery at Darrah Sanctuary on little uphill climb and has human forms and patterns dating back to early history and beyond. A well-preserved collection of cave art of the early man is also available for viewing at Kanyadah in Baran district.

## *Forts and Palaces*

The early medieval and medieval fortifications of Gagron, Taragarh, Bundi (Fig. 18.23), Shergarh, and palaces like Garh Palace, Kota (Fig. 18.24), are reminiscent of the valiant past of Hadoti. The Jagmandir–Kishore Sagar (Fig. 18.25), Abheda Mahal (Fig. 18.26), Rajvilas, Kesarbagh, and Rani Bagh complex with their intricate sculpturing and frescoed walls provide enough proof of the glory and opulence of their occupants.

**Fig. 18.23** Bundi Fort, Bundi. *Courtesy: Devendra Bhardwaj*

**Fig. 18.24** Garh Palace, Kota. *Courtesy: Sunil Singhal, Kota*

## *Places of Pilgrimage and Other Places*

The rulers and their subjects welcomed and assimilated the migrants of all faiths and beliefs. Mathuradhish Temple, Kota; Keshav Rai Temple (Fig. 18.27), Keshoraipatan; Padmanabh Sun Temple, Jhalrapatan; and Sheetaleshwar Mahadev Temple, Chandrabhaga are well-known pilgrimage places. Some of the most sacred places of Jainism, like Adinath Temple, Chandkheri; Swami Suvratnath Temple, Keshoraipatan; Nageshwar Parshwanath Temple, Unhel and Kolvi; and Vinayaka—located on the red mud bank of Kyasari River and a hillock holding a rock-cut Buddhist monastery, are of immense significance. This group of monasteries belongs to seventh century A.D. and has whole blocks of prayer halls, stupas, temples, and double-storied living quarters. Many Sufi saints came from as far as Persia and


**Fig. 18.25** Jagmandir, Kota. *Courtesy: Sunil Singhal*, Kota


**Fig. 18.26** Abhera *Mahal* (Palace), Kota. *Courtesy: Sunil Singhal, Kota*

**Fig. 18.27** Lord Keshorai Temple. *Courtesy: Sunil Singhal, Kota*


**Fig. 18.28** Badoli Temple, Kota. *Courtesy: Sunil Singhal, Kota*

made this place their home to spread the message of love and peace. Badoli, situated 45 km from Kota on Chittourgarh road, has a unique tenth- to eleventh-century temple portraying celestial beauty (Fig. 18.28). Bhand Devra, Ramgarh, is an early medieval temple made in the style of famous Khajuraho temples; the beautifully carved pillars are famous for their erotic depictions. Vilas at Kanyadah has a deep natural reservoir on the Vilas River. The cave-shelters and cave-paintings make this visit a worthwhile experience. Kakoni has a huge collection of ninth- to eleventh-century statues of Gods and Goddesses, carved pillars, and torans which make it an exquisite place to visit. Bheem Chauri is the famous statue of a stringed instrument player which was displayed at exhibitions all over the world. Geparnath Mahadev Temple has a three-step waterfall running in the valley during rainy season. The pristine beauty and wildlife makes it fascinating for the tourist. Bijolia Temple is also famous for its architecture (Fig. 18.29). Majority of temples in Rajasthan invariably have a *Ficus benghalensis* or *Ficus religiosa* tree in the campus where Hanuman Langur can be found in large groups (Fig. 18.30). A rare photograph depicts two langurs at a water hole in a forest (Fig. 18.31). They pose a major attraction, especially for the international tourists.

In addition, the museums of Kota and Jhalawar possess a good collection of antiquities. Rao Madho Singh Museum is a private collection of items belonging to the erstwhile rulers of Kota kept at Garh Palace, Kota. The miniature and wall-paintings are a must-see for the tourists.


**Fig. 18.29** Bijolia Temple, Kota. *Courtesy: Sunil Singhal, Kota. Courtesy: Devendra Bhardwaj*

### *Fairs and Festivals*

National Dussehra fair held at Kota during the months of Oct–Nov every year is the most famous all over India. Kartik fair at Keshoraipatan held on the banks of Chambal River, Chandrabhaga Kartik fair at Jhalrapatan, Bundi *Utsav* (festival) and Teej fair at Bundi, Dol fair at Baran, Tribal fair at Sitabari of the Saharia tribal, Nhan festival at Sangod, and the handicraft and industrial fair at Kota are among other popular fairs attended by locals and tourists in large numbers.

## Ecotourism: A Double-Edged Sword

No doubt, the ecotourism industry constitutes the backbone of the economy of the state of Rajasthan, but it is also becoming a major threat to its varied ecosystems. Several hundreds of hotels are currently running in the PAs and other biodiversity-rich areas outside them without any proper waste management, and at some places, sewage is being released either in the open or into the nearby aquatic body. Tourists also increase the anthropogenic pressures in an already burdened ecotourism site. Although, a separate tourism policy has been formed in 2007 by the state government, we still need to honestly implement its various guidelines in order to carry on

**Fig. 18.30** Hanuman Langurs *Semnopithecus entellus* sitting on *Ficus bengalensis* tree. *Courtesy: Anil Kumar Chhangani*

**Fig. 18.31** Hanuman Langurs *Semnopithecus entellus* at a water hole in a forest. *Courtesy: Bernard Castelein/Sanctuary Asia Photo Library*

with a sustainable ecotourism by actively involving the target groups, key stakeholders, and above all the local people. Please see Chaps. 1, 2 and 3 from *Faunal Heritage of Rajasthan: Ecology and General Background of Vertebrates*, Vol. 1; B. K. Sharma et al. (eds.), 2013, springer Pub. and Chaps. 1, 8, 19 and 20 from this volume for more pictures and information.

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# Part III
# Vanguards of Wilderness

# Chapter 19
# Wildlife Conservation in Rajasthan: The Legal Framework Versus the Wildlife Trade

**B.K. Sharma, B.S. Nathawat, Shailja Sharma, and Seema Kulshreshtha**

**Abstract** This chapter profoundly describes the legal framework right from the British period to the present times and the policies and strategies made by the central and the state government for conserving wilderness of the country in general and the state of Rajasthan in particular. The safeguard of forests has been included in the list of fundamental duties of the citizens of India in Article 51(g). The Wildlife (Protection) Act of 1972 and its implications along with the amendments of 1986, 1991, 2000, 2003, 2006, and 2008 have also been presented chronically in this chapter. Unfortunately, deforestation and other activities detrimental to nature conservation are still going on in the state due to the negligence of competent authorities in implementing the laws. The Government of India has also constituted the National Board of Wildlife, National Tiger Conservation Authority, Other Endangered Species Crime Control Bureau, and Tiger Conservation Foundation under various sections and Amendment Acts of the Wildlife Protection Act, 1972. Likewise, the state government has also constituted the State Board of Wildlife, Advisory

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Committee, Conservation Reserve Management Committee, Steering Committee for community reserves, State Biodiversity Board, Tiger Task Force, or State Empowerment Committee under these Acts. Under Section 4 of the Act, the state government has got the power to appoint an honorary wildlife warden. The implication of laws has been in bad shape during 1980–1995, a crucial period for wildlife particularly for the carnivores and Schedule I animals due to heavy demand from western countries for their fur, skin, bones, and meat. The ill-famed wildlife crime cases from the state are the Sansar Chand's case of international wildlife smuggling responsible for the Sariska debacle, trade of critically endangered animals, Peregrine (resident species) and Shaheen Falcon (migratory) on the border of Jaisalmer district, recovery of 250 kg elephant tusks (ivory) by the police in Jaipur, film star Salman Khan's case for killing Blackbuck and Chinkara in Jodhpur district, and Kalia Bawaria case—a tribal responsible for the killings of a large number of panthers. Authors have also discussed the loopholes in the laws, taking advantage of which a maximum number of accused are discharged with minimum penalty and sentences.

## Introduction

The forests play a pivotal role in protecting, producing, and providing accessory benefits to the economy of a country. Forests conserve soil and water, without which life in any form is impossible, and also have a salutary effect on climate. The productive role of forest as a supplier of wood and a number of other forest products is gaining importance progressively because of the rise in population and the standard of living of people which is reflected in the mounting demand for wood and wood products. Forests also form ideal resorts for recreation and assets of aesthetic value.

## Wildlife and the Indian Constitution

The importance of protection and improvement of forests has been given due recognition in the Constitution of India. According to the stipulation in Article 48 A, "*The state shall endeavor to protect and improve the environment and to safeguard the forests and wildlife of the country*." Fundamental duties enumerated in Article 51 A (g) lay down,

"*It shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, river and wildlife and to have compassion for living creatures.*"

## *The Laws*

The whole body of legal enactments and the rules are distinguishable into two categories, namely, the general laws and the special laws. General laws consist of

the general or ordinary law of the land such as the Indian Panel Code, the Criminal Procedure Code, and the Indian Contract Act, which apply in India uniformly and regulate the conduct of general public in day-to-day life. The public is also aware of the existence of these laws regarding theft, assault, murder, rape, etc. Special laws pertain to a specific subject such as the Opium Act, the Salt Act, and the Forest Act or to a special locality like the Bombay Prohibition Act and the Tamil Nadu Forest Act, which are operative in Bombay and Tamil Nadu, respectively. The latter category of the special law is also called "local law" (vide Sections 41 and 42 of I.P.C). The Indian and State Forest Acts are special laws according to the above criterion. The provision in general laws is not found adequate to deal effectively with special conservational problems because a forest, as a piece of property, has certain peculiarities which need to be dealt in a special manner via a separate enactment, and so the acts for the conservation and protection of wildlife and forests came into being.

## History of Forest Laws in India

The, then British Empire in India pioneered formulation of the forest policy. More than 30 years ago, the administration of India's forests was governed by a comprehensive law, while other colonial territories tried to model the Indian Forest Act. On the other hand, India did not pay any heed to the subject as late as 1828, when, for the first time, the government in those days asserted its proprietary right of wastelands which included vast forest areas. Until then, the public believed that a forest, being of natural origin, could be cleared, burnt, and cultivated by anybody who takes the trouble of doing the same and hence there was no need of conservation.

For a long time, the government did little efforts but gradually realized the value of these forests and initiated steps to conserve them. The first phase of their efforts culminated in the passing of the Forest Act (1878). A passage from Baden Powell's Forest Law (1893) which describes this phase is given below. The first attempt to enact a comprehensive forest law was made in 1865, but this did not prove successful, the main drawback being that it professed to deal only with government forests. Forests were defined as "land covered with trees, brushwood, and jungle." This definition was a source of great deal of trouble as all the areas to which the Forest Act was intended to be made applicable did not fall within its purview. Hence, this definition was omitted in the later Indian Forest Acts, which has not proved to be much of a handicap, as the provisions of the Forest Act are to be applied to government-owned forests. The most glaring defect of the act of 1865 was that it made no provision regarding the rights of user.

In 1878, the Forest Act VII of 1878 was passed. This act was amended in 1890 and later in 1927 and continues to be in force even today but, the act in its practical application, did not extend to the whole of India. Certain parts of the country like Burma (which formed part of India until 1937), the Madras Presidency as it then existed, Ajmer–Merwara, Assam, and Baluchistan had their own forest acts or regulations to meet their special requirements. The General Act of 1878, as subsequently

amended last in 1927, was in force in the rest of what used to be called as British India. The position has changed dramatically with the Independence in 1947, resulting in the conglomeration of the erstwhile princely states with the rest of India. These political changes have broadened the horizon for the application of the India Forest Act to the newly formed states with suitable amendments wherever necessary. Yet, a few states chose to have their own forest acts such as Andhra Pradesh, Assam, Jammu and Kashmir, Kerala, Karnataka, Rajasthan, Tamil Nadu, and Orissa. Further, special additional legislation has been enacted in most of the states with a view to control the working of private forests as well as to conserve soil and water in the catchment area of the river systems liable to erosion as the provision made for this purpose in the Indian Forest Act was found inadequate. These laws have some special provision for constituting reserved forests, protected forest, and village forests including their wildlife content by preventing the commission of offenses therein and punishing the offenders if and when the offenses are committed. It provides similar protection to the timber and other forest produce in transit to the market and other destinations and equips the forest officers with necessary legal powers to carry out the purpose of the act or rules and enforce them wherever a violation takes place. Controlling the management of privately owned forests and wastelands also comes in its purview when the circumstances warrant such action to be taken.

## *Forest (Conservation) Act, 1980 with Amendments Made in 1988*

The above act prohibits the non-forest use of the forest land and "non-forest purpose," meaning the breaking up or clearing of any forest land or portion for the cultivation of tea, coffee, spices, rubber, palms, oil-bearing plants, horticultural crops, or medicinal plants and any purpose other than reforestation. It does not include any work relating or ancillary to conservation, development, and management of forests and wildlife, namely, the establishment of check posts, fire lines, and wireless communications and construction of fencing, bridges and culverts, dams, waterholes, trench marks, boundary marks, pipelines, or other purposes.

## *Forest Rights Act, 2006: Illusion or Solution?*

After an intense public debate for more than a year since tabling in the parliament on December 13, 2005, the Scheduled Tribes (Recognition of Forest Rights) Bill, 2005, rechristened as "the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006," was passed in the lower house of Indian Parliament on December 13, 2006. The President of India assented to the bill on December 29, 2006, and the act finally came into force. However, the debate since the tabling of the initial bill in December 2005 to the passage of the act in the *Lok Sabha* (the upper house of Indian parliament) has unveiled age-old prejudices against the tribal people to the fore and further eroded their rights.

The draft of Scheduled Tribes (Recognition of Forest Rights) Bill, 2005 faced stiff opposition from two-quarters. First, a few environmentalists advocated management of forest, wildlife, and other biodiversity with complete exclusion of tribal people, local communities, or forest dwellers contrary to the Rio Declaration, decisions of the Conference of Parties of the Convention on Biological Diversity, and recommendations of the United Nations Forum on Forest. The poaching of tigers in the Sariska Wildlife Sanctuary provided the much needed excuse. Secondly, the Ministry of Environment and Forest had opposed the bill on the ground that implementation of the bill will result in the depletion of the country's forest cover by 16%. All this is despite the fact that over 60% of the country's forest cover is found in 187 tribal districts where less than 8% of national population lives. On the other hand, the Ministry of Environment and Forest has diverted 73% (9.81 lakh hectares of forestland) of the total encroached areas for non-forest activities such as industrial and development projects.

The following were the objections to the 2005 draft bill which was referred to the Joint Parliamentary Committee (JPC) headed by V. Kishore Chandra S. Deo of the Congress Party. On May 23, 2006, the JPC submitted its recommendations. However, the recently passed Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, states, "*An act to recognize and vest the forest rights and occupation in forest land in forest dwelling scheduled tribes and other traditional forest dwellers who have been residing in such forests for generations but whose rights could not be recorded….*"

## Legal Aspects of Wildlife Conservation: The Wildlife Protection Act, 1972

Until the middle of the last century, wildlife in India was abundant, and their habitat was largely intact. Hunting was a popular sport of erstwhile royal families. In the early 1970s, it became clear to decision makers that unless a uniform, well-structured law was promulgated across the country, survival of wildlife would be in jeopardy. The Wildlife (Protection) Act of 1972 was, therefore, put into place. It became applicable to all the states of India except Jammu and Kashmir, which later enacted its own law called the J & K Wildlife (Protection) Act of 1978.

The Wildlife (Protection) Act of 1972 reflected the realities of its time. It allowed hunting permits and a regulated trade in wildlife articles including ivory, fur, skins, and other wildlife derivatives. When the gruesome activities of wildlife traders and poachers were exposed, two amendments in the act were made in 1986 and 1991 to plug loopholes, by adding chapters pertaining to the management of zoos, protection of plants, prohibition of trade in animal articles, etc. These amendments were not carried out in the J&K Act, which led to a number of problems. However, the J&K Wildlife (Protection) Act was amended in May 2002 to bring it at par with the central act in most respects. The Central Amendment Act of 2000 is not yet incorporated in the J&K Act.

To begin with the Amendment Act of 2002, it has substituted the long title of the act to make it more meaningful, and therefore this reads as follows:

"*An Act to provide for the protection of wild animals, birds and plants and for matters connected therewith or ancillary or incidental thereto with a view to ensure the ecological and environmental security of the country*." The addition of the words "*ensuring the ecological and environmental security of the country*" is significant.

Prolific changes have been made in Section 51 by enhancing the penalty for offenses relating to animal and derivatives specified in Schedule I or Part II of Schedule II and offenses relating to hunting or altering the boundaries of a sanctuary or national park. The minimum imprisonment has been increased to three years but may extend to seven years and a fine which shall not be less than ten thousand rupees. Introduction of Section 51 A makes it more difficult for a repeat offender to obtain bail.

## *Judicial Activism and Wildlife Law*

The judicial activism of the last decade has major impact on the implementation of the Wildlife (Protection) Act, 1972. Of the numerous orders and judgments passed, there are three important orders passed by the Honorable Supreme Court of India, which have important implications on the implementation of the wildlife act:

1. Order dated November 13, 2000, in center for *Environmental Law vs Union of India*, prohibiting the de-reservation of national parks, sanctuaries, and forests without the approval of the Supreme Court. This was contrary to the legal provisions as contained in the Wildlife Act as well as the Forest (Conservation) Act, 1980. The Wildlife Act, prior to the amendment in 2003, vested the power of de-notification of national parks and sanctuaries on the state legislature. In November 2005, the Supreme Court was informed that such settlements are yet to take place in many protected areas (14 out of 85 national parks and 170 out of 494 wildlife sanctuaries).
2. Order dated November 20, 2000, in *Naveen Raheja vs Union of India and others*, prohibiting the establishment of any new zoo without approval of the Central Zoo Authority as well as the Supreme Court.
3. Order dated February 14, 2000, in *T. N. Godavarman vs Union of India* (on a writ petition filed under Article 32 of the Constitution of India), prohibiting the removal of grass, dead and decaying trees, drift wood, etc. from national parks and sanctuaries. This order was a landmark so far as protected areas were concerned. Many non-forestry activities, mostly noncommercial in nature, were stopped due to the intervention of the Supreme Court and the court appointed a Central Empowered Committee (CEC).

## Implication of the Supreme Courts' Order

An issue frequently raised is that of the implication of an order passed by the Supreme Court, which is contrary to the level as laid down by the parliament. It is clear that the power to de-reserve a national park or sanctuary is legally vested in the state government to be exercised with the prior approval of the National Board for Wildlife. Similarly, the power to unreserve a reserved forest is vested in the state government to be exercised only with the prior approval of the central government. The question, therefore, arises as to under which provisions of law does the Supreme Court have the power to override a statutory provision and how binding are the orders passed.

The basic purpose underlying Article 32 is to empower the Supreme Court to give relief to an aggrieved person whose fundamental right has been infringed; the Supreme Court has used Article 32 for a much wider purpose than that, namely, to lay down general guidelines having the effect of law to fill the vacuum until such time the legislature steps to fill in the gap by making the necessary law. Clarifying on the issue further, in another case the Supreme Court observed:

> …it is not possible for the court to give any direction for amending the Act or the Statutory Rules. It is for the Parliament to amend the acts and rules….However, it is equally settled that in case where the acts and rules are silent on a particular subject…the court can necessarily issue direction or orders on the said subject to fill in the vacuum or void till a suitable law is enacted.

With respect to the Wildlife Act, the Supreme Court's intervention did lead to positive amendments to incorporate the concerns of the court. Three significant amendments can be directly credited to the concerns of the court's intervention:

- Insertion of Section 25 A whereby a time limit of two years has been stipulated "as far as possible" for the completion of acquisition proceedings with respect to national parks and sanctuaries.
- Amendment of the provision relating to alteration of boundaries of national parks and sanctuaries: The powers vested on the state legislature have been withdrawn and replaced by the statutory National Board for Wildlife. As a result of this, any de-notification will require the prior approval of the National Board for Wildlife as well as the Supreme Court.
- Amendment of Sections 29 and 35 (4) of the act relating to situations where destruction of wildlife is permissible. The amendment in 2003 provided that if forest produce is removed from a national park or sanctuary on the ground that it is essential for the better management of wildlife or its habitat, the same can be used for meeting the bona fide requirement of the people living around the sanctuary/national park and not for any commercial purpose.

The directions issued by the Supreme Court under Article 32 have the force of law. The general direction issued by the courts is, thus, *quasi-legislative* in nature for they bind not only the parties to the specific disputes before the court but also even others. Breaches of these directions constitute contempt of court. Further, Article 142 provides that the Supreme Court may pass any order for doing complete

justice in any cause or matter pending before it and the order so made shall be enforceable throughout the territory of the country. Even if a statute contains a specific prohibition or restriction, the Supreme Court has held that it shall not circumscribe the power of the Supreme Court to do what it thinks is necessary to do complete justice.

## *Rajasthan Biological Diversity Rules, 2009*

In exercise of the powers conferred by Section 63 of the Biological Diversity Act, 2002 (Act No. 18 of 2003), the state government made Rajasthan Biological Diversity Rules, 2009. These rules are formed to issue directions for the formation, management, and functions of the various state boards, authorities and committees, and legal rights and duties of their members.

## *Rajasthan State Forest Policy, 2010*

National Forest Policy, 1988, lays down the guiding principles for forest management in the states of the country. National Forestry Commission has also recommended the formation of such policy by the states. The Government of Rajasthan accordingly adopted this forest policy.

## *The Objectives*

1. Protecting, conserving, and developing natural forests with the help of local communities.
2. Undertaking massive afforestation on all kinds of land.
3. Combating desertification and preventing land degradation of the land by plantation.
4. Meeting the livelihood needs of tribal and dependent communities by development of non-timber forest produce.
5. Conservation by protected area network.
6. Endangered species conservation by undertaking *in situ* and *ex situ* conservation measures.
7. Empowering the village communities for sustainable forest management under joint forest management.
8. Instituting research activities and human resource development, upgrading technical skills, and providing support system to farmers for agroforestry.
9. Shifting focus from traditional- to people-oriented approach of forest management.
10. The principal aim is the environmental stability and ecological security through increased forest cover ultimately leading to climate change for the better future.

The review of implementation of the State Forest Policy will be done by establishing "State Forest Advisory Council" at the level of chief minister and cabinate ministers of concerning departments.

## *Rajasthan Ecotourism Policy, 2010*

As ecotourism is gaining importance, it became paramount to formulate a policy to encourage, guide, and regulate in such a manner that it grows in a sustainable way and benefits the people in general, thereby achieving the conservation goals. Although the number of tourists has doubled during last five years, ecotourists have not increased in this proportion.

## *Objectives of the Ecotourism Policy*

(a) To promote ecotourism in specified areas of the National Parks, Wildlife Sanctuaries, and forests as conservation and education tools
(b) To encourage ecotourism to visit, enjoy, and appreciate nature on sustainable basis
(c) To enhance awareness about the need for nature conservation among the masses
(d) To preserve the existing forts, palaces, and heritage buildings by providing access to ecotourism for educational and recreational purposes
(e) To empower local communities to manage ecotourism and generate incentives for conservation through alternate and additional livelihood options

## *Guiding Principles*

The various provision as laid down in the Rajasthan Forest Act, 1953; Wildlife Protection Act, 1972; Forest Conservation Act, 1980 and Environment Protection Act, 1986 provide a firm footing to the guiding principles.

## *Strategies*

1. Maximum benefits to local communities through Village Forest Management Committee (VFMC), Eco-Development Committee (EDC), etc., engaged in conservation and development of forest and wildlife areas
2. Multi-stakeholder partnership in developing and operating facilities and activities to be encouraged
3. Capacity building of government staff, local communities, and tourism enterprises through regular training by seminars and workshops

### *Policy Implementation*

For overseeing the implementation of the policy, "Rajasthan Tourism Society" has been formed under the chairmanship of the forest minister of Rajasthan government. It is well equipped with financial and technical resources by availing funds from national and international agencies for projects and getting necessary help from the concerning departments.

### *Facilities for Ecotourists*

The general activities usually permissible in such ecotourism sites are safariing, trekking, nature walking, boating, overnight camping, bird-watching and studying of fauna and flora, nature camping for students, angling, etc. In order to provide additional facilities for ecotourists, formation of "Nature Interpretation Centres" will be encouraged. It is hoped that the ecotourism policy shall result in better conservation of forest resources, education to general public, and benefits to the locals.

## Powers of Central Government/State Governments to Constitute Boards, Committees, Authorities, and Funds

To provide protection to wild animals, birds, and plants and for matters connected with or ancillary to or incidental and with a view to ensure ecological and environmental security, the Government of India as well as state governments have constituted various boards, authorities, funds, and committees under the Wildlife (Protection) Amendment Act, 2006, which are as follows:

### *National Board for Wildlife*

Under Section 5 A of Wildlife (Protection) Amendment Act, 2006, the Government of India constituted National Board for Wildlife under the chairmanship of the Prime Minister of India vides notification no. S.O. 1093 (E) dated September 22, 2003. The Vice Chairperson of the board is the Minister of Forests and Wildlife. Other members include the members of the Parliament and Planning Commission, heads of NGOs, conservationists, directors of premium wildlife and forest institutes, secretaries of the concerning departments, and state government representatives.

## *Functions of the National Board*

The National Board promotes the conservation and development of wildlife and forests by:

(a) Framing policies and advising the central government and the state governments on the ways and means of promoting wildlife conservation and effectively controlling poaching and illegal wildlife trade
(b) Making recommendations on the setting up of and management of national parks, sanctuaries, and other protected areas and matters relating to restriction of activities in those areas
(c) Carrying out or causing to be carried out impact assessment of various projects and activities on wildlife or its habitat
(d) Reviewing, from time to time, the progress in the field of wildlife conservation in the country and suggesting measures for improvement thereto
(e) Preparing and publishing a status report at least once in two years on wildlife in the country

## *Central Zoo Authority*

Under Section 38 A of Wildlife (Protection) Amendment Act, 2006, the Central Government has got the power to constitute the Central Zoo Authority (CZA) to exercise the powers, conferred on, and to perform the functions assigned to it. The authority shall consist of a chairperson and members not exceeding ten and a member secretary for three years tenure.

## *Functions of the CZA*

The CZA shall perform the following functions:

(a) Specify the minimum standards for housing, upkeep, and veterinary care of the animals kept in a zoo.
(b) Evaluate and assess the functioning of zoos with respect to the standards or the norms as may be prescribed.
(c) Recognize or derecognize zoos.
(d) Identify endangered species of wild animals for purposes of captive breeding and assigning responsibility in this regard to a zoo.
(e) Coordinate the acquisition, exchange, and loaning of animals for breeding purposes.
(f) Ensure maintenance of studbooks of endangered species of wild animals bred in captivity.

(g) Identity priorities and themes with regard to display of captive animals in a zoo.
(h) Coordinate training of zoo personnel in India and outside India.
(i) Coordinate research in captive breeding and educational programmers for the purposes of zoos.
(j) Provide technical and other assistance to zoos for their proper management and development on scientific lines.
(k) Perform such other functions as may be necessary to carry out the purposes of this Act with regard to zoos.

There shall be constituted a fund called the "Central Zoo Authority Fund." The fund referred to in Subsection (2) shall be applied for meeting the salary, allowances, and other remuneration of the members, officers, and other employees of the authority and the expenses of the authority in the discharge of its functions under this chapter and expenses on objects and for purposes authorized by this Act. The authority shall prepare its annual report, giving a full account of its activities during the previous financial year, during meetings with the central government authorities, and related to proceedings in each House of Parliament.

## *Recognition of Zoos*

No zoo shall be established or operated without being recognized by the CZA. On and after the commencement of the Wildlife (Protection) Amendment Act, 2002, no recognition to a zoo will be granted by the CZA unless having due regard to the interests of protection and conservation of wildlife.

## *Acquisition of Animals by a Zoo*

Subject to the other provisions of this act, no zoo shall acquire, sell, or transfer any wild animal or captive animal specified in Schedules I and II except with the previous permission of the authority.

## *National Tiger Conservation Authority*

Under Section 382 of Wildlife (Protection) Amendment Act, 2006, the Central Government constituted the National Tiger Conservation Authority (NTCA) for three years under the chairmanship of the Minister of Environment and Forests; members of the parliament, House of People, and state council; eight experts on tiger conservation; Director Generals, of the Department of Forests; Chief Wildlife Wardens; etc.

## *Powers and Functions of NTCA*

(a) To approve the tiger conservation plan prepared by the state government under Subsection (3) of Section 38 V of this act.
(b) To evaluate and assess various aspects of sustainable ecology and disallow any ecologically unsustainable land use such as, mining, industry, and other projects within the tiger reserves.
(c) To lay down normative standards for tourism activities and guidelines for Project Tiger from time to time for tiger conservation in the buffer and core area of tiger reserves and ensure their due compliance.
(d) To emphasize focus on management and measures for addressing man–animal conflicts and to accentuate peaceful coexistence in forest areas outside the national parks, sanctuaries, or tiger reserve, in the working plan code.
(e) To provide information on protection measures including future conservation plan, estimation of population of tiger and its natural prey species, status of habitats, disease surveillance, mortality survey, patrolling, reports on untoward happenings, and such other management aspects as it may deem fit including future plan conservation.
(f) To approve, coordinate research, and monitor on tiger, co-predators, prey, habitat, related ecological, and socioeconomic parameters and their evaluation.
(g) To ensure that the tiger reserves and areas linking one protected area or tiger reserve with another protected area are not diverted for ecologically unsustainable uses, except in public interest and with the approval of the National Board for Wildlife and the advice of the Tiger Conservation Authority.
(h) To facilitate ongoing capacity building program for skill development of officers and staff of tiger reserves.
(i) To perform such other functions as may be necessary to carry out the purposes of this Act with regard to conservation of tigers and their habitat.

The Tiger Conservation Authority may, in the exercise of its powers and performance of its functions under this chapter, issue directions in writing to any person, officer, or authority for the protection of tiger or tiger reserves, and such person, officer, or authority shall be bound to comply with the directions, provided that no such direction shall interfere with or affect the rights of local people particularly the scheduled tribes.

## *Grants and Loans to NTCA and Constitution of Fund*

There shall be constituted a fund to be called the *Tiger Conservation Authority Fund*. The fund referred to in Subsection (2) shall be applied for meeting salary, allowances, and other remuneration of the members, officers, and other employees of the NTCA and the expenses of the authority incurred in the discharge of its functions under this chapter. The NTCA shall prepare a report annually and submit it to the Central Government and the parliament.

## *The National Biodiversity Authority*

In exercise of the powers conferred by Subsections (1) and (4) of Section 8 of the Biological Diversity Act, 2002 (18 of 2003), the central government established a body called the National Biodiversity Authority, on and from the first day of October, 2003, for the purpose of the conservation of the biodiversity of India under the chairmanship of the Minister of Environment and Forests.

## *The Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA)*

In exercise of the powers conferred by Section 15 of the Prevention of Cruelty to Animals Act, 1960 (59 of 1960), the central government, on the advice of the board, and being satisfied that it is necessary for the purpose of controlling and supervising experiments on animals, the CPCSEA was finally constituted. The central government nominated the Additional Secretary, In-charge of Animal Welfare, Ministry of Environment and Forests to be the chairperson of the committee.

## *Tiger and Other Endangered Species Crime Control Bureau*

Under Section 384 of Wildlife (Protection) Amendment Act, 2006, the Central Government constituted Tiger and Other Endangered Species Crime Control Bureau to be known as the *Wildlife Crime Control Bureau* consisting of the Director of Wildlife Preservation-Director ex office, the Inspector General of Police-Additional Director, the Deputy Inspector General of Police-Joint Director, the Deputy Inspector General of Forests-Joint Director, the Additional Commissioner (Customs and Central Excise)-Joint Director, and other officers.

## *Powers and Functions of the Wildlife Crime Control Bureau*

The Bureau takes measures with respect to:

1. Collection and collation of intelligence related to organized wildlife crime activities and to dissemination of the same to the state and other enforcement agencies for immediate action so as to apprehend the criminals and to establish a centralized wildlife crime data bank.
2. Coordination of actions by various officers, state government, and other authorities in connection with the enforcement of the provisions of this act, either directly or through regional and border units set up by the bureau.

3. Implementation of obligations under the various international conventions and protocols that are in force at present or which may be ratified or acceded to by India in the future.
4. Assistance to concerned authorities in foreign countries and concerned international organizations to facilitate coordination and universal action for wildlife crime control.
5. Developing infrastructure and capacity building for scientific and professional investigation into wildlife crimes and assisting state governments to ensure success in prosecutions related to wildlife crimes.
6. Advising the Government of India on issues relating to wildlife crimes having national and international ramifications and suggesting changes required in relevant policy and laws from time to time.

## State Level Boards and Committees

### *State Board for Wildlife*

Under Section 6 of the Wildlife (Protection) Amendment Act, 2006, the state government constituted a State Board for Wildlife under the chairmanship of the Chief Minister of the State, with the Minster in-charge of Forests and Wildlife as Vice Chairperson; three members of the state assembly; and experts and directors of various concerning NGOs, secretaries, and forest officials.

### *Duties of the State Board for Wildlife*

It shall be the duty of the state board for wildlife to advise the state government:

1. In the selection and management of areas to be declared as protected areas.
2. In the formulation of policy for protection and conservation of the wildlife and specified plants.
3. In any matter relating to the amendment of any Schedule.
4. In relation to the measures to be taken for harmonizing the needs of the tribal and other forest dwellers with the protection and conservation of wildlife.
5. In any other matter connected with the protection of wildlife, which may be referred to the board by the state government.

### *Advisory Committee*

Under Section 33 B of Wildlife (Protection) Amendment Act, 2006, the state government has constituted an Advisory Committee consisting of the Chief

Wildlife Warden or his nominee not below the rank of the Conservator of the Forests as its head and shall include a member of the state legislature within whose constituency the sanctuary is situated, three representatives of *Panchayati Raj* Institutions, two representatives of nongovernmental organizations and three individuals active in the field of wildlife conservation, one representative each from departments dealing with home and veterinary matters, honorary Wildlife Warden, if any, officer In charge of the sanctuary as a Member Secretary. The committee shall render advice on measures to be taken for better conservation and management of the sanctuary including participation of the people living within and around the sanctuary.

### *Conservation Reserve Management Committee*

Under Section 36 B of Wildlife (Protection) Amendment Act, 2006, the state government has the power to constitute a Conservation Reserve Management Committee to advise the Chief Wildlife Warden to conserve, manage, and maintain the conservation reserve. The committee shall consist of a representative of the forest or wildlife department, who shall be the Member Secretary of the committee, or representative of each Village *Panchayat* in whose jurisdiction the reserve is located; three representatives of the nongovernmental organizations working in the field of wildlife conservation; and one representative each from the Department of Agriculture and Animal Husbandry.

### *Community Reserve Management Committee*

Under Section 360 of Wildlife (Protection) Amendment Act, 2006, the state government has the power to constitute a Community Reserve Management Committee which shall be the authority responsible for conserving, maintaining, and managing the community reserves. The committee shall consist of five representatives nominated by the village *Panchayat* or where such *Panchayat* does not exist by the members of the *Gram Sabha* and one representative of the state forests or wildlife department under whose jurisdiction the community reserve is located. The committee shall be the competent authority to prepare and implement the management plan for the community reserve and to take steps to ensure the protection of wildlife and its habitat in the reserve. The committee shall elect a chairman who shall also be the honorary Wildlife Warden of the community reserve.

### *Steering Committee*

Under Section 38 U of the Wildlife Protection Act, the state government may constitute a Steering Committee for ensuring coordination, monitoring, protection, and

conservation of tiger, co-predators, and prey animals within the tiger range states. It shall consist of the Chief Minister as the Chairperson, Minister in charge of Wildlife as the Vice Chairperson, five official members including at least two Field Directors of tiger reserve or a Director of a national park and one from the state government's department dealing with tribal affairs, three experts or professionals having qualifications and experience in conservation of wildlife of which at least one shall be from the field of tribal development, two members from the State's Tribal Advisory Council, and one representative each from state government's departments dealing with *Panchayati Raj* and Social Justice and Empowerment, and the Chief Wildlife Warden of the state shall be the Member Secretary as officio.

### *Tiger Conservation Foundation*

Under Section 38 X of Wildlife Amendment Act, 2006, the state government has got the power to establish the Tiger Conservation Foundation for tiger reserves within the state in order to facilitate and support their management for conservation of tiger and biodiversity and to take initiatives in eco-development by involvement of people in the development process.
The Tiger Conservation Foundation shall, inter alia, have the following objectives:

(a) To facilitate ecological, economic, social, and cultural development in tiger reserves.
(b) To promote ecotourism with the involvement of local stakeholder communities and provide support to safeguard the natural environment in the tiger reserves.
(c) To facilitate the creation of and/or maintenance of such assets as may be necessary for fulfilling the above-said objectives.
(d) To solicit technical, financial, social, legal, and other support required for the activities of the foundation for achieving the above-said objectives.
(e) To augment and mobilize financial resources, including recycling of entry and such other fees received in tiger reserve, to foster stakeholder development and ecotourism.
(f) To support research, environmental education, awareness, and training in the above-related fields.

Apart from the above, the Forest Development Authority (FDA) and Rajasthan Forest and Biodiversity Project Empowered Committee (RFBP) also exist.

## Smirch on the Façade of the Nation: The Illegal Wildlife Trade

Wildlife trade and poaching have decimated a large number of gallant animal species in India, and the ones remaining are surviving amid extreme pressure and an array of threats. India without the pachyderms, the ravishing fauna would be a deadening painting; we have already lost cheetah, with 1,411 tigers remaining and rampant

killing of leopards; it is high time that they must be guarded and kindled with the best efforts and strategies. Apparently, India has a strong legal and policy framework to regulate and restrict wildlife trade. Trade in over 1,800 species of free-ranging animals, plants, and their derivative is prohibited under the Wildlife (Protection) Amendment Act, 2006 with the objective of effectively protecting the wildlife and to control poaching and smuggling of free-ranging animals and their derivatives. The Act comprises of two acts, one bill, 11 notifications, and one guideline. The Ministry of Environment and Forests (MOEF), Government of India, has also constituted "National Tiger Conservation Authority," "National Wildlife Board," and "Tiger and Other Endangered Species Crime Control Bureau" under various sections of the above act. It is unfortunate that the legal policies for conserving the forests and wildlife have not been very successful despite the fact that safeguarding the forests has been included in the list of fundamental duties of the citizens of India [Article 51(g) of the Indian Constitution]. India is perhaps the only country in the world which has provided for protection of animals under its constitution. Though the above act was amended in 1986, 1991, 2000, 2003, and 2008, the carefree attitude of administration and lack of implementation of laws are still a major concern.

According to the Red Data Book (2013) of the International Union for Conservation of Natural Resources (IUCN), India harbors 2,530 vertebrate species. Protected areas (PAs) in India comprise of 80 national parks including 28 tiger reserves governed by the "Project Tiger" and 441 wildlife sanctuaries (IUCN IV category of PAs). "Project Tiger" was launched by the then Prime Minister of India Mrs. Indira Gandhi in 1973, the main objective of which is to ensure a viable population of tiger in India.

India is a member of the Convention on International Trade in Endangered Species of Fauna and Flora (CITES) since 1976. Trade Record Analysis of Flora and Fauna (TRAFFIC) which started in 1991 is a wildlife trade monitoring network and a joint venture of the World Wide Fund for Nature-India (WWF) since 1987 and the International Union for Conservation of Nature (IUCN) established in 1976 which works closely with the national and the state governments to monitor and influence action to curb illegal wildlife trade. On the other hand, Wildlife Institute of India (WII) established in 1982 as an autonomous institute of MOEF is internationally acclaimed and offers training programs, academic courses, and advisory in wildlife research and management. Wildlife Protection Society of India (WPSI) founded in 1994 by Belinda Wright is one of the most coveted wildlife conservation organizations in India which have assisted in the arrest of over 375 criminals and seizures of massive illegal wildlife products during the past decade. The legal program of WPSI currently supports the prosecution of over 151 wildlife court cases in 13 Indian states. According to WPSI, 893 tigers and 3,354 leopards were poached during 1994–2009, whereas the mortality and poaching figures for 2010 are 41 tiger and 248 leopard.

Wildlife trade is amplifying and continues to be a challenge for the "antipoaching teams" of our forest departments owing to poor law enforcement and the seemingly uncontrollable nexus between wildlife officials, smugglers, and aborigines. Hence, it has become pertinent for the government to make more stringent policies

in this regard. Killing of animals for hair (mongoose); skin (snake and monitor lizard); horn for oriental aphrodisiac (rhino); claws, bones, skins, and whiskers (tiger and leopard); tusks for ivory (elephant); antlers (deer); skin and fur (shahtoosh); traditional medicine (pangolin, civets); shells (turtle); musk pods and cosmetics (musk deer); and skin and gall bladder (bear) is common, while caged birds, such as parakeet, myna, ducks, storks, waders, partridges, quails, munia, and peacock feathers are always in great demand for the trade of companion animals and ornamental purposes.

According to estimates, 150 K birds of 300 indigenous species are captured and traded in India every year. A large part of wildlife trade is meant for the international market and has no or little direct demand within the country. Peregrine and Saker Falcon from Rajasthan have been smuggled to western Asia for wealthy Sheikhs, who used them for hunting bustard— a Critically Endangered grassland bird of the state. Birds used in black magic include the horned owls, hornbills, egrets, and hoopoes. Following the ban on exports, traders have now resorted to the "bird release business" since several sects and communities, including the Jains and Hindus, buy birds and snakes and get them released to their natural habitat as an act of doing good and getting rid of sins.

The *Pardhis* and *Bawariyas,* the nomadic hunting tribes working for the traders, travel across the country to poach animals for huge sums of money. They are responsible for killing over a thousand tigers and other endangered species like leopards, birds, bear, ungulates, and so on. The hunting brigade including women and children is well acclimatized with the impending dangers and difficulties in trapping large mammals. Orders for as much as 60 tigers a year are received by the hunters. According to forest officials and experts, a team of a dozen men is involved in monitoring the movement of tiger and patrolling routine of forest guards before striking. According to investigators and insiders of the trade, the strong jaws of the iron trap are laid by the hunters close with a great force strongly capturing and sometimes even cracking the powerful leg of a tiger. The hunters immediately arrive on the scene from the hiding and push a thick bamboo pole with a pointed spear into the tiger's mouth, stuffing earth into it to make sure death is quick and quiet. Half a dozen men are then required to release the dead tiger from this "death trap."

India has two-thirds of world's tiger population and three out of the eight species (Caspian, Bali, and Javan) already extinct, about 250 are killed every year. Forests and PAs of Rajasthan, Madhya Pradesh, Uttar Pradesh, Orissa, West Bengal, Assam, and Arunachal Pradesh states of India are most susceptible to poachers as they still harbor a large population of tigers and other free-ranging animals. Killing of tigers at an alarming rate is a burning issue in India with only 1,411 tigers left, while more than 1,000 poached during the preceding decade. We need committed individuals to help enforce anti-trafficking laws to conserve threatened habitats and rescue the captured free-ranging animals since corruption in this domain is rampant due to high inflow of quick money. Wildlife wardens often risk their lives to enforce laws only to end up in frustration and face overnight transfers. The sophisticated weapons possessed by the poachers pose a serious threat for our forest department where a guard is expected to protect 15 $km^2$ and armed with just a *danda* (wooden stick).

Modern amenities to counter poaching are a dire need in India. It is an agonizing fact that the security forces and courts arrest and accuse the "small fishes" in a well-knit network while the real culprits abscond far beyond reach, but recently the trend witnessed a different scene with the government getting strict on "big fishes."

## Implementation of Wildlife Laws and Ethics: Wildlife Crimes in Rajasthan

Under the Wildlife (Protection) Amendment Act, 2006, trading in tiger, leopard, and other animal skins and parts is a serious offense. Apart from that, India is a signatory to both the UN Convention on International Trade in Endangered Species (CITES) and the UN Convention against Transnational Organized Crime (CTOC). However, despite these national and international laws, many species of wildlife, for example, tigers, leopards, and bison, are under threat of extinction, mainly due to the poaching organized by international criminal traders and destruction of the habitats.

Some of the infamous wildlife crimes and notorious smugglers from India which have attracted both national and international attention include Sansar Chand and Shabeer Hasan Qureshi, both international wildlife smugglers responsible for the poaching of hundreds of tigers, trading of Critically Endangered animals like Peregrine (resident species) and Shaheen Falcon (migratory species). In addition, recovery of 250 kg of elephant tusk (ivory) in Jaipur, Rajasthan; film star Salman Khan's case of Blackbuck and Chinkara killings in Jodhpur district of Rajasthan; and Kaliya Bawaria case—a tribe who killed a large number of leopards in Rajasthan alone are still other infamous wildlife crimes for which Rajasthan has remained in the center stage during the past one decade.

After the 2006 amendment, some important court cases in Rajasthan under Wildlife (Protection) Amendment Act, 2006 for poaching are as follows:

### *Sansar Chand Case*

250 tigers (Fig. 19.1), 2,000 leopards, 5,000 otters, 20,000 wild cats, 20,000 wild foxes, and the list continue of the number of innocent animals fallen prey to the gruesome trade operated by Sansar Chand (Fig. 19.2). Sansar Chand, 55, himself admits boldly about his crimes; they are "uncountable" and evince no remorse about this havoc. The obstinate poacher and his associates, including five family members, have been convicted guilty in about 57 cases involving the trade of animal parts. It is unfortunate that the man, who candidly accepts that he has no regrets and proudly relates his macabre activities with hereditary profession, has been acquitted in 10 cases and convicted only in one while seven cases are still pending. Presently, the slayer is behind bars in the Jaipur Central Jail and looking forward to freedom after serving a five years term. The sustained cruelty to animals brought rich

**Fig. 19.1** Bengal Tiger: killed for trading skin and other body parts (*Courtesy: Dr. Anil Kumar Chhangani*)


**Fig. 19.2** Sansar Chand, 55—the incorrigible poacher turned smuggler from Rajasthan, responsible for a record killing of wildlife, claimed after being sentenced that hunting and trade in animal parts are a hereditary profession (*Courtesy: Tejveer Singh*)

dividends to him and his family. Over the years, Sansar Chand amassed 45 properties, some of them covering an entire lane in Delhi's Sadar Bazar. A conservative estimate puts their cost at Rs 40 crore, but the present market value would be much more. He claims he has no bank account, but the rent from the shops and flats alone keeps him comfortable.

A long history of criminal activities is associated with Sansar Chand starting with a 1974 arrest for 680 skins including tigers, leopards, and other wild animals when he was just 16. But later he was released under probation, considering him a juvenile delinquent. In the consequent years, he and his gang established a complex, smuggling network in order to meet the rampant demand for tiger and leopard parts and skins outside India's borders, particularly to China. It is alleged that Sansar Chand and his gang are accused in 57 wildlife cases between 1974 and 2005 in the courts of Uttar Pradesh, Rajasthan, and Delhi. His family members, including his brother Narayan Chand, are involved in the seizure of two tiger skins, 38 leopard skins, and one snow leopard skin in New Delhi. His son and wife were also caught trading tiger paws and claws in Jaipur.

The Supreme Court of India on Monday, October 4, 2010, lambasted the poacher Sansar Chand for "destroying the wildlife in India." The court said, "*You want only money....Today, people sell animal skin; tomorrow they would start selling human skin also*."

## *Film Star Salman Khan Case*

India's famed film star Salman Khan was found guilty by the sessions court of Jodhpur for killing two Blackbucks and a Chinkara at a village near Jodhpur in the year 1998. There were other prominent film personalities, including Saif Ali Khan, Sonali Bandre, Tabu, and Neelam, among the eight accused of poaching two Chinkaras at a village near Jodhpur in 1998 during the shooting of Sooraj Barjatya's film *Hum saath saath hain*. The verdict came in despite the fact that the only eye-witness, the driver, had been absconding for over two years. The arrest of the star was actuated by intense protests from the *Bishnoi* people who worship and protect animals and trees and consider them as sacred. On April 10, 2006, Salman (Fig. 19.3) was ordered a five years jail term for hunting the Chinkara and was sent to the Central Jail of Jodhpur by a local court in connection with Blackbuck poaching case. The, then Chief Judicial Magistrate Brijendra Kumar Jain also imposed a 25,000 rupees fine on him. The court ordered one year's rigorous imprisonment for co-accused Govardhan Singh and imposed a fine of rupees 5,000. He was sent on remand to Jodhpur Jail and remained there until April 13 when he was granted bail. On August 24, 2007, the Jodhpur Session Court upheld the five years jail term for Salman Khan in the Chinkara poaching case by turning down his appeal against the 2006 judgment. The court accepted Salman Khan's plea for bail after a two hours long hearing by the Justice HR Panwar of the Jodhpur bench of Rajasthan High Court on August 31, 2007. Khan was released on bail from the Jodhpur Central Jail where he spent six days. Salman stated that there was no evidence against him in the case. His driver Harish Dulani's testimony in the court was not trustworthy since he had been frequently changing his statements. The defense lawyers were not given a chance to cross-examine Dulani.

**Fig. 19.3** Salman Khan, the famous Bollywood film star accused, tried, and jailed for hunting Blackbuck near Jodhpur (Rajasthan) (*Courtesy: Anonymous*)

On a similar trail, the former Indian cricket captain (late) Mansur Ali Khan Pataudi, convicted on charges of killing a Blackbuck, pleaded in the Punjab and Haryana High Court, saying "I'm old and innocent," while seeking anticipatory bail. He had killed a Blackbuck and then absconded as a fugitive. In his application, Pataudi had denied killing the Blackbuck, citing its autopsy report that said the antelope died of knife wounds while the Police alleged that the animal was shot during a hunt. A case registered at Jhajjar in Haryana district under the Wildlife (Protection) Amendment Act, 2006 names Pataudi and seven others. They have also been accused of killing two rabbits during the shikar in June, 2005.

Some other court cases including the Kalya Bawaria Case (Fig. 19.4) filed under Wildlife (Protection) Amendment Act, 2006 for the poaching of endangered animals in Rajasthan are given in Table 19.1.

The current status of the implementation of Wildlife Act and laws in the state is no good as is evident by the recent death of a relocated tiger by poisoning in Sariska Tiger Reserve under mysterious circumstances, even after all the precautions and safeguarding of the forest officials. On March 22, 2009, eight poachers were arrested for poaching of panther skin, nails, claws, and paws.

The awareness started in the country as well as in the state when for the first time 250-kg elephant tusks (ivory) were recovered by the Rajasthan Police in Jaipur. The cases are still under trial.

**Fig. 19.4** Kalya Bawaria—one of the key wildlife criminals belonging to a hunting tribe of Rajasthan (*Courtesy: Tejveer Singh*)

Blackbuck (*Antilope cervicapra*) (Fig. 19.5a, b) often called Indian Antelope is a species of antelope that is native to the Indian Subcontinent. The Blackbuck is the provincial animal of India also known as *Krishna Mriga* in Kannada. It is popularly known as *Krishna Jinka* in Telugu and has been declared as the state animal of Andhra Pradesh. Other local names for the species include *Krishnasar in Bengali and Kala Hiran, Sasin, Iralai Maan, and Kalveet* in Marathi. The skin of *Krishna Mriga* plays an important role in Hinduism, and *Brahmin* boys are traditionally required to wear a strip of unleathered hide after performing *Upnayanam*.

Its number decreased rapidly during the twentieth century. In 2003, the IUCN listed the species as Near Threatened. This species is the only member of the genus Antelope and was introduced in Texas and Argentina. Interestingly, it is one of the fastest of all terrestrial animals possessing the speeds of up to 80 km/h and one of the few antelopes where males and females have distinctive coloration, as the male bucks are distinctive black and white and have long twisted horns, while females are fawn colored with no horns.

## *Clarke R. Bavin Award, 2007 to Rajasthan Police Department by the Animal Welfare Institute (AWI), Washington D.C.*

On the evening of February 3, 2006, a team of police officers of the Special Operation Group from the Rajasthan Police Department seized 34 freshly tanned tiger and leopard skins (Fig. 19.6) and four otter skins in Delhi after a well-planned operation spread over a number of states involving two arrests. One of the criminals was an

**Table 19.1** Important orders issued by various courts in Rajasthan under Wildlife Protection Act, 1972 for the poaching of tigers and panthers

| | |
|---|---|
| 1 | Kalya Bawaria Case 1<br>A poacher, Kalya Bawaria, from village Kolva, Distt. Dausa, Rajasthan, has been convicted for the poaching of panther on May 11, 2007 at Alwar district. Under Section 9 read with 51 of Wildlife (Protection) Act, 1972 and 49B read with 51 for imprisonment of 4 years and a fine of rupees 10,000 in each section and imprisonment of 3 years. Under Section 27 and Section 51 of Wildlife (Protection) Act, 1972; u/s 27 read with 51 of Wildlife (Protection) Act, 1972; u/s 31 read with 51 of Wildlife (Protection) Act, 1972; and u/s 39 read with 51 of Wildlife (Protection) Act, 1972. In the case of nonpayment of fine, the accused will undergo an imprisonment for 2 months in each section |
| 2 | Kalya Bawaria Case 2<br>A poacher, Kalya Bawaria, has been convicted for the poaching of panther by ACJM Rajgarh tehsil on April 9, 2010. The Honorable ACJM Rajgarh has convicted the accused Kalya Bawaria u/s 9, 27, 29, and 39 read with 51 and u/s 49B read with 51 of Wildlife (Protection) Act, 1972 for rigorous imprisonment of 5 years each and 7 years for the latter and a fine of rupees 20,000 for each. In the case of nonpayment of fine, the accused will undergo rigorous imprisonment of 1 year for each |
| 3 | Kalya Bawaria Case 3<br>Accused Kalya has been convicted for the poaching of panther By Honorable court CJ (JD) JM, Rajgarh on January 8, 2008. Honorable CJ (JD) JM, Rajgarh has convicted the accused u/s 9, 27, 29, 39, 48A, 49A, and 49B read with 51 of Wildlife (Protection) Act, 1972 for imprisonment of 3–3 years and a fine of rupees 10–10,000. In the case of nonpayment of fine, the accused will undergo an imprisonment for 3–3 months in each section |
| 4 | Kalya Bawaria Case 4<br>Accused Kalya, Distt. Dausa, has been convicted for the poaching of panther by Honorable court ACJM No. 2 Alwar on January 17, 2010 |
| 5 | Kalya Bawaria Case: Juhru, Ramjan, Tayaib, and Kalya<br>Accused Kalya, Distt. Dausa, along with Juhru, Ramjan, and Tayaib has been convicted for the poaching of panther by Honorable court ACJM No. 2 Alwar on March 23, 2009, which has convicted the accused u/s 9 read with 51 for imprisonment of 5 years and a fine of rupees 5,000; u/s 27 read with 51, for imprisonment of 1 year and a fine of rupees 500; u/s 39 read with 51, for impressments of 3 years and a fine of rupees 1,000; u/s 44 read with 51 for imprisonment of 3 years and a fine of rupees 1,000; u/s 48A read with 51 for imprisonment of 3 years and a fine of rupees 1,000; and u/s 49B read with 51, for imprisonment of 3 years and a fine of rupees 2,000. In the case of nonpayment of fine, the accused will undergo an imprisonment for 3 months, 7 days, 1 month, 1 month, 1 month, and 2 months in each section, respectively. Decision of trial court has been upheld by first appellate court. Revision of which is pending in the high court of Rajasthan |
| 6 | Hiralal Case<br>Accused Hiralal, Distt. Alwar, has been convicted for the poaching of panther by Honorable court CJ (JD) JM, Rajgarh on November 28, 2007, which has convicted the accused u/s 39 read with 51 of Wildlife (Protection) Act, 1972 for impressments of 3 years and a fine of rupees 10,000. In the case of nonpayment of fine, the accused will undergo an imprisonment for 4 months in section |
| 7 | Juhru, Ramjan, and Tayaib Case<br>Accused Juhru, Ramjan, and Tayaib S/o Subba Meo R/o Kherada, PS Malakhera, Dist. Alwar, have been convicted for the poaching of panther by Honorable court ACJM No. 2 Alwar on January 13, 2009, which has convicted the accused u/s 9 read with 51, u/s 31 read with 51, u/s 39 read with 51, u/s 44 read with 51, u/s 48A read with 51, and u/s 49B read with 51 of Wildlife (Protection) Act, 1972. Accused Kalya Bawaria acquitted by ACJM No. 2 Alwar revision has been filed in Honorable Additional District and Session Judge (fast track) No. 1 Alwar, revision of which has been filed by accused in Rajasthan high court. Subsequently the accused filed S.B. criminal miscellaneous second bail (suspension of sentence). The said criminal miscellaneous second bail (suspension of sentence) was dismissed by Honorable high court of Rajasthan on February 15, 2010<br>Petitioners Juhru, Ramjan, and Taiyab filed a petition for special leave to appeal and filed a false affidavit. Apex court released the petitioners on bail to the satisfaction of the Trial Court, awaiting the outcome of the revision petition on September 6, 2010. Actually the petitioners had undergone the imprisonment of one year and 10 months in the said case. When the OIC submitted the documents regarding false affidavit, the Hob'ble apex court recalled the application for bail and quashed the order of bail passed by the Honorable lower court on September 6, 2010 and directed the police to take the petitioners into custody |

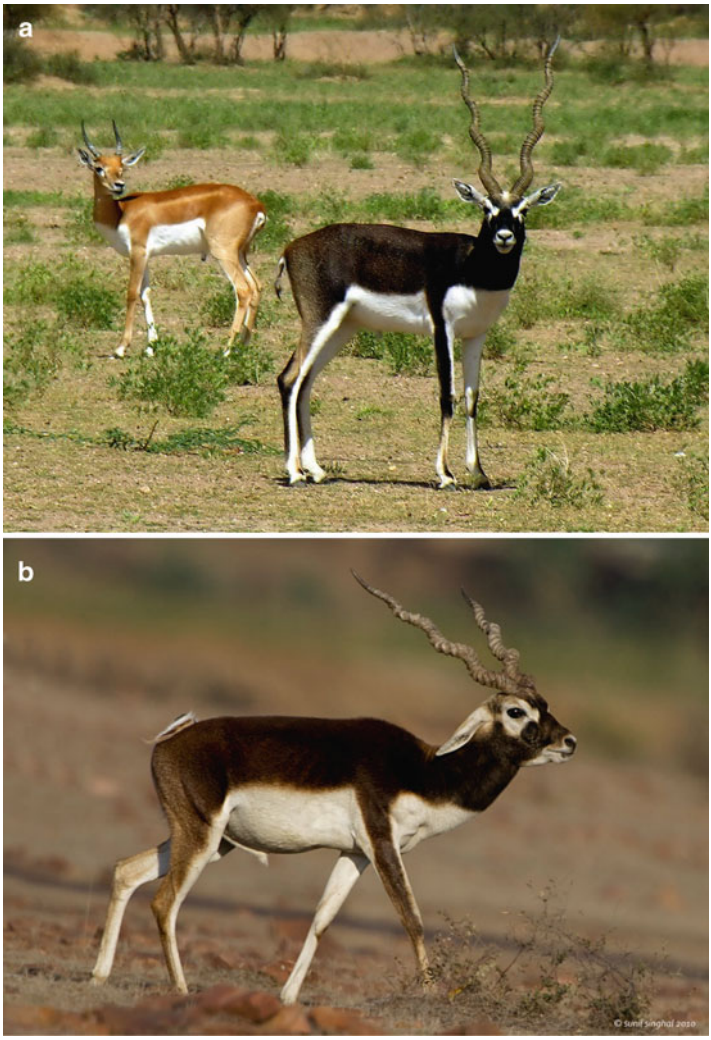


**Fig. 19.5** (**a**) Blackbuck *Antilope cervicapra* a male and a female, one of the most wanted animals by poachers (*Courtesy: Dr. Anil Kumar Chhangani*). (**b**) An Alpha male Blackbuck (*Courtesy: Sunil Singhal, Kota*)

important member of an organized ring of poachers responsible for the repeated smuggling of tiger, leopard, and otter skins to Tibet. Both before and after this significant seizure of wildlife products, the Rajasthan Police Department has demonstrated its commitment of enforcing wildlife protection laws in India. According to a partial compilation of investigations conducted since January 2003, the Rajasthan Police have seized animal skins, claws, paws, bones, and ivory and have arrested nearly three dozen criminals, including India's most notorious wildlife criminals. It has succeeded in breaking up the entire wildlife criminal networks

**Fig. 19.6** Dried tiger skins seized by Rajasthan Police at New Delhi (*Courtesy: Tejveer Singh*)

from the poachers, suppliers, middlemen, and those receiving the wildlife products within India. For its effort to combat wildlife crimes in India, the Rajasthan Police Department was awarded the prestigious Clark R. Bavin Wildlife Law Enforcement Award, 2007.

The animal-loving people, the conservationists, the organizations involved in stopping cruelty against animals, and the public in general have witnessed over decades that animal welfare concerns in India exist in various forms and in fact are looming large in every nook and corner of the society as well as at the governmental level. The callous, carefree, and thoroughly insensitive attitude of policy makers, administrators, and even politicians coupled with the greed of handful of "well-connected" businessmen killing and selling animals for food, leather, and other products have badly affected the pace of welfare efforts. To this end, "Animal Liberation" and the concept of "the Rights of Animals" seem pertinent in the present milieu. Although the recently setup National Institute of Animal Welfare (NIAW) running under the Ministry of Environment and Forests, Government of India, and other such premier organizations involved with wildlife conservation have taken some serious initiatives toward stopping the trade of animals, a lot more is still required to be meticulously planned and implemented in its strictest sense as far as the wildlife protection and other such acts and laws are concerned. We badly need concrete strategies, with committed individuals and officials, if at all ethical principles which extend equal rights and considerations to animals are to be met.

The current status of the implementation of wildlife acts and laws in the state is no good as is evident by the recent death of a relocated tiger in Sariska Tiger Reserve under mysterious circumstances, even after all the precautions and safeguarding of

the forest officials. This episode has again shocked the entire country. It seems that wildlife criminals are hundred times ahead than the relocation efforts. Hunting traditions are deep-rooted in the minds of hunter tribes which have now got associated with greed for a better life full of luxury. The present Wildlife Act was introduced in 1972 by the late Smt. Indira Gandhi as per international treaty. Prior to this act, hunting was a permitted game, and by paying a nominal amount of money as a fee, anybody could kill the wild animals, but when the important species started declining, amendments to the act were made, and a blanket umbrella ban was imposed on hunting and killing of all scheduled wild animals. 1980–1995 was a crucial period for wildlife particularly for carnivores and Schedule I animals like Bengal Tiger, Panther, Sloth Bear, Hyaena, Golden Jackal, Gray Wolf, Bengal and Red Fox etc., due to heavy demand from western countries for their fur, skin, bones, and meat. Trapping of the beautiful birds like Rose-ringed Parakeet, Red and Green Avadavat, Falcon spp. and varieties of pigeons and keeping of Indian Star Tortoise, cats, dogs, rabbits, and other animals as pets are also liked by the society. Use of the body parts of animals like tigers, elephant tusk, musk, and horns for making artifacts and furs for the paintbrushes is quite common. A burning example of this period is Sariska National Park where the maximum number of tigers and panthers were killed by poachers, especially by international wildlife smuggler Sansar Chand and his family. The Sariska debacle of 2005 shocked the entire country. The greed for the money fetched by selling the skins and the body parts of the tiger had led to such crime. In Jaisalmer district and on its border, trade of Critically Endangered animals and Peregrine (resident species) and Shaheen Falcon (migratory) has been unearthed. These birds are smuggled to Arab Sheikhs, taking the advantage of system's loopholes. The awareness started in the country as well as in the state when for the first time 250-kg elephant tusks (ivory) were recovered by Rajasthan Police in Jaipur. At the same time famous film stars Salman Khan and others were arrested by the police in Jodhpur for killing Blackbuck and Chinkara. The poaching of animals including peacock is still going on in the state. Kalya Bavaria killed a large number of leopards and was punished by the High Court. Lack of awareness, slow process of law, untrained staff, lack of moral, and other similar reasons support the accused in the court, and a maximum number of accused are discharged. After Sariska episode, the then Prime Minister of India had set up "Tiger Task Force" and "Wildlife Crime Control Bureau (WCCB)" which were armed with investigative powers to poaching cases. The parliament also passed the Wildlife (Protection) Amendment Bill, 2006, paving the way to set up the "National Tiger Conservation Authority" and "National Wildlife Crime Bureau." Please see Chaps. 1, 2, 3 and 4 from *Faunal Heritage of Rajasthan: Ecology and General Background of Vertebrates*, Vol. 1; B. K. Sharma et al. (eds.), 2013, springer Pub. and Chaps. 1, 8, 18 and 20 from this volume for more relevant details and pictures.

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# Part IV
# Management of Faunal Conservation in Rajasthan: A Synthesis

# Chapter 20
# Unfurling Conservation Strategies, Major Initiatives, and Gaps in Research: A Vision on the Future of the Fauna of Rajasthan under Current and Predicted Threats

**B.K. Sharma, Seema Kulshreshtha, and Asad R. Rahmani**

**Abstract** This concluding chapter pertains to the conservation efforts being undertaken in Rajasthan at various levels while stressing upon the dire need for filling research gaps in the light of the fast-changing climatic conditions in Rajasthan and their ill effects on the biodiversity. Rajasthan is currently under the strong clutches of desertification due to the world climate crisis, although it has been felt that the Thar Desert was more arid half a century ago but due to IGNP and plantation, its climate has moderated to an extent. An already existing xeric ecosystem, fast pace of urbanization, excessive and unchecked mining, oil and natural gas excavations, and nuclear tests have further altered the situation. In fact, the Indira Gandhi Irrigation Canal Project, popularly known as IGNP, has completely changed the landscape in some regions of the Thar Desert, causing grave changes particularly in the land use patterns. Fauna from the rest of Rajasthan is dwindling in population due to habitat loss, hunting, and habitat fragmentation, resulting in the decline in number of some rare species. It is high time to conduct intensive surveys in order to

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monitor the altered land-use patterns and assess the status of threatened species in various geographical regions of the state and adopt a concrete conservation planning. Likewise, the reintroduction of tiger at Sariska Tiger Reserve in the Aravallis, establishment of Siberian Crane breeding center at Keoladeo National Park (KNP), protection of grasslands and the state bird Great Indian Bustard, revival of Sambhar Salt Lake, conservation planning for the protection of avian diversity, Gharial and Mugger and Ganges River Dolphin at Chambal Riverine system, improvement in the conditions of zoos, wildlife trade, and rapidly declining population of common birds like the house sparrow and crow in urban areas are the issues, based on which new researches and strategies should be planned with multiple approaches. Introduction of innovative forest management technologies, biotechnology, winning economic fronts by making ecotourism more attractive, and rehabilitation of hunting tribes are some other areas which require planning and political will. This chapter also aims at creating awareness about biodiversity conservation in addition to presenting a future picture of the existing fauna of Rajasthan under current and predicted threats. It would also encourage researchers in their transition from "lab to field" and, thus, in adopting the right approach toward conservation of our faunal heritage

## Introduction

Until the current decade, the economic status of the country was looked at as a measure of being "developed" by exploiting its natural resources, but this attitude did not add to the quality of life as the environment deteriorated rapidly as a result. The concept of wise use of resources and "sustainable development" was put forward, particularly after Earth Conference in Rio in 1992. In the International Year of Biodiversity, 2010, the International Union for Conservation of Natural Resources (IUCN) [1] clearly spelled out its theme *Biodiversity is the backbone of all life on Earth*; likewise, the United Nations declared 2011 as the *International Year of Forests* to raise awareness and strengthen sustainable management, development, and conservation of all types of forests for the benefit of current and future generations. Realizing the importance of increasing sustainable access to energy, energy efficiency, and renewable energy, the current year (2012) is marked as the *International Year of Sustainable Energy* for all since energy services have a profound effect on productivity, health, education, climate change, food and water security, and communication services. Today, when 1.4 billion people still do not have access to modern energy and three billion rely on "traditional biomass" and coal as their main fuel sources, efforts of the United Nations in increasing mass awareness about these issues are of paramount importance. To this end, India feels proud to host the XI Conference of Parties (CoP) on Convention on Biological Diversity (CBD) at Hyderabad from 1 to 19 October, 2012. The conference logo aptly describes and symbolizes the cycle of life with a tiger, a dolphin, a bird, and a woman with grains depicting linkage of biodiversity with livelihoods while on top is a slogan in Sanskrit with English translation *Nature Protects if She is Protected*.

All this reflects that the time has come when the crisis is felt with sensitivity and sincerity for sustaining human civilization and other life forms on planet earth.

In the ancient Indian tradition, people have always valued the Mother Nature together with the flora and fauna by associating them with religion and worshiping them as deities, but, in due course of time, modernization and development changed this thinking. Many decades ago, Mahatma Gandhi envisioned and formed village community based on sound environmental management by recycling the animal and human manure and having well-ventilated cottages made of recycled material and dust-free roads. He had designed sustainable lifestyle for himself when such concepts were not even part of general thinking [2]. Today, there is a great need to perpetuate his ideology which says "Nature could support people's need but not their greed." In addition, Hindu, Buddhist, and Jain philosophies are intrinsically woven around nonviolence, respect, and reverence to all life forms.

Rajasthan cradles a great diversity in topography and biological species which is one of the most significant in the world. The varied ecosystems of its desert, hills, forests, and wetlands have supported its proud people for centuries, and, in return, the natives have also sacrificed their lives for conserving biodiversity. Unfortunately, during the past couple of decades, this functional relationship between man and nature has lost connectivity.

## Conservation Issues in Rajasthan

Drastic changes in the environment and wildlife habitats due to population growth, mismanaged developmental activities, and various other anthropogenic pressures are proving so detrimental that many faunal and floral species are being threatened. Between 1,600 and 1,950, the rate of loss of species was one in every 10 years, but perhaps it is one every year in the present decade [3]. The rate of deforestation of tropical forests is so rampant that if it continues, scientists estimate that roughly 5–10% of the species may face extinction within the next 30 years [3]. The ecosystem diversity of the desert and Aravalli in Rajasthan, southern moist deciduous forests, and Indo-Gangetic Plains is facing tremendous pressure. In fact, every geographic region of the state has its own specific conservation issues in addition to the common ones as described below.

### *Climate Change*

Low and erratic rainfall, extreme temperature, high wind, and low humidity conditions make it inhospitable to majority of fauna, particularly in the Thar Desert. Studies of the arid region show that there was no significant change in the annual rainfall in the arid districts during 1901–2006 [4], but since past three- four years,

there are frequent rainfalls in the extremely arid districts of western Rajasthan [4]. Studies on climate change along the tracts of Indira Gandhi Canal command region have clearly shown that though Ganganagar region has canal irrigation since past six decades, the increase in annual rainfall was apparent only during the last three decades [5]. Likewise, semiarid areas are facing lesser rainfall but extreme low temperature in winter which is a surprising phenomenon [4]. The Global Circulation Models (GSM) predicts more hot days as well as warmer nights for the arid Rajasthan [4]. It is now realized all over the world that the fast-changing climate and other environmental factors can lead to spatial movement of fauna or habitat loss or adaptation of the new environment [4]. Furthermore, Rajasthan as a favorite hub for industrialization and urbanization is currently undergoing drastic environmental changes at various levels.

## *Mining*

The state has 21.7% share of India's total mines. The fauna of Rajasthan especially belonging to the Aravallis is greatly affected by mining activities. The mined and spoiled soil should be properly reclaimed in order to regenerate vegetation (Fig. 20.1a–g).

## *Oil and Natural Gas Drilling*

Following the discovery in 2004 of natural gases and petroleum oil in Rajasthan at Mangla in Sanchore-Barmer, developmental activities have increased exponentially. A total of 480 million tons of oil reserve (3.5 billion barrel) in 22 fields have been found. Five fields are involved in the commercial production since 2009, affecting the surrounding environment with burning oil and large amount of smoke containing particulates and toxic gases beyond the level of tolerance for both humans and animals [6]. Oil spill releases liquid petroleum or hydrocarbon into the environment which is found to be especially hazardous to the birds and mammals. Studies show that these two faunal groups are capable of handling the risk of fire and smoke, but oil spill can prove dangerous as once coated with the spilled oil, they can be hardly revived [7, 8].

## *Population Explosion, Urbanization, and Industrialization*

Human population in the state has grown up by 232% since 1901 including an increase by 28% in rural and 59% in urban population. Besides urbanization,


**Fig. 20.1** (**a**) Stone mining around Jaipur. *Courtesy: Devendra Bhardwaj.* (**b**) Stone mining at Aravalli Hills in Udaipur. *Courtesy: Devendra Bhardwaj.* (**c**) Aftermath of mining around Jaipur. *Courtesy: Devendra Bhardwaj.* (**d**) Aftermath of mining near Sikar district. *Courtesy: Devendra Bhardwaj.* (**e**) Lime-stone mining near Udaipur. *Courtesy: Sonali Singh.* (**f**) Mining for stone near Jodhpur. *Courtesy: Dr Anil Kmar Chhaganii.* (**g**) Excellent stone quality near Udaipur has increased the greed and lobbying of mine owners. *Courtesy: Sonali Singh*


**Fig. 20.1** (continued)


**Fig. 20.1** (continued)


**Fig. 20.1** (continued)

**Fig. 20.2** Rapid urbanization has caused extension of cities and destroyed the forest cover. *Courtesy: Devendra Bhardwaj*

industrialization has engulfed the districts of Jaipur and Jodhpur, while Kota, Pali, Udaipur, and Ajmer districts are fast emerging as the new industrial centers of the state (Fig. 20.2). Increased population, urbanization, and industrialization continue to be the leading causes of rapid degradation of the natural resources. Both population

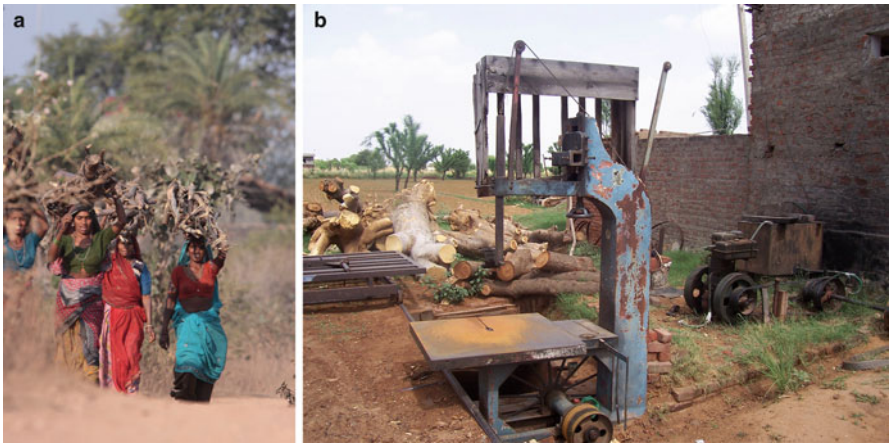


**Fig. 20.3** (**a**) Large scale tree cutting for economic gains has caused massive deforestation. (**b**) Tree cutting for fuel wood by villagers and locales has deteriorated faunal habitats. *Courtesy: Devendra Bhardwaj*

explosion and modernization are directly linked with pollution, excessive resource utilization, encroachment, and unplanned extension of villages and cities.

## *Habitat Depletion*

Heavy deforestation, overgrazing, and altered land use patterns have led to the destruction and fragmentation of habitat of many animals. Unregulated specimen collection by scientific and educational bodies, exploitation of forests by local authorities for revenue purposes, firewood and food collection by local communities, and unchecked use of medicinal plants have further complicated the problem of habitat destruction.

## *Excessive Resource Utilization, Illegal Hunting, and Poaching*

Hunting traditions in many communities especially tribes of Rajasthan have finally turned into trafficking of animals and their body parts and a variety of forest produce including timber (Fig. 20.3a, b). For example, the Wildlife Flying Squad of Jaipur had registered 383 cases for wildlife offenses during 1974–1998 [9]. About 24 mammalian species, 13 bird species and eight reptilian species were found to be the major targets. Among the tribes, *Bawarias* top the list for trading animals [9]. Studies have revealed that such offenders belong to more than four dozen casts, subcasts, communities, and tribes [9]. For further details please see Chaps. 1 and 4 from *Faunal Heritage of Rajasthan: Ecology and General Background of Vertebrates*, Vol. 1; B. K. Sharma et al. (eds.), 2013 and Chap. 19 from this volume.

### *Natural Calamities*

Famine in the desert areas of Rajasthan on account of extreme temperature and low rainfall is repeated every five to seven years. On the other hand, floods caused due to abnormally heavy rainfall in Jaisalmer, Barmer, and Bikaner districts during the recent past have resulted into spread of diseases. The major reason attributed to this is perhaps the presence of 'murram' layer beneath the sand, which does not let the surface water to seep underground. Forest fire in Kumbhalgarh Aravalli Hills is quite frequent while there is always a fear of radiation leakage from the nuclear plant at Rawatbhata near Kota.

### *Road Kills*

A large number of wild animals, such as Striped Hyaena, cats, dogs, Nilgai, Small Indian Civet and Leopard are killed every year due to road accidents. Owing to habitat loss, they often come out of their territorial areas in search of food and water and are killed while crossing the roads constructed amid and in the close proximity of the dense forests and protected areas (Fig. 20.4a–f).

### *Increased Desertification*

Habitat depletion has led to further desertification and drifting of sand sheet on the desert fringes, causing expansion of the rocky and sandy tracts. It is unfortunate that the forest cover in the Mallani Hill system situated in Barmer, Sirohi, Jalore, and Pali districts has already reduced to only 1.92% while only 0.22% vegetation cover supports the Marwar Hills in Jodhpur, Nagour, and Pali districts [10]. In addition, rapid desertification is taking place in many other districts particularly in fringe areas [10].

### *Management of Human Resources*

Changes in lifestyle and attitude coupled with a dilution of the traditional values and faunal linkages, and lack of knowledge and awareness are also greatly affecting conservation-related activities by the government agencies and NGOs. Apart from this, the tourism development via untrained personnel is also worsening the situation in many areas.


**Fig. 20.4** (**a**) A Panther killed in a road accident near Udaipur. *Courtesy: Devendra Bhardwaj.* (**b**) A gravid female Panther killed in a tragic road accident was carrying four fetuses. *Courtesy: Devendra Bhardwaj.* (**c**) Four foetuses of the killed Panther after postmortem (see Fig. 20.4a). *Courtesy: Devendra Bhardwaj.* (**d**) Stripped Hyaena killed in a road accident near Jaipur. *Courtesy: Devendra Bhardwaj.* (**e**) Stripped Hyaena killed in a road accident near Udaipur. *Courtesy: Ashish Kothari.* (**f**) Small Indian Civet killed in a road accident. *Courtesy: Devendra Bhardwaj*

## *Political and Policy Issues*

Lack of policy implementation, interdepartmental coordination, and political pressure remain the major issues to be looked in to sincerely.

## Threats to Ecosystems

### *Wetlands*

#### Fresh Water Wetlands

The wetlands in the state are continuously exposed to untreated sewage, industrial effluents, pesticide residues, heavy metal contamination, and toxic waste along with the scarcity of both surface and underground water. Excessive withdrawal of ground water for industrial, irrigation, and domestic purposes is also badly affecting wetland conservation in Rajasthan. The loss of wetlands has been alarming to an extent of 66% in a decade in the 13 districts studied [11] which is likely to increase manifolds with the rapid pace of development and climate change.

#### Salt Lakes

The recently vanished Deedwana Lake, Phulera Lake, and the rapidly deteriorating and shrinking Sambhar Salt Lake (Please see Chap. 8 for further details) are indicative of the worsening ecological disaster in the state. Not only this, the land of permanently dried Phulera Lake is being sold for residential purpose, while Sambhar Salt Lake is facing serious conservation threats like shrinkage of water spread, exploitation of lake bed, and excessive resource utilization by illegal salt manufacturers. The catchment of the lake itself has issues like altered land use patterns, desertification, deforestation, overgrazing, and urbanization. In fact, desertification is a serious issue for the entire Indian arid zone in general [10] The most devastating anthropogenic actions have been the construction of a 12.4 km road from Nawa to Khakarki village near Korsina in the southwest of the lake, dividing the lake bed into two unequal parts. This may severely affect the population of migratory avifauna and may further diminish its status of a Ramsar Site. Disturbances by unmanaged tourism activities and poaching of flamingos are other serious issues.

### *Aravalli Mountain Range*

It is unfortunate that the Aravalli Hills are being continuously exploited for mining by the stone industry. This could be the single largest category of threats which in the year 2010 was evident from the fact that, in some cases, the state government granted permission for mining in the sensitive Aravalli Mountains despite stay orders issued by the court of law [11]. In addition, the small mammals of this region have terribly suffered during the past nine decades at the hands of irrigated agriculture [12]. Apart from this, fauna of the Aravalli is facing threats like overgrazing, deforestation, invasion of weedy species and alien flora, forest fire, and monoculture

**Fig. 20.5** Land degradation at Jhadol, Udaipur. *Courtesy: Ashish Kothari*

plantation. Land degradation is yet another major issue to be solved in this area (Fig. 20.5). It is a sigh of relief that, by the beginning of 2012, the state government has been taking strict action against the violators and mining activities are expected to reduce in due course.

## *The Thar or Great Indian Desert*

On account of its hostile and harsh climate, the Thar Desert is considered a fragile ecosystem where, if unchecked, even minor factors may create a major imbalance. From the biodiversity point of view, the Thar may not be that rich but has a great importance being an extension of the Sahara Desert through Persian and Arabian Deserts and is located at the meeting point of the Palaearctic and Oriental biogeographical regions. Hence, Thar has the admixture of Palaearctic, Oriental, and Saharan elements in its biodiversity. Moreover, the flora and fauna in this desert constitute an invaluable stock of rare and resistant germplasm. The biodiversity of the Thar is presently under tremendous pressure to meet the huge demands of food and fodder for increased human and livestock populations. During the last six

decades, several developmental projects have been completed in this region; out of them the Indira Gandhi Nahar Pariyojna (IGNP) is worth mentioning since it has literally not only transformed 11% of the desert wasteland into croplands but also changed the rainfall patterns, soil texture, and a rise in water table in the command areas particularly in Shri Ganganagar district (Fig. 20.6a, b). Due to the increased water availability in such areas, the xeric faunal elements are being replaced by "mesic" species and some minor pests of the region are becoming a major problem [4, 5]. In fact, the Gang Canal and the Indira Gandhi Canal or IGNP were initiated in 1927 and 1961, respectively, to divert water from the eastern rivers of the Indus system, namely, the Ravi and Beas Rivers, toward the arid western Rajasthan. The IGNP utilizing 7.59 MAF of Ravi-Beas water caters to irrigate 1.14 million ha in Shri Ganganagar, Bikaner, and Jaisalmer districts [5].

In addition, flood conditions in some areas have increased the salinity which has adversely affected the native biodiversity. All this together has been responsible for the invasion of new agricultural pests, weeds, and other plant, animal, and human diseases.

Some wildlife species which are either not found at all or are fast vanishing in other parts of India are found in this habitat such as the Great Indian Bustard, the Nilgai, and the Indian Gazelle or Chinkara. In addition, some reptilian species of the Thar are endemic to the desert [13, 14]. Besides climatic vagaries, erratic monsoon, and extremes in diurnal temperature, the Indian desert is confronted with a major threat, namely, escalation of human and livestock population in spite of low productivity of the arid zone, causing a serious stress on the already depleting natural resources. Due to human interference, 4.33% area of the sand sheet in western Rajasthan has led to intensive desertification [15].

Furthermore, the introduction of canal irrigation in the arid regions via the Indira Gandhi Nahar Pariyojna (IGNP) during the past several decades has brought many changes,

## *Grasslands*

Grasslands in Rajasthan are mainly present in the western Rajasthan (Sewan Grasslands), southeastern plateau of Kota, Jhalawar, and Baran districts and sporadically in some other arid regions too. These are one of the most threatened ecosystems in the state. Apart from the usual commercial pressures, threats also come from overgrazing (Fig. 20.7), pollution, development projects, firewood extraction, fire, harsh climatic conditions, mining, altered land use for agriculture, and spread of exotics. Due to easy availability of water everywhere, unsustainable livestock grazing is taking place.

Sewan grass forms bushy thickets in sandy deserts where it is used for pasture, hay, and fodder for livestock. It provides forage to both wild mammals and livestock, and soil cover and may be used to stabilize desert sandy dunes. Sewan grasslands are grazing pastures of outmost importance in areas where annual rainfall is below


**Fig. 20.6** (**a**) Indira Gandhi Nahar Pariyojna (IGNP) (or Indira Gandhi Canal Project) is a major factor responsible for the fast-changing ecology in the arid zone of Rajasthan causing havoc among environmentalists, wildlife specialists, and even the general public. (**b**) IGNP amid desert. *Courtesy: Partap Singh*

**Fig. 20.7** Overgrazing is yet another serious conservation threat looming large in the forests of the desert state. *Courtesy: Devendra Bhardwaj*

250 mm. The Sewan is relished by ruminants and camels but does not stand heavy grazing and disappears when overgrazed. Sewan grasslands which have survived for hundreds of years with low grazing pressure are now under tremendous pressure, and the famous Indira Gandhi Canal has adversely affected the Sewan grasslands, which have provided highly nutritious fodder for cattle in the Thar Desert over the centuries. These grasslands are the major habitat of the Critically Endangered Great Indian Bustard *Ardeotis nigriceps* and the winter migrant Houbara or the Macqueen's Bustard *Chlamydotis undulata*. It is worthwhile to mention here that Karera in Madhya Pradesh, Sorsan in Kota, and Rannibennur in Karnataka have already lost their bustards. Habitat alteration by expansion of agriculture or by human settlements, development of roads or canals, and spread of industries is still going on, and unless immediate measures are taken, sanctuaries like Ghatigaon in Madhya Pradesh would totally lose its bustard population in just another two-three years.

## Conservation Issues Pertaining to Protected Areas

### *Keoladeo National Park (KNP), Bharatpur*

The Keoladeo National Park (KNP) is one of the world's most sought after national parks and best studied wetland ecosystems [16]. Once a flood prone area, it has faced water scarcity and drought for many years after the construction of Panchna

**Fig. 20.8** Hydroelectric thermal power plant at Kota. *Courtesy: Sunil Singhal, Kota*

Dam in the catchment area. A few years back the issue was resolved by bringing water through pipeline from Chambal River. Hopefully, now water is assured in this wonderful park. Banning and subsequent cessation of cattle grazing and collection of firewood and roots of *Vetiveria* (*khus* plant) after 1980 have led to the accumulation of combustible material resulting in frequent fires inside the park. In fact, the unchecked growth of the *khus* plant is destroying the open grassland habitat of wild ungulates, particularly the Blackbuck which is now extinct from the park. Despite 10 years of ecological study in KNP, conservation actions were not taken on science but on whims and fancies of PA managers and decision makers in Jaipur, resulting in deterioration of this wonderful park.

## *National Chambal Sanctuary*

National Chambal Sanctuary harbors the largest Gharial (*Gavialis gangeticus*) population in the world [17] and highest density of the Gangetic River Dolphin (*Platanista gangetica*) [18] besides being a wintering ground for the migratory waterfowl. It is also one of the last remnant nesting grounds for Indian Skimmer (*Rynchops albicollis*), Black-bellied Tern (*Sterna acuticauda*) and also the Small Indian Pratincole (*Glareola lactea*) inhabiting the islands of Chambal River. The major issues affecting the integrity of Chambal basin are the burgeoning population; extraction of river water by the states of Madhya Pradesh, Rajasthan, and Uttar Pradesh; discharge of industrial and domestic effluents into the river; and uncontrolled soil erosion and ravine formation, making it unsuitable for Gharial nesting [19]. Fishing also affects both the Gharial and Gangetic River Dolphin population [20–22]. In addition, the construction of dams and barrages for irrigation and hydroelectric power generation, and the thermal power plants (Fig. 20.8) in the vicinity have checked the regular flow of Chambal River while greatly reducing the same even during years of low rainfall. Irregular water release from the dams and barrages

**Fig. 20.9** Man-animal encounter is a common problem at Ranthambhore National Park. *Courtesy: Sunil Singhal, Kota*

has made the habitat unsuitable for Gangetic River Dolphin and caused inundation of the eggs of Gharial, turtles, and many breeding birds. Actually, quarrying for building stone in the basin is the primary cause of the severe soil erosion. Mining of the Chambal's riverbed for stones and sand has further aggravated the situation and caused siltation of the main river course. Excessive use of pesticides and fertilizers in the basin is adding to its pollution [22].

## *Sariska Tiger Reserve*

Tiger reserves of Rajasthan are facing several ecological and other serious problems, namely, habitat fragmentation, inadequate protection, degradation of forests due to anthropogenic pressures, conflicting land use pattern, presence of heavily used infrastructure, and biotic pressure. Such a situation leads to frequent man-wildlife conflict (Fig. 20.9). This has also led to poaching of tiger and other wild animals and trafficking of their body parts. Owing mainly to poaching, the tiger became extinct from Sariska Tiger Reserve in 2005. It is perhaps not an isolated example, since the recent National Scale Assessment has reported that tigers have gone locally extinct from the 97 districts in the past 150 years [23]. In terms of potential habitat and prey availability, Sariska can support at least 15 tigers in the Core Zone I [24]. Quarrying, mining, and other biotic disturbances are posing threat to the conservation values of this reserve. Reintroduction of tiger along with relocation of some villages and other developmental works have been undertaken recently on a large scale to conserve this habitat.

### *Kheechan and Demoiselle Crane Conservation*

The institutional arrangement for management of the *Bird Feeding Home* at Kheechan is weak, which was being solely managed by a 74-year-old man who actually initiated this service long ago and died a few months ago. There is no known second line of management. Water in the ponds dries up during severe drought, and the cranes have to fly long distances in search of water. Presence of live, naked, and over-ground electric cables in and around the villages is responsible for the death of many cranes each year. In addition, the unchecked tourism-related activities result in frequent disturbance to the bird population apart from the indifference of local and subdistrict administration and forest department, which has made the situation worse. However, it is also true that the tourists provide great incentive to the villagers, and this in turn inspires them to protect the cranes. According to an estimate, as much as 12,300 tourists visited Kheechan village during the year 2010–2011 (please see chap. 11 for more details).

## Conservation Issues of Faunal Groups/Individual Species

The devastated ecosystems and wildlife habitats of Rajasthan have brought many faunal species on the verge of extinction, namely, Caracal, Sloth Bear, Indian Civet, Desert Cat, Jungle Cat and wolf. The declining population of anurans may be attributed to habitat destruction and/or alteration due to anthropogenic activities apart from low rainfall, environmental change, and role played by contaminants. The unchecked use of frogs for dissection purposes while imparting life science education in universities and colleges since 1920 has also led to the diminished population of frog species like *Rana tigrina*, while trade of frog legs from Banswara and Udaipur districts of Southern Rajasthan continues to be a major concern.

*Uromastyx hardwickii* is hunted extensively for oil extraction despite a legal ban. In spite of mass killing, this species is still fairly common in Barmer, Jaisalmer, Bikaner, Sriganganer, and some parts of the Pali district but for how long? Likewise, there is a great need for the conservation of an isolated population of Green Munia and Red Avadavat at Mount Abu since these beautiful birds are still being frequently captured, caged, and sold for ornamental purposes. In the same manner, the major reason of the fast-declining population of the Houbara Bustard is the indiscriminate killing by Arab hunters [25] who use falcons for the purpose, loss and fragmentation of habitat, excessive biotic pressure, military exercises and construction of roads, oil and natural gas exploration, and lack of awareness. Fruit bats such as the Indian Flying Fox *Pteropus giganteus* and Greater Short-nosed Fruit Bat *Cynopterus sphinx* are reported to have spread in the desert areas of Rajasthan, owing to changes in habitat and vegetation due to development of newer irrigation systems. Wolves in Rajasthan are now restricted to a few pockets only. Kumbhalgarh Wildlife Sanctuary is perhaps the only place in Rajasthan where wolf can still be seen breeding, however, their number is rapidly declining. Sloth Bear population is also struggling to

**Fig. 20.10** Nilgai is a common crop pest all over the state. *Courtesy: Dr. Anil Kumar Chhangani*

survive from the man-animal conflict and habitat loss being distributed in fragmented patches through the Aravallis, especially in southern and eastern regions and Vindhyan Hills in southeast Rajasthan. On the other hand, the Large Brown Flying Squirrel is still being shot by tribals.

Coming to the big cats, it is feared that leopard population will decline across most of its range in Rajasthan due mainly to habitat destruction and poaching [26]. Frequent discovery of poisoned livestock carcasses killed by leopards in and around the PAs of Rajasthan indicates a significant danger to the survival of this species [27]. In addition, massive reduction in the Bengal Tiger population in India has brought increasing poaching pressure upon the leopard to meet the demands for the skin and bone trade. In addition, Leopards are also frequently killed while involved in conflicts with humans on account of their large home ranges, adaptability for diverse diet including domestic livestock, ability to withstand anthropogenic pressure, and decline in natural prey-base.

Unfortunately, even the monkeys are not safe in Rajasthan. The problem of monkey nuisance lies in their attempts to procure food and space inside human habitations which in turn is a fall out of their natural habitat—the forest. With shrinking forests, altered microhabitat, decreased availability of food and water, and decreased human tolerance to the increasing number of monkeys, there is a frequent conflict between humans and monkeys and even mutual hostility.

Likewise, Nilgai and Indian Peafowl, considered as crop pests (Fig. 20.10), are also frequently poisoned or shot by the farmers. Despite the general awareness about wildlife trade, there is little information on the extent and prevalence of ille-

gal trade in otter skins and consequently the threats to the species. All the three Indian species, namely, Eurasian Otter, Smooth-coated Otter and Small-clawed Otter, have been recorded in trade. Nomadic hunting tribes such as *Gilhara*, *Badiya*, and *Jogis* are known to regularly kill otters for their skin and flesh [17, 28]; the major markets are Kanpur, Lucknow, Kota, Kolkata, Bengaluru, and Delhi.

## The Dire State of Zoos

The zoos of Rajasthan situated at Bikaner, Jaipur, Jodhpur, Kota, and Udaipur are in a bad shape due to neglect and mismanagement. Hardly any new fauna has been introduced during the past many years, and the existing inhabitants continue to thrive in poor health without any proper management. Owing to this, the zoos have lost attraction, while their shifting to other places for revival is being done at snail pace.

## Threats to Community Conserved Areas (CCAs)

The sociopolitical exigencies influence decision-making and management, thereby affecting conservation and distribution of benefits arising from such conservation. Since the colonial and post-Independence take-over of common lands by the state, CCAs mostly contain government lands or a mix of government, private, and community lands. There is a serious lack of tenurial security. They also suffer from developmental threats, governance indifference, and lack of support.

## Implementations of Laws

The current status of implementation of the Indian Wildlife (Protection) Amendment Act, 2006, and other laws in the state is no good as is evident by the recent death of a relocated tiger in Sariska Tiger Reserve under mysterious circumstances, even after all the precautions and safeguarding of the forest officials. The episode shocked both the government and conservationists, and it appears that wildlife criminals are much ahead of the forest department officials and the police.

## Unmanaged Ecotourism

The state has a large number of dense forests with monuments, temples, and scenic beauty spots. Most people visit them for recreation, but many go there for illegal activities like poaching, tree-cutting, and other crimes. Inadequate funds, lack of coordination between various government departments, and special taxes are some

of the major issues on the way to promote ecotourism and in the direction of implementation of the newly formed ecotourism policy, which needs to be implemented out without delay.

## Major Initiatives and Current *in situ* Conservation Efforts

### *Relocation of Tiger at Sariska Tiger Reserve*

The state and central governments have planned to realign and reinforce tiger conservation strategy both for the "core" as well as "buffer" areas of national parks and tiger reserves. In a bid to elicit support of the local people toward tiger conservation, eco-development activities, namely, dairy and horticulture, are also being taken up in the peripheral areas like ecotourism. Apart from this, in an attempt to reduce man-wildlife conflict, relocation of villages from core areas to make inviolate habitats, construction of crop protection wall to avoid damage to the crops by wildlife and humans, and provision for timely payment of appropriate compensation for the loss occurred are also being done.

As a recovery plan for tigers at Sariska, an adult tiger and tigress were successfully reintroduced in Sariska on June 28 and July 4, 2008, respectively. All in all, a total of seven big cats have been successfully reintroduced at Sariska till now. Two female tigresses were also relocated at Sariska in January 2013 while two cubs were spotted by a camera trap at STR in September 2012. Recent death of one of the relocated tigers under mysterious circumstances is currently being investigated. Major boost toward tiger protection was recently given during a meeting held at New Delhi on January 13, 2011, whereby the Union Cabinet approved the creation of four additional positions in the rank of Inspector General of Forests for the three regional offices and headquarters. This is seen in conjunction with a recent decision to set up three regional offices of the NTCA at Nagpur, Guwahati, and Bengaluru. In principle, approval has been accorded for the creation of five more tiger reserves in India including Mukundara Hills National Park in Rajasthan. The park will encompass Darrah, Jawahar Sagar, and Chambal Wildlife Sanctuaries.

### *Efforts to Revive Siberian Crane at Keoladeo National Park, Bharatpur*

It is now well known that the Siberian Crane vanished from the KNP, Bharatpur, due to hunting on its long migratory route, perhaps mainly in Afghanistan. On Feb. 3, 2011, the Union Environment Minister of India proposed to set up a breeding center for the Siberian Cranes in the park, and a detailed plan is being chalked out in consultation with the Bombay Natural History Society and WWF-India to revive

the migratory route of Siberian Crane in an effort to bring them back to Keoladeo National Park. Earlier in November 2010, the minister had sent a letter to the Chief Minister of Rajasthan asking him to lift water from the Govardhan Drain situated at Mathura in the adjoining Uttar Pradesh state and later from Panchna Dam also.

## *Cheetah Reintroduction in Rajasthan*

The Cheetah is the flagship species of grasslands, scrublands, and open forests. The recent report submitted to the Ministry of Environment and Forests, by Wildlife Trust of India and Wildlife Institute of India mentions a detailed survey carried out at selected sites to explore the potential of reintroducing Cheetah in India. Ten sites were selected from the seven landscapes located in the states of Rajasthan, Gujarat, Madhya Pradesh, Uttar Pradesh, and Chhattisgarh. The Shahgarh landscape close to the international border falling under the Jaisalmer district of Rajasthan and the proposed Desert National Park were initially considered ideal for Cheetah reintroduction. Cheetahs were proposed to be sourced from Africa and Iran. Unfortunately, following a staunch protest from the Indian Army and Border Security Forces (BSF), the site selection of Shahgarh and DNP was formally canceled in March 2011.

## *Strengthening Protected Area Network*

The Government of Rajasthan is in the process of converting all the closed areas to conservation reserves. Till date, only three such areas could be declared as conservation reserves. The efforts are also being done to create "buffer zones" near the PAs to reduce the dependency of villagers on the forests. For a better safety of Ranthambhore NP and Sariska TR, in addition to the forest officials, ex-army personnel and home guards are being deployed. To this end, direct appointment of hundreds of forest guards is also being undertaken in the state. Tiger Conservation Foundation has now been established in the state for the better management and conservation of tigers. Similarly, under the village relocation program in and around STR, people from three villages, namely, Bhagani, Umri, and Kankwari, are being shifted to Badod Rundh village. Likewise, at the Ranthambhore NP, village Indala has been completely shifted, while relocation of village Machanki is in the process.

For the better management of PAs of the state, "Rajasthan Protected Area Conservation Society" has been formed under the chairmanship of the Chief Secretary. Eco-development Committees (EDC) and Joint Forest Management Committee (JFMC) are being created in every PA. Co-management of forests by involving local people and institutions and restoration of their rights are paramount for resolving conflicts related to resource use which is likely to lead to better management of natural resources. The Government of India has decided to extend some

PAs and develop corridors between the Ranthambhore National Park and the Kailadevi Sanctuary, and Ramgarh Vishdhari Sanctuary to Sheopur district of Kuno-Palpur Wildlife Sanctuary of Madhya Pradesh state, and the third one shall connect Khandar to Darra. Some new conservation reserves and community reserves are also planned to be formed. New ecotourism and forest policies, 2010, have been framed by the state government in a bid to strengthen the PAs and area outside them. All the five zoos of the state are now being shifted to better places to be renamed as Biological Parks. To this end, Jaipur Zoo will now be called Nahargarh Biological Park, Udaipur Zoo as Sajjjangarh Biological Park, Jodhpur Zoo as Macheda Biological Park, and Kota Zoo as Abheda Biological Park.

## Conservation Efforts by Premier Agencies Toward Faunal Conservation in Rajasthan

### *Regional Research Station, Zoological Survey of India (ZSI), Jodhpur*

ZSI, Jodhpur was established five decades ago, and since then, it is involved in exploring the faunal resources of Rajasthan. It has carried out massive status surveys of a variety of animal species including Mountain Lizard, Chinkara and Desrt Cat in addition to Environment Impact Assessment of Gambhiri Dam Project, Chittourgarh, Som Kamala Amba Project, Aspur, Dungarpur, and other research-based studies of various invertebrate and vertebrate faunal groups.

### *Salim Ali Centre for Ornithology and Natural History (SACON), Coimbatore, Tamil Nadu*

This center was established in 1990 after the famous birdman Dr. Salim Ali, in association with the Ministry of Environment and Forest (MOEF), Government of India, to study all aspects of natural history and ornithology. Having worked in Rajasthan for most of their life, the stalwarts of this institution, namely, Dr. V. S. Vijayan and Dr. Lalitha Vijayan, the scientists from SACON, undertook major projects on "Ecology of Keoladeo National Park." "Identification and mapping of Lesser Florican breeding sites to develop a fodder producing grassland network in western India" was undertaken by (Late) Dr. Ravi Shankaran. A workshop was later organized at Vadodara, Gujarat, which involved officials from Rajasthan, Gujarat, and Madhya Pradesh, NGOs, local stakeholders, and wildlife experts deliberated to devise "conservation planning for Lesser Florican in western India." Dr. Shankaran had conducted extensive surveys of Lesser Florican habitat in Rajasthan with the members of Hadoti Naturalist's Society, Kota, for three consecutive years, and then a seminar was organized at Kota which culminated in the preparation of a conservation strategy document for Rajasthan.

## *Bombay Natural History Society (BNHS), Mumbai*

Bombay Natural History Society (BNHS) synonymous with wildlife research and faunal conservation has been actively and dedicatedly promoting the cause of nature conservation for the past 127 years since 1883. The society has since grown in to a mammoth research and conservation-based organization of international repute. Mr. R. C. Wroughton, a forest official and member of the society, undertook in 1912 the colossal task of surveying mammals inhabiting Indian subcontinent, resulting in a massive collection of 50,000 specimens in 12 years and 47 scientific publications. The doyens of the society like Dr. Salim Ali, S.D. Ripley, Humayun Abdul Ali, Zafar Futehally, J.C. Daniel, and its present director, Dr. Asad Rafi Rahmani, have immensely contributed toward its various goals and objectives. It has a very rich library and a museum which displays over hundred thousand specimens including 26,000 birds, 20,000 mammals, 7,500 reptiles and amphibians, and 50,000 insects. Recipient of the coveted "Indira Gandhi Paryavaran Puraskar" and "Rajeev Gandhi Wildlife Conservation Award," the society publishes a quarterly magazine *Hornbill* and the *Journal of Bombay Natural History Society* (JBNHS), which are highly referred scientific journal.

BNHS has had close links with Rajasthan since its scientists have worked for many years at KNP, Bharatpur, Desert National Park, and many other areas of potential significance to biodiversity. They have studied the wetland ecology of Keoladeo National Park, devised action plans, researched flora, limnology, bird ecology, and raptors including vultures of the area. Dr. Asad Rahmani has been quite instrumental toward conservation of the Great Indian Bustard (GIB) in Rajasthan. This state bird of Rajasthan is one of the Critically Endangered bird species in the world and realizing the importance of public participation in its conservation, Dr. Rahmani in association with the Birdlife International launched conservation education campaign "Project Bustard." A walk through the desert habitat of GIB was organized by the BNHS in which local NGOs, wildlife enthusiasts, forest officials, and public at large participated in huge numbers. In association with Ministry of Environment and Forests, Government of India, BNHS had launched "Environment Information System" (ENVIS). It also runs a "Bustard Forum," which disseminates information on the status of various bustard species in India, their status, and conservation priorities in addition to supporting small research and conservation initiatives through Salim Ali Nature Conservation Fund.

## *Hadoti Naturalists Society, Kota*

Patronized and spurred by (late) Mr. Shantanu Kumar—environmentalist and Deputy General of Rajasthan Police—a diverse group of wildlife and nature lovers endeavored to launch a society with the sole objective of protecting and conserving the fast-dwindling wildlife of the Hadoti region of southeastern Rajasthan. The society has been working toward its goals for nearly two decades now. The changes brought

about by the society in the status of the wildlife in Chambal Gharial Sanctuary between Jawaharsagar and Kota may be considered as one of the biggest achievements. In 1998, when the society found that quarrying in the valley was rampant and fishing licenses were being issued by the Department of Fisheries, the members in close association with the Department of Forest (Wildlife Wing), Kota, decided to eradicate this menace. The society provided logistic and personnel support and has stood shoulder to shoulder in the times of crisis with the Wildlife Wing. On a number of occasions raids were conducted and during which members were even attacked by criminals. The society also took up the issue with the Department of Fisheries and made them cancel the fishing licenses of the river in 1999–2000, since then the wildlife is flourishing in the valley and as a result Gharial and Crocodile sightings have improved. Sloth Bear, Panther, Hyaena, Chinkara, Nilgai and Indian Vulture are regularly sighted in this area, while the Smooth-coated Otter has made a comeback after two decades.

Apart from the above, the society has been closely associated with the conservation and management of Sorsan Great Indian Bustard Closed Area in Baran district and various projects directly linked with conservation education and man-animal conflict mitigation to spread the message of conservation among villagers residing in the area. The society members have conducted regular wildlife census in Darrah Sanctuary since 1996. Researches by the society members on Sarus Crane, Lesser Florican, crocodile, wetland birds, and heronries in and around Kota were highly appreciated by national institutes like Wildlife Institute of India (WII), BNHS, and SACON, and taking up the cue, they instituted large-scale research projects. The society has been involved with mid-winter Waterbird Census, Sarus Crane survey, Crocodile Census, Lesser Florican Survey, national and state level seminars on wildlife conservation, Great Indian Bustard, Lesser Florican, bird identification workshops, illegal trade in wildlife and wildlife products with TRAFFIC India, rural workshop on alternative energy sources, lecture programs on small mammals of Aravalli, and biodiversity of the desert and white ants along with renowned scientists of the Zoological Survey of India and other key organizations.

## Recommendations for Conservation and/or Management

### *Fresh Water Wetlands*

Not only the State of Rajasthan but the whole country needs a comprehensive wetland program; formulation of a National Wetland Conservation and Sustainable Use Strategy and Action Plan as well as Wetland Authority at national, state, and village levels comprising members from among the stakeholders to oversee, liaise, and initiate appropriate policy legislations and action-oriented programs. Conservation strategies should be evolved based on the biodiversity and socio-ecological usages, as the wetlands are being excessively exploited by various agencies and the local community. Rajasthan being a desert state thriving under severe water scarcity needs special and concrete steps in this direction. India also needs a Wetland Conservation Act, on the pattern of Forest Conservation Act of 1980.

### *Salt Lakes*

The priority for the conservation of salt lakes shall be given to the areas which are worst affected and need immediate attention. Ecological destruction of any kind shall be strictly prohibited in priority eco-sensitive zones by the government and other responsible agencies and stakeholders [29]. Since *Dunaliella salina* and Spirulina algae found in Sambhar Salt Lake are a proven source of ß-carotene, glycerol, and protein for human consumption, there is a need to manage these resources scientifically and wisely.

### *Integrated Conservation Planning for Chambal River Basin*

For effective conservation of the basin, development and strengthening of policy, legislation support for integrated river basin management backed by strong political will, and involvement of stakeholders while minimizing the impacts of land use and water abstraction projects are extremely important. There are prospects involving local communities through ecotourism and through the existing network of Forest Protection and Village Eco-development Committees located in and around the forests and PAs and the basin in all the three concerned states, namely, Rajasthan, Madhya Pradesh, and Uttar Pradesh.

### *Conservation of the Aravalli Hills*

Regional conservation plans should be adopted especially in the western Aravallis to maintain corridors between the forests. Barring a few protected areas and forest divisions, population of most species across Aravalli Range is small and fragmented. If issues like human-animals conflict and poaching are not handled seriously, the already shrinking faunal elements will become vulnerable to eventual extirpation. Education and awareness programs using modern pedagogy while emphasizing wildlife and conservation biology, behavioral ecology, role of the Sloth Bear in this important ecosystem, and the importance of sustainable forest management should be considered on priority.

### *Grassland Conservation*

To this end, implementation of the recommendations made by XI Planning Commission's Task Force on Grasslands and Deserts (2006) are crucial. Attempts should also be made to conserve and properly manage the grasslands with native grass species. This may be achieved by formulating a Rational Grazing policy.

The *sevan* grass (*Lasiurus sindicus*) was abundantly found in the command area of IGNP, but now these vast grasslands are being transformed into crop fields. These grasslands are important in the Thar region because the *sevan* grass not only has rich nutritive value but also caters to the needs of a large population of livestock, especially during peak summer season. The seeds and fruits of many plants in this area also provide food for many wild animals. Hence, serious efforts should be made to conserve these grasslands via peoples' participation. In addition to this, immediate steps for the conservation of grassland ecosystem and proper management of the needs of villagers for fodder have to be taken care of by making a village level committee in conjunction with the local *Panchayat samiti*. Restrictions should be imposed on cultivation areas to check shrinkage of the grasslands.

## *Tiger Reserves*

The two tiger reserves of Rajasthan have been under severe threat due mainly to wildlife trade and a variety of anthropogenic pressures. Rehabilitation of the ten human settlements from Core I of the Sariska Tiger Reserve, stopping heavy vehicular traffic on the state highways running through the park, reducing livestock pressure on the forest, and implementing people-oriented programs all around the reserve would improve the overall conservation status. The Ranthambhore tigers, apart from other potential threats are facing shortage of area for dispersal resulting into frequent territorial fights. Solution of this long pending issue may well be sorted out by creating the suggested eco-corridors and relocation of tigers to other nearby wildlife sanctuaries such as Kailadevi Wildlife Sanctuary.

## *Conservation of the Faunal Elements*

The proper planning for the prevention of extinction and decline of known threatened species can be safeguarded by developing and implementing suitable strategies and action plans. Threatened species of fish can be conserved by protecting their breeding ground and monitoring of the diversity via sample collection at regular intervals, and restoration by stocking of yearlings is strongly suggested. Similarly, habitat restoration for snakes can be carried out by leaving fallen logs, bark, and snags as such; adding vegetated borders and hedges; building dry-stack rock walls; and constructing brush and rock piles or compost piles. Thousands of snakes may be saved by public awareness program, "vehicle driver awareness" campaign, and launching effective rescuing service in the tribal, rural, and urban areas.

Recent studies on the Great Indian Bustard reveal that habitat protection and development of marginal areas for breeding in a large multiple-use area could help in increasing its population. In order to protect all Indian species of bustards and their habitat, the Government of India shall start "Project Bustards" and a "Bustard Conservation Breeding Centre" may be established for increasing the population. To

protect the Critically Endangered Great Indian Bustard (less than 500 left in the whole world), Lesser Florican, Bengal Florican, and other grassland-associated flora and fauna, Project Bustard should be initiated. As protection of grasslands would greatly benefit livestock, the Ministry of Agriculture and Animal Husbandry should also be involved. These bustards are found in at least ten states of India, and therefore, it is vital to develop a centrally coordinated and funded scheme. The support of locals, the BSF, and the local wing of the forest department may play a pivotal role in the protection of Great Indian Bustard, Houbara Bustards, and other desert species such as Desert Fox, Indian Grey Mongoose, Golden Jackal, Spiny-tailed Lizard and Desert Monitor and can also help in nabbing poachers by taking advantage of their widespread and sound information network. There should be some legal and social protection of these grasslands from invasion of nomadic graziers, especially during the growing period of the grasses.

Conservation of the Sarus Crane requires increasing awareness of the people and their participation. A ban on disturbing bat roosts in old *havelis* and ruins and breeding sites of vultures needs to be implemented to protect these species. The Department of Tourism, Government of Rajasthan should take stringent measures to promote vulture and bat roosting/nesting sites as tourist spots and encourage locals to consider them as source of income. Activities relating to awareness about conservation education should be taken up to dispel myths and superstitions pertaining to bats among the general public through print and electronic media.

## *Ecotourism Development*

Potential ecotourism sites should be selected and listed district-wise on the basis of forest areas with rich biodiversity, natural scenic beauty, and adventure tourism. Proposed activities at these sites and the ones already established may be value-added through campaigning and wide publicity. To this end, prospects of various sites in Rajasthan as potential ecotourism attractions may be ascertained with emphasis laid upon community-based ecotourism via encouraging private sector participation and infrastructural developments. Formation of Ecotourism Society and Ecotourism Advisory Bureau would be of great assistance in this direction.

## *Development of Fossil Parks*

Rajasthan also has a number of geological heritage sites. Two national fossil parks have already been established in Rajasthan, namely, Stromatolite Fossil Parks at Jhamarkotra and Bhojunda in Udaipur and Chittourgarh districts, respectively, and the Akal Fossil Wood Park in Jaisalmer District. The later is attracting domestic as well as international tourists, while the former two still need to be further developed and advertised to attract geo-tourism. In addition, a few more sites are worthy of

consideration for conservation as geological heritage sites. These may include Kanak Vrindawan near the world famous Amber Fort in Jaipur for tracing fossils in the Proterozoic rocks and Sursagar in Jodhpur district and Kuldhar and Ramgarh in Jaisalmer district for Jurassic invertebrates and larger foraminiferans.

## *Role of Stakeholders*

Stakeholders shall communicate their knowledge on biodiversity to inform decision making at all levels of governance, support various discussions on development over a platform on biodiversity and ecosystem conservation, and promote action toward building resilience of ecosystems and people depending on them for livelihoods. Collaboration with scientific and technical community and organization like IUCN on biodiversity conservation and ecosystem management by drawing upon their expertise in a wide range of thematic areas and issues like species, protected areas, access and benefit sharing, inland waters, forests, and arid zones is of paramount importance.

## *Mobilization of Forest Officials and Academics at Regional, National, and International Levels*

The Government of Rajasthan may decide to help set up the agenda for its forest department to influence the MOEF outcomes through the involvement of academics, experts, and members of various national level and state boards and commissions. The secretariat and regional offices play a catalytic role by encouraging members to use and profile policy positions in developing their inputs and positions at different levels. This includes information exchange on key lessons learned as well as opportunities, issues, official events, and other aspects of national and international processes for biodiversity conservation. To influence policy decision making, value addition of the members and their work by drawing their knowledge would prove productive.

## *Advocacy, Public Awareness, and Extension Strategy*

The objectives of communication strategy shall deal with advocacy of policy matters and spread them in the public. It may be done by increasing awareness of the crisis pertaining to biodiversity loss and explaining to people about the importance of saving our biodiversity, building mass awareness about the existing biodiversity and the important role of ecosystems in economic development, human well-being, and poverty reduction. We must ensure that press releases and all outreach materials including technical and scientific articles, priority issues, key strategies, and regional

policy are properly distributed to the stakeholders and general public by district level officials and by providing effective coordination and collaboration of academics and forest officials within the country, and organizing global events.

## Specific Recommendations for the Thar or Great Indian Desert

1. Although, a lot of information has been gathered on the distribution of plant and animal species in the Thar Desert, majority of the microorganisms are yet to be discovered and named. It is, therefore, suggested that the Thar should further be explored for its microorganisms including agricultural pests and other species of economic importance. Knowledge on the ecology, feeding behavior, food preferences, alternative hosts, and biology of key/potential pests of agricultural crops (e.g., nematodes, insects, birds, and mammals) and their predators will help in finding out cost-effective methods in the management of pests and finally in increasing the agricultural productivity in this area.
2. As the Thar Desert is spread over four states in India, namely, Punjab, Haryana, Rajasthan, and Gujarat, a well-planned collaborative study is needed for exploration of plants and animal species before some of them become extinct, many even without being named. Since plant and animal species in the Thar constitute an invaluable stock of rare germplasm, it is necessary to restore the original state of desert.
3. Since the Great Indian Desert is the most populous deserts in the world, human and livestock populations should be checked so that the pressure on this ecosystem may be brought down. In order to bring down the population of weak livestock, it is suggested that we improve the breed of native cattle. To ease the pressure on land (ecosystem) and to improve the financial status of people, attempts should also be made by the government and NGOs to provide employment in the nonagricultural sector. In this direction, eco-friendly tourism, cottage industries, fish culture, etc. should be encouraged in the region.
4. The farmers may be encouraged to grow crops like barley, instead of wheat and chili which require huge amount of water. Thereafter, a policy of water management may be formulated, and the farmers may be strictly asked to use water more judiciously.
5. In view of a very thin and limited forest cover in the Thar, illegal cutting of trees should be checked effectively.
6. More protected areas should be created for the conservation of threatened faunal and floral species. There is also an immediate need to create protected areas in the vicinity of Indira Gandhi Canal. Area covering about one kilometer on either side of the canal (mainly extending from 1251 RD to 1458 RD, Nachna to Mohangarh in Jaisalmer district covering an area of about 140 sq km) may be declared as a wildlife sanctuary. This will serve as alternative habitat for a number of mammalian species like *Gazella bennetti* and *Boselaphus tragocamelus* during prolonged drought period. The people living in and around the reserve should also be involved in the conservation program.

7. A proper policy should be erected for mining in the Thar region and the laws should be enforced effectively to stop illegal mining.
8. Declaration of the proposed Desert National Park (DNP) as a Biosphere Reserve.

The Ministry of Environment and Forest (MoEF), Government of India, had constituted a working group in 1988 under in the chairmanship of (late) Dr. K.S. Sankhla to prepare a project document on the Thar Desert Biosphere Reserve with the objective of integrating biological, socioeconomic, and cultural elements. The working group had recommended up gradation of the Desert National Park as the Thar Desert Biosphere Reserve to conserve this representative ecosystem on a landscape level. The BNHS has also submitted a project report for declaring it as the Thar Desert Biosphere Reserve. The Planning Commission of India has also recommended the up gradation of Desert National Park as a *Biosphere Reserve* in the 11th Five Year Plan (2007–2012). Despite this, a decision has to be arrived at by the state government in connection with the selected and demarcated area. This will also help in ameliorating the economic condition of the locals. A major chunk of the land is revenue land in the Desert National Park, which should be immediately transferred to the forest department for its better management and development. Similarly, the transfer of forest land which is part of the Desert National Park, currently under the possession of the territorial division of Barmer, should also be handed over to the Desert National Park management for its protection and proper management.

## Research Gaps

It is unfortunate to mention here that the vivid faunal diversity of Rajasthan has never been documented in toto. No one knows the current status of the fauna of Rajasthan and also as to how many species are sliding into oblivion every day. The research on the following focal areas is the need of the hour:

- Many data-deficient species badly need scientific studies and surveys on their ecology, distribution, migration, and population status in virtually every physiographical region of the state in the absence of which policies and future planning for their conservation could not be made.
- Strong interaction for biodiversity monitoring projects between academics and forest department is rampant. The urgent need to establish a state Database Center for vital information on the current states of biodiversity and ongoing researches accessible to both specialists and common men is emphasized. Instead of collecting or killing individual species for research and teaching purpose, new techniques like sound analysis, DNA preservation, bio-informatics, computer-assisted dissections, and digitized morphology of organisms are suggested. Creation of new courses/papers on biodiversity, ornithology, wildlife biology, and conservation biology in the state universities and colleges together with

emphasis on field training programs for junior researchers has been strongly suggested by experts.

- It is high time to develop new captive breeding strategies to improve the fertility status and the declining reproductive performance of the rare and endangered faunal species with the help of biotechnological approaches like assisted reproduction (AR). AR involves application of techniques such as semen collection, gamete and embryo cryopreservation, estrus induction and artificial insemination (AI), and more complex methods such as oocyte pick-up (OPU), in vitro fertilization (IVF), in vitro production of embryos (IVP), intracytoplasmic sperm injection (ICSI), embryo transfer (ET), and cloning. Hand in hand with AR, molecular markers based on genetic makeup of animals need to be developed and applied to ascertain the extent of genetic polymorphism in the surviving wildlife populations. This would help in planning captive breeding program, to further facilitate maintenance of genetic heterozygosity and prevent genetic homogenization which leads to extinction. Thus, assisted reproductive technologies (ART) and molecular marker technology could help achieve the long-term goal of wildlife conservation in this modern era of technological advancement.

## Strategic Planning for Biodiversity Conservation and a Vision on the Future Fauna of Rajasthan under Current and Predicated Threats

The values of biodiversity are directly reflected in national and local development, strategies, and planning processes. Conservation efforts shall be made to minimize the rate of loss, degradation, and fragmentation of natural habitats including forests. Invasive alien species may be identified, prioritized, and controlled or eradicated, and measures may be taken to control pathways for their introduction and establishment. In a nutshell, the following strategies can be taken into account:

1. Ecosystem provides essential services and contributes to health, livelihood, and well-being and must be safeguarded while taking into account the needs of women, indigenous and local communities, and the poor and vulnerable. The ecosystem resilience and the contribution of biodiversity shall be enhanced through conservation and restoration at least 15% of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combat desertification.
2. At least 15–20% of the terrestrial and inland water especially in areas of particular importance for biodiversity shall be conserved through comprehensive, ecologically representative, and well-connected systems of effectively managed protected areas.
3. Access to genetic resources may be enhanced, and benefits are shared consistently with the national legislation and the international protocol by timely providing adequate and predictable funds to developing countries.

4. We must have a strong legal system to protect our traditional knowledge, innovations, and indigenous practices of the local communities that are extremely relevant to biodiversity conservation. The customary sustainable use of such knowledge is respected, preserved, and maintained, and its contribution to conservation and sustainable use of biodiversity is duly recognized, mainstreamed, and enhanced.

Strategic planning thus chalked out has to be focused and action-oriented by including a vision for the year 2050; a revised biodiversity target for at least one decade together with other short-term ambitious and realistic targets must be implemented with indicators to measure progress. The plan shall, therefore, highlight the importance of biodiversity for poverty eradication. It shall also address the drivers of biodiversity loss (direct and indirect) and integrate biodiversity considerations into relevant sectoral and cross-sectoral policies and find out new and additional financial resources by engaging private sector and/or public-private partnership (PPP). It shall finally include a clear logic linking the vision, mission, and targets comprising a more effective framework for national/regional implementation. Such strategy will keep on pushing for amendment in the Wildlife (Protection) Amendment Act, 2006, together with its better understanding and implementation for recommending specific follow-up actions and policies to strengthen the legal framework. A separate platform to provide technical advice and support for activities related to the use of traditional knowledge associated with biodiversity resources and conservation-related legal issues and their compliance shall be launched in the state since progress made in these areas at both regional and national level is imperative.

The state forest department is currently playing an important role in the conservation of rare and endangered wild animals and "Village Displacement Schemes" in and around protected areas. As most of the biodiversity-rich dense forest areas are mainly situated in and around the wildlife sanctuaries and national parks, efforts have been made to reduce the biotic pressure caused by the human settlements. The end result of such biotic and anthropogenic pressures is reflected as everyday conflict between wildlife managers and local villagers. In a bid to handle this tension and competition, the buffer zones lying close to protected areas are being currently developed so that the dependence of locales on these areas for various reasons e.g. fodder and fuel wood etc. could be minimized. Apart from this, habitat improvement programmes, development of water bodies and food resources and development of roads/passages inside forests are being undertaken in these rapidly declining wildlife-rich areas. The major efforts done and/or proposed by the state forest department during the year 2009–2011 include: deployment of ex-army personnel and home guards in Ranthambhore and Sariska Tiger Reserves to strengthen security; displacement of villages from Ranthambhore and Sariska Tiger Reserves and Karouli buffer zone; water restoration to the World Heritage Keoladeo National Park via Goverdhan Drain; establishment of "Tiger Conservation Foundation" for Ranthambhore and Sariska to facilitate ecotourism activities and other eco-development programmes like water-harvesting projects, eco-corridors at Sawai Mansingh and Kailadevi WLSs especially created for tigers to stop territorial fights; management of wildlife outside protected areas targeting the satellite wetlands of the Thar Desert and Keoladeo National Parks; development of Kumbhalgarh and Hadoti as

potential ecotourism destinations; development of Kheechan and Tal Chhapar WLSs; relocation of two more tigers to Sariska; establishment of "Rajasthan Protected Area Conservation Society" for the management of national parks and wildlife sanctuaries of the state; Bustard Conservation Project; Mount Abu declared as an "Eco-sensitive Zone"; and meeting of the Directors of all the national parks and tiger reserves falling under "Project Tiger" held at Sariska Tiger Reserve during July 2009 to discuss management of tiger projects. The newly notified national park by NTCA, Mukundra Hills in Kota district of Hadoti region shall be the major conservational strategy in coming years. Efforts are being made to develop and include the latter as a tiger reserve which is popularly known as the "maternity home" for Ranthambhore tigers. The world famous Ranthambhore National Park and Tiger Reserve is fighting with problems related to shrinking territory. Very recently, the central government has asked all the state forest departments of the country to establish eco-sensitive zones/buffer areas around national parks and wildlife sanctuaries in a 10 km radius. This scheme was lying unattended for the past nine years due to pressures created by local people, miners and hoteliers since; there are a number of mines and hotels running in many of these areas. In addition, the Government of Rajasthan has decided to conserve Sariska Tiger Reserve by developing a 10-km-long ring road in Thanagazi area around the reserve for vehicular traffic which is presently running through Sariska Tiger Reserve and is considered a great disturbance for the wildlife. Plans to develop eco-corridors between Ranthambhore and Kailadevi WLS and Sariska Tiger Reserve to Kunho–Palanpur of Shivpuri district of Madhya Pradesh are being acted upon to get rid of the frequent territorial fights among tigers. In addition, places of pilgrimage and historical importance in and around the reserve are also being constructed. This scheme, apart from the Sariska Tiger Reserve will include Ajabgarh–Bhangarh, Taal–vriksha and Garhi Mamund, Virat Nagar, Parashar and Jahaaj, Bhrathari, Pandupol and Neelkanth Mahadev. Please see Chaps. 1, 2, and 3 from *Faunal Heritage of Rajasthan: Ecology and General Background of Vertebrates*, Vol. 1; B. K. Sharma et al. (eds.), 2013, springer Pub. and Chaps. 1, 8, 18 and 19 from this volume for more details and pictures.

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# Appendices

## Appendix 1: Threatened Animals of Rajasthan

**Table 1a** CITES species of Rajasthan (Valid from 25 September 2012)

| Appendix I | Appendix II | Appendix III |
|---|---|---|
| **CLASS MAMMALIA** | | |
| **Order Artiodactyla** | | |
| **Family Cervidae** | | |
| *Axis porcinus* | | |
| **Family Bovidae** | | |
| | | *Antilope cervicapra* |
| | | *Tetracerus quadricornis* |
| **Family Canidae (Bush dog, Foxes, Wolves)** | | |
| *Canis lupus* | *Cuon alpinus* | *Canis aureus* |
| | | *Vulpes bengalensis* |
| | | *V. vulpes* |
| **Family Felidae (Cats)** | | |
| *Caracal caracal* | *Felis chaus* | |
| *Panthera pardus* | *Felis silvestris* | |
| *Panthera tigris* | | |
| *Prionailurus bengalensis bengalensis* | | |
| *Prionailurus rubiginosus* | | |
| **Family Herpestidae (Mongooses)** | | |
| | | *Herpestes edwardsii* |
| | | *Herpestes smithii* |
| **Family Ursidae (Bears , Pandas)** | | |
| *Melursus ursinus* | | |
| **Family Viveridae** | | |
| | | *Paradoxurus hermaphrodi* |
| | | *Viverricula indica* |

(continued)

B.K. Sharma et al. (eds.), *Faunal Heritage of Rajasthan, India: Conservation and Management of Vertebrates*, DOI 10.1007/978-3-319-01345-9,

**Table 1a** (continued)

| Appendix I | Appendix II | Appendix III |
|---|---|---|
| **Order Cetacea** | | |
| **Family Platanistidae** | | |
| | *Platanista gangetica* | |
| **Order Chiroptera** | | |
| **Family Pteropododae** | | |
| | *Pteropus gigenteus* | |
| **Order Perrisodactyla** | | |
| **Family Equidae** | | |
| *Equus hemionus Khur* | | |
| **Order Pholidata** | | |
| **Family Manidae** | | |
| | *Manis crassicaudata* | |
| **Order Primata** | | |
| **Family Cercopithacidae** | | |
| *Semnopithecus entellus* | *Macaca mulata* | |
| **Order Scadentia** | | |
| **Family Tupaiidae** | | |
| | *Anthana elliotii* | |
| | *Tupaia belangeri* | |
| | *Tupaia nicobarica* | |
| **Class Aves** | | |
| **Order Anseriformes** | | |
| **Family Anatidae (Geese, Ducks, Swans)** | | |
| | *Branta ruficollis* | |
| | *Oxyura leucocephala* | |
| | *Sarkidiornis melanotos* | |
| **Order Ciconiiformes** | | |
| **Family Ciconidae (Storks)** | | |
| | *Ciconia nigra* | |
| **Family Phoenicopteridae (Flamingos)** | | |
| | *Phoenicopterus roseus* | |
| | *Phoeniconaias minor* | |
| **Family Threskiornithidae (Ibises, Spoonbills)** | | |
| | *Platalea leucorodia* | |

(continued)

**Table 1a** (continued)

| Appendix I | Appendix II | Appendix III |
|---|---|---|
| **Order Falconiformes** | | |
| **Family Acciptridae (Hawks, Eagles)** | | |
| *Aquila heliaca* | *Accipiter badius* | |
| *Haliaeetus albicilla* | *Accipiter gentilis* | |
| | *Accipiter nisus* | |
| | *Accipiter virgatus* | |
| | *Aegypius monachus* | |
| | *Aquila clanga* | |
| | *Aquila nipalensis* | |
| | *Aquila pomarina* | |
| | *Aquila rapax* | |
| | *Butastur teesa* | |
| | *Buteo buteo* | |
| | *Buteo hemilasius* | |
| | *Buteo rufinus* | |
| | *Circaetus gallicus* | |
| | *Circus aeruginosus* | |
| | *Circus cyaneus* | |
| | *Circus macrourus* | |
| | *Circus melanoleucos* | |
| | *Circus pygargus* | |
| | *Elanus caeruleus* | |
| | *Gypaetus barbatus* | |
| | *Gyps bengalensis* | |
| | *Gyps fulvus* | |
| | *Gyps himalayensis* | |
| | *Gyps indicus* | |
| | *Gyps tenuirostris* | |
| | *Haliaeetus leucoryphus* | |
| | *Haliastur indus* | |
| | *Hieraaetus fasciatus* | |
| | *Hieraaetus pennatus* | |
| | *Ichthyophaga humilis* | |
| | *Ichthyophaga ichthyaetus* | |
| | *Milvus migrans* | |
| | *Milvus milvus* | |
| | *Neophron percnopterus* | |
| | *Pernis ptilorhynchus* | |
| | *Sarcogyps calvus* | |
| | *Spilornis cheela* | |
| | *Spizaetus cirrhatus* | |
| **Family Falconidae** | | |
| *Falco jugger* | *Falco cherrug* | |
| *Falco peregrinus* | *Falco chicquera* | |
| | *Falco columbarius* | |
| | *Falco naumanni* | |
| | *Falco severus* | |
| | *Falco subbuteo* | |
| | *Falco tinnunculus* | |

(continued)

**Table 1a** (continued)

| Appendix I | Appendix II | Appendix III |
|---|---|---|
| **Family Pendionidae** | | |
| | *Pandion haliaetus* | |
| **Order Galliformes** | | |
| **Family Phasianidae** | | |
| | *Gallus sonneratii* | |
| **Order Gruiformes** | | |
| **Family Gruidae** | | |
| *Leucogeranus* | *Anthropoides virgo* | |
| | *Grus antigone* | |
| | *Grus grus* | |
| **Family Otididae (Bustards)** | | |
| *Ardeotis nigriceps* | | |
| *Chlamydotis macqueenii* | | |
| *Sypheotides indicus* | | |
| **Order Passeriformes** | | |
| **Family Estrillidae** | | |
| | *Amandava formosa* | |
| **Family Pycnonotidae (Bulbul)** | | |
| | *Pycnonotus zeylanicus* | |
| **Pelacaniformes** | | |
| **Pelecanidae (Pelican)** | | |
| *Pelecanus crispus* | | |
| **Order Psittaciformes** | | |
| **Family Psittacidae** | | |
| | *Psittacula cyanocephala* | |
| | *Psittacula eupatria* | |
| **Order Strigniformes** | | |
| **Family Tytonidae (Barn Owl)** | | |
| | *Tyto alba* | |
| **Family Strigidae (Owl)** | | |
| | *Asio flammeus* | |
| | *Athene brama* | |
| | *Bubo bubo* | |
| | *Bubo coromandus* | |
| | *Glaucidium radiatum* | |
| | *Ketupa zeylonensis* | |
| | *Ninox scutulata* | |
| | *Otus bakkamoena* | |
| | *Otus sunia* | |
| | *Strix ocellata* | |

(continued)

**Table 1a** (continued)

| Appendix I | Appendix II | Appendix III |
|---|---|---|
| **CLASS REPTILIA** | | |
| **Order Crocodylia (Alligators, Caimans, Crocodiles)** | | |
| **Family Crocodylidae** | | |
| *Crocodylus palustris* | | |
| **Family Gavialidae** | | |
| *Gavialis gangeticus* | | |
| **Order SAURIA** | | |
| **Family Agamidae (Agamas, Mastigures)** | | |
| | *Uromastyx* hardwikkii | |
| **Family Chamaeleonidae (Chameleons)** | | |
| | *Chamaeleon zeylanicus* | |
| **Family Varanidae** | | |
| *Varanus bengalensis* | | |
| *Varanus griseus* | | |
| **Order SERPENTES (Snakes)** | | |
| **Family Boidiae (Boas)** | | |
| | *Gongylophis conicus* | |
| | *Eryx johnli* | |
| **Family Elapidae** | | |
| | *Bungarus caeruleus* | |
| | *B. sindanus sindanus* | |
| | *Naja naja* | |
| | *Naja oxiana* | |
| **Family Pythonidae (Pythons)** | | |
| *Python molurus molurus* | | |
| **Family Viperidae** | | |
| | | *Daboia russelii* |
| **Family Colubridae** | | |
| | *Ptyas mucosa* | |
| **Testudines Tortoises (land-dwelling) and Turtles (aquatic forms)** | | |
| **Family Geoemydidae (Box turtles, Freshwater turtles)** | | |
| *Pangshura tecta* | *Batagur kachuga* | |
| **Family Testudinidea (Tortoise)** | | |
| | *Geochelone elegans* | |
| **Trionychidae (Softshell turtles, Terrapins)** | | |
| *Aspideretes hurum* | *Chitra indica* | |
| *A. gangeticus* | *Lissemys punctata* | |
| **CLASS AMPHIBIA** | | |
| **Ranidae(Frogs)** | | |
| | *Euphlyctis hexadactylus* | |
| | *Hoplobatrachus tigerinus* | |

Source: www.cites.org/eng/resources/species.html. (Downloaded on Nov 25, 2012)

**Table 1b** Scheduled Fauna of Rajasthan as per Wildlife (Protection) Amendment Act, 2006

| S. No. | Scientific name | Common name |
|---|---|---|
| **Avifauna** | | |
| *Schedule I* | | |
| 1. | *Ardeotis nigriceps* | Great Indian Bustard |
| 2. | *Chlamydotis undulata* | Houbara Bustard |
| 3. | *Sypheotides indica* | Lesser Florican |
| 4. | *Platalea leucorodia* | Eurasian Spoonbill |
| 5. | *Gyps indicus* | Long-billed Vulture |
| 6. | *Gyps bengalensis* | Indian White-backed Vulture |
| 7. | *Pandion haliaetus* | Osprey |
| 8. | *Falco peregrinus* | Peregrine Falcon |
| 9. | *Falco chicquera* | Red-necked Falcon |
| 10. | The whole Accipitridae family | Hawks |
| 11. | *Grus nigricolis* | Black-necked Stork |
| 12. | *Pavo cristatus* | Indian Peafowl |
| 13 | Gyps *tenuirostris* | |
| *Schedule II* | | |
| 1. | *Gallus sonneretii* | Grey Junglefowl |
| *Schedule III* | No Bird | |
| *Schedule IV* | All Birds except those which are in other schedules | |
| *Schedule V* | | |
| 1. | *Corvus splendens* | House Crow |
| **Mammals** | | |
| *Schedule I* | | |
| 1. | *Antelope cervicapra* | Blackbuck |
| 2. | *Tetracerus quadricornis* | Four-horned Antelope |
| 3. | *Gazella bennettii* | Indian Gazelle (Chinkara) |
| 4. | *Equus hemionus khur* | Asiatic Wild Ass |
| 5. | *Panthera tigris* | Bengal Tiger |
| 6. | *Caracal caracal* | Caracal |
| 7. | *Prionailurus rubginosus* | Rusty-spotted Cat |
| 8. | *Prionailurus viverrinus* | Fishing Cat |
| 9. | *Platanista gangetica* | Ganges River Dolphin |
| 10. | *Canis lupas pallipes* | Indian Wolf |
| 11. | *Moschiola meminna* | Mouse Deer |
| 12. | *Panthera pardus* | Panther |
| 13. | *Manis crassicaudata* | Pangolin |
| 14. | *Melursus ursinus* | Sloth Bear |

(continued)

**Table 1b** (continued)

| S. No. | Scientific name | Common name |
|---|---|---|
| *Schedule II* | | |
| 1. | *Macaca mulatta* | Rhesus Monkey |
| 2. | *Semnopithecus entellus* | Hanuman Langur |
| 3. | *Canis aureus* | Jackal |
| 4. | *Vulpes bengalensis* | Indian Fox |
| 5. | *Vulpes vulpes* | Red Fox |
| 6. | *Felis chaus* | Jungle Cat |
| 7. | *Lutragale perspicillata* | Smooth-coated Otter |
| 8. | *Viverricula indica* | Small Indian Civet |
| 9. | *Paradoxurus hermaphroditus* | Common Palm Civet |
| 10. | *Herpestes edwardsii* | Grey Mongoose |
| 11. | *Herpestes smithii* | Ruddy Mongoose |
| 12. | *Petaurista philippensis* | Indian Giant Flying Squirrel |
| *Schedule III* | | |
| 1. | *Cervus unicolor* | Sambar |
| 2. | *Axis axis* | Spotted Deer or Chital |
| 3. | *Boselaphus tragocamelus* | Nilgai |
| 4. | *Sus scrofa* | Wild Boar |
| 5. | *Hyaena hyaena* | Indian Striped Hyaena |
| *Schedule IV* | | |
| 1. | *Lepus nigricollis* | Indian Hare |
| 2. | *Funambulus pinnantii* | Five-striped Palm Squirrel |
| 3. | *Hystrix indica* | Indian Porcupine |
| *Schedule V* | | |
| 1. | – | Rats, Mice |
| 2. | – | Fruit Bats |

Source: http://envfor.nic.in/legis/wildlife/wildlife1.html. Downloaded on Nov 25, 2012

# Appendix 2

**Appendix 2** International, national and state level awards for excellence in the field of environmental sciences/wildlife sciences

| S. No. | International awards | Contribution |
|---|---|---|
| 1. | Birdlife International Awards | To promote the development of future conservation leaders and provide them with the capacity to address the most significant conservation issues of the present time. The CLP focuses on building the skills and capabilities of young professionals by providing project grants, training, mentoring and networking opportunities |
| | a. Future Conservationist Awards | US $12,500 each |
| | b. Conservation Follow-up Awards | Up to US $25,000 each available only to previous CLP Future Conservationist Award winners |
| | c. Conservation Leadership Awards | US $50,000 each available only to previous CLP Follow-up Award winners |
| 2. | Animal Welfare Institute, Washington DC, USA | |
| | a. Clark R. Bavin Wildlife Law Enforcement Award | For distinguished law enforcement in wildlife crime and trafficking |
| | b. Schweitzer Medal | For outstanding achievement in the advancement of animal welfare |
| 3. | Defenders of Wildlife<br>a. Legacy Award<br>b. Spirit of Defenders Award for Public Service<br>c. Spirit of Defenders Award for Science<br>d. Spirit of Defenders Award for Citizen Advocacy | For extraordinary distinguished service towards wildlife conservation |
| 4. | Disney Worldwide Conservation Fund (DWCF) | 1.5 million $ grant to substantial projects |
| 5. | H. Bean Award from the Association of Zoos and Aquariums | Recognizes institutions that contribute to the reproductive success of one or more species and/or subspecies |
| 6. | National Wildlife Achievement Awards (USA) also known as “Connie Awards” | National Wildlife Federation, USA recognizes individuals and organizations that have made outstanding contributions for protecting wildlife through education, advocacy, and on-the-ground conservation |
| 7. | PETA Awards:<br>a. Humanitarian Award<br>b. Nancy Alexendar Award<br>c. Bee Arthur Activist Award | Groundbreaking work for animals and honored activists and celebrities for their dedication to PETA’s animal rights campaigns around the globe |

| | | |
|---|---|---|
| 8. | Smithsonian Fellowship Program | The Research Internship Program of the National Zoo's Conservation and Research Center (CRC) as a unit of the Smithsonian Institution, which competitively awards both graduate and post-graduate fellowships each year |
| 9. | The British Trust for Ornithology's BTO-Hanson Business Bird Challenge Prizes | A celebration of the partnership between business and the environment, recognizing conservation initiatives by company sites throughout the UK. Prizes are awarded in the categories of birds, community and conservation |
| 10. | The Indianapolis Prize sponsored by Elli Lily Co. Foundation and given by Indianapolis Zoo, USA | The biennial, unrestricted $100,000 cash prize is given every other year to an individual who has made significant strides in conservation efforts involving an animal species or multiple animal species. |
| 11. | The International Union for Conservation of Nature (IUCN)-Reuters—COMplus Media Awards by Thomson Reuters Foundation and COMplus | A worldwide competition in environmental journalism to recognize excellence in professional reporting on environmental and sustainable development issues. A cash prize of US$ 5,000 and a travel grant to attend the award function and six regional winners receive certificates and a cash prize of US$ 500 each |
| 12. | The International Wildlife Film Festival (IWFF) Life-time Achievement Awards for Conservation and Media | To individuals from the media and conservation fields for their significant contributions, exemplary service, knowledge, and impact on wildlife filmmaking and wildlife or marine conservation |
| 13. | The Rufford Small Grant Award | A grant of up to £50,000 as innovation awards are given to substantial projects having ground-breaking effects in nature conservation in the developing world |
| 14. | The Wildlife Society (TWS) Awards | |
| | a. Aldo Leopold Memorial Award | For distinguished service to wildlife conservation. It is the highest honor bestowed by the society to encourage and recognize exceptional achievements in the dissemination of conservation knowledge to the public in the categories of writings, media, programs, and related audio-visual works |
| | b. Ethnic and Gender Diversity Award | Honors innovative programs and individuals that promote diversity in employment, academic enrollment, and membership |
| | c. Jim McDonough Award | Recognizes continuous outstanding service to any area of concern to TWS |
| | d. Donald H. Rusch Memorial Award | Recognizes a certified wildlife biologist significantly contributing to the profession as an active TWS member |
| | e. Game Bird Research Scholarship | Assists a graduate student studying upland game bird or waterfowl biology and management |
| | f. TWS Fellow | Recognizes members who have distinguished themselves through exceptional service to the wildlife profession |
| | g. Wildlife Publication Awards | Recognizes excellence in scientific writing (article, monograph, book, and editorship) |

(continued)

**Appendix 2** (continued)

| S. No. | International awards | Contribution |
|---|---|---|
| 15. | United Nations Environment Program (UNEP) Awards | |
| | a. Champions Of The Earth | Recognizes outstanding environmental leaders, whether individuals or organizations, that have exemplified inspiration, vision, innovation, leadership and action for the environment |
| | b. UNEP Sasakawa Prize | Recognizes laureates with a proven record of achievement, as well as the potential to make outstanding contributions to the environment consistent with UNEP's policy and objectives |
| | c. The SEED Award | Recognizes innovation in local, environmentally responsible and sustainable entrepreneurship. The award is a flagship programme of the SEED Initiative, a partnership founded by the United Nations Development Programme (UNDP), UNEP, and the International Union for Conservation of Nature (IUCN) |
| | d. The Green Award Star | Recognize those who have made remarkable efforts to prevent, prepare for, and respond to environmental disasters around the world. It is a joint initiative between UNEP, the UN Office for the coordination of humanitarian affairs and Green Cross International |
| | e. Focus on Your world-UNEP International Photography Award | Recognizes artists who use photographs to reflect the diversity of the planet and its people and aims to showcase participants' talent as well as their concern for our environment |
| 16. | Wildlife Preservation Society of Austaralia (WPSA) Community Wildlife Conservation Awards | A crystal trophy and 2,500 $, given each year to recognize organizations which make a significant contribution to the preservation of Australian wildlife |
| 17. | Wildlife Trust Conservation Award and Wildlife Trust Scientist Award | For pioneering work in the innovative field of conservation medicine while working to understand the links between ecosystems, wildlife and human health |
| 18. | Wildscreen Film Festival Golden Panda Award | Given to the world's best film on wildlife and environment |
| 19. | World Wetlands Network (WWN)Globe Awards: | For the best wetland management practice (supported by the Spanish Fundación Biodiversidad) |
| | a. Green Globe | a. for restored habitats |
| | b. Grey Globe | b. for wetlands in danger |
| | c. Blue Globe | c. for wetland management |

| | | |
|---|---|---|
| 20. | WWF Fellowships | The $200,000 cash award goes to fund graduate fellowships. The awards aims to acknowledge individuals making pioneering and substantial contributions to conservation as well as foster the development of future leaders in conservation. |
| | a. J. Paul Getty Award | For conservation leadership |
| | b. J. Paul Getty Award | For conservation |
| | c. Paul Getty Award | For political conservation leadership |
| **National (Indian) Awards** | | |
| 1. | Rajiv Gandhi Wildlife Conservation Award | Cash prize of 1 lac rupees is given to two wildlife conservationists annually, having the potential to make a major impact on the conservation of wildlife in the country |
| 2. | Shri Kailash Sankhla National Wildlife Fellowship Award | Indian citizens engaged in wildlife management/research are awarded rupees 4,000 per month in addition to rupees 18,000 per annum contingency every alternate year |
| 3. | Small Grant Fellowships by Central Zoo Authority (CZA) | Local need based zoo research projects in the field of *ex-situ* conservation and scientific management of animals are awarded Rs. 2 lacs per year up to a maximum 3 years by this statutory body under the Ministry of Environment and Forests, Government of India |
| 4. | The Indira Gandhi Paryavaran Puraskar (IGPP) | Two cash prizes of rupees 5 lacs each, and under the individual category three prizes of rupees 5 lacs, 3 lacs and 2 lacs each are awarded for overall improvement of the environment |
| 5. | Indira Priyadarshini Vrikshamitra Awards | Pioneering and exemplary work in the field of afforestation and wasteland development is awarded by a cash award of rupees 250,000 |
| 6. | Pitambar Pant National Environment Fellowship Award | Outstanding work done for the environment protection |
| 7. | B.P. Pal National Environment Fellowship Award for Biodiversity | In recognition of significant research and development contributions in the fields of environmental sciences and biodiversity. |
| 8. | National Awards for Excellence in Forestry by Indian Council of Forestry Research and Education (ICFRE) | Four awards are presented under this category carrying a sum of rupees 1 lac for original and outstanding work/research in the fields of forestry education, research and extension |

(continued)

**Appendix 2** (continued)

| S. No. | International awards | Contribution |
|---|---|---|
| 9. | Medini Puraskar Yojana | Four cash awards are presented under this category to Indian authors each year to encourage original works in Hindi on environment and its related subjects such as wildlife, water resources and conservation |
| 10. | Dr. Salim Ali National Wildlife Fellowship Award | The fellowship is awarded for a period of 2 years with a stipend of rupees 4,000 per month, in addition to rupees 18,000 per annum as contingency expenses for research or experimental projects aimed at conserving the wildlife heritage of India |
| 11. | Best Environmental Information System (ENVIS) Centre Award | A cash award of rupees 50,000 is presented along with a certificate every 2 years to collect, collate and disseminate information on the status of the country's environment |
| 12. | Desert Ecology Fellowship of Jodhpur University | A one-time endowment of rupees 6 lacs (a monthly stipend of rupees 3,500 and a contingency grant of rupees 1,000 per month) in recognition of the *Bishnoi* community's contribution to nature conservation and to encourage studies in this field |
| 13. | Amrita Devi Bishnoi Wildlife Protection Award | A cash award of rupees 1 lac is presented to individuals/institutions having shown exemplary courage or having done exemplary work for the protection of wildlife |
| 14. | E.K. Janaki Ammal National Award for Taxonomy of Plants and Animals | For outstanding word in botanical and zoological taxonomy including work done on microorganisms |
| 15. | National Award for Prevention of Pollution | A trophy, a citation and rupees 1 lac each for meeting pollution prevention goals and taking substantial and consistent steps for environmental improvement |
| 16. | Vishisht Vaigyanik Puraskar | To two Group "A" scientists of the Ministry of Environment and Forestry and its associated formations carry a cash prize of rupees 20,000 and is awarded every year |
| 17. | Rajiv Gandhi Environment Award for Clean Technology | For development of the innovative modification of existing, technologies and practices that substantially reduce or prevent environmental pollution. A cash prize of rupees 1 lac is awarded to an industrial unit |
| 18. | National Environmental Sciences Fellow Programme | Is awarded to ten young scientists, with a generous fellowship who are working in the forefront of environmental sciences, engineering and technology providing the opportunity to perform cutting-edge research on critical environmental issues in collaboration with leading institutes and scientists in India and abroad |

| | | |
|---|---|---|
| 19. | Association for Species Conservation In India (ASCI) | Provides an open transparent and on-line forum for inviting proposals and appeals from individuals, action groups, researchers and Protected Area managers seeking financial, material or trained research support for protection and conservation of lesser known sanctuaries or sites of conservation importance |
| 20. | Kumble Wildlife Institute<br>a. The Jumbo Fund Wildlife Awards<br>b. Foot Soldier of Karnataka<br>c. Exemplary Range Forest Officer<br>d. Outstanding Civil Servant<br>e. Wildlife Leadership Award<br>f. Exceptional Applied Conservation Scientist | Various categories of awards are given to individuals for significant wildlife conservation work |
| 21. | a. The Sanctuary-RBS Wildlife Award<br>b. Lifetime Service Award,<br>c Five Wildlife Service Awards<br>d. Green Teacher Award<br>e. Three Young Naturalist Awards<br>f. Wind under the Wings Award<br>g. Three Wildlife Photography Awards | To recognise the best in the field of wildlife conservation and to celebrate the unsung heroes of India who are defending her wildernesses and consequently safeguarding her food and water security. Cash prizes ranging from 150,000 to 25,000 rupees are given |
| 22. | Travel Operators for Tigers (TOFT) Wildlife Tourism Awards<br>The Lodge Naturalist of the year | The first ever awards designed to highlight the very best operators, providers, experts and individuals making a difference in support of the forest and tiger conservation through the use of responsible and sustainable wildlife tourism |
| 23. | Wildlife Protection Society Of India (WPSI)<br>a. Tiger Protection Award<br>b. Award for information that lead to seizure of tiger parts<br>c. Support to prosecution of wildlife court cases | To bring a new focus to the daunting task of tackling India's growing wildlife crisis by providing support and information to government authorities to combat poaching and the escalating illegal wildlife trade particularly of wild tigers and provide support for research projects |
| 24. | Wildlife Trust of India (WTI) | Wild aid of below 150,000 rupees is provided as support to individuals and grass-root organizations, doing small, short and medium term interventions to address urgent or critical conservation needs. The WTI functions through its two divisions, Executive Director's Discretionary Grant (EDDG) and Rapid Action Projects (RAP). It is non-bureaucratic, rapid in implementation and can react to requests, if required, within 24 hrs. |

(continued)

**Appendix 2** (continued)

| S. No. | International awards | Contribution |
|---|---|---|
| 25. | World Wide Fund for Nature, India (WWF-India) | Instituted jointly by WWF-India and the Pacific Asia Travel Association (PATA) |
| | a. WWF-PATA Jeev Mitra Award | Two Awards (Rupees 50,000 and a citation) for each individuals who have made an outstanding and lasting contribution to wildlife conservation in India |
| | b. WWF-PATA Vanyajeev Mitra Sangathan | Rupees 1 lac and a citation to an organization for outstanding and lasting contribution to wildlife conservation in India |
| | c. WWF-PATA Vanyajeev Mitra Samudaya | Rupees 1 lac and a citation is given to a community level institution or group, preferably working in rural areas for outstanding and lasting contribution to wildlife conservation in India |
| Rajasthan State Awards | | |
| 1. | Vriksha Vardhak Puraskar | For plantation /reforestation in mining areas and deteriorating forest areas |
| 2. | Van Prahari Puraskar | For forest conservation and management |
| 3. | Van Vitarak Puraskar | For forest extension |
| 4. | Forest Publication Award | For original book/publication in forestry |
| 5. | Vaniki Pandit Puraskar | For best worker in forest conservation and extension |
| 6. | Amritadevi Memmorial Award scheme<br>a. To Institutions/organizations<br>b. To Individual for forest development and conservation<br>c. To individual for wildlife conservation | To organizations which have developed more than 20 ha of land and individual/organization worked best in forest development and conservation |

# Appendix 3

**Appendix 3** Academic and professional bodies offering undergraduate and postgraduate courses and doctoral/post-doctoral research in ecology, forestry and wildlife science in India

| S. No. | Name of the institution | Courses offered |
|---|---|---|
| 1. | Wildlife Institute of India, Post Box 18, Chandrabani Dehra Dun, Uttarakhand, India | Masters/P.G. Diploma/Certificate Courses in Wildlife Management |
| 2. | Forestry Research Institute, Dehra Dun, Uttrakhand, India | M.Sc. Forestry/Wood Science and Technology/Environment Management<br>Post Masters Diploma:<br>i. Natural Resource Management<br>ii. Non-wood Forest Products<br>P.G. Diploma in Pulp & Paper Technolgy |
| 3. | Indian Institute of Forest Management, Nehru Nagar, Bhopal, Madhya Pradesh, India | PG Diploma in Forestry Management |
| 4. | Birsa Agricultural University, Kanke, Ranchi, Jharkhand, India | B.Sc./M.Sc. Forestry |
| 5. | Centre for Wildlife Studies, Bengaluru, Karnataka, India | M.Sc. Wildlife Biology and Conservation |
| 6. | The Indian Institute of Ecology and Environment, A-15, Paryavaran Complex, Saket-IGNOU Road, New Delhi, India | B. Sc./M.Sc. Ecology and Environment/Disaster Mitigation/ Sustainable Development/Eco Tourism/ Pollution Control |
| 7. | National Centre for Biological Science (NCBS), Gandhi Krishi Vigyan Kendra (GKVK), Bellary Road, Bengaluru, Karnataka, India | M.Sc. Wildlife Biology and Conservation |
| 8. | Aligarh Muslim University, Aligarh, Uttar Pradesh, India | M.Sc. Wildlife Science |
| 9. | Andhra University, Waltair, Vishakhapatnam, Andhra Pradesh, India | Diploma & Certificate Courses in Environment and Wildlife |
| 10. | Anna University, Coimbtore, Tamil Nadu, India | PG Diploma in Environmental Engineering<br>1-Year PG Diploma in Environmental Science |
| 11. | APS University, Rewa, Madhya Pradesh, India | 1-Year P.G. Diploma in Environmental Impact Assessment (PGDEIA)<br>1-Year Diploma in Environmental Science |
| 12. | AVC College, Mayuram, Nagapattinam, Tamil Nadu, India | M.Sc. Wildlife Biology |
| 13. | B.R. Ambedkar University, Agra, Uttar Pradesh, India | M.Sc. Environmental Toxicology |
| 14. | Banaras Hindu University, Varanasi, Uttar Pradesh, India | M. Sc. Environment and Wildlife Science |
| 15. | Bangalore University, Bengaluru, Karnataka, India | M. Sc. Environment Science |
| 16. | Barkatullah Vishwavidyalaya, Hoshangabad Road, Bhopal, Madhya Pradesh, India | 1-Year PG Diploma in Environmental Management<br>1-Year PG Diploma in Environmental Law |
| 17. | Bharathidasan University, Tiruchirapalli, Tamil Nadu, India | PG Diploma in Environmental Science. |

(continued)

**Appendix 3** (continued)

| S. No. | Name of the institution | Courses offered |
|---|---|---|
| 18. | Bharati Vidyapeeth (Deemed University), Lal Bahadur Shastri Marg, Pune, Maharashtra, India | 1-Year Diploma in Environmental Management<br>1-Year Diploma in Environmental Education |
| 19. | Bombay Natural History Society (BNHS), Mumbai, Maharashtra, India | Correspondence Courses:<br>Marine Biodiversity Conservation<br>Awareness Programme in Basic Ornithology,<br>On-line course: Leadership in Biodiversity Conservation |
| 20. | Centre for Environmental Law, New Delhi, India | Diploma in Environmental Law |
| 21. | Centre for Wildlife Studies, Bengaluru, Karnataka, India run by Wildlife Conservation Society of India | M.Sc. Wildlife Biology and Conservation |
| 22. | College of Forestry, Trissure, Kerala, India | M.Sc. Wildlife Studies |
| 23. | Delhi University, Delhi, India | B.Sc./M.Sc. Environmental Science |
| 24. | Dimoria College, Guwahati, Assam, India | B.Sc. Forestry and Wildlife Management (Vocational Course)<br>Diploma & Certificate Courses in Environment and Wildlife Management |
| 25. | Dr. B.R. Ambedkar Open University, Road No.46, Jubilee Hills, Hyderabad, Andhra Pradesh, India | 1-Year PG Diploma in Environmental Studies |
| 26. | Dr. Harisingh Gour Vishwavidyalaya, Gour Nagar, Sagar, Madhya Pradesh, India | 1-Year Diploma in Environmental Geology |
| 27. | H.N.Bahuguna Garhwal University, Uttar Pradesh, India | B.Sc./M.Sc. Forestry |
| 28. | Indira Gandhi National Open University (IGNOU), Maidan Garhi, New Delhi, India | Certificate Course in Environmental Studies |
| 29. | Jamia Millia Islamia, Mohammad Ali Jauhar Marg, Jamia Nagar, New Delhi, India | Diploma course in Environmental Engineering and Environmental Studies |
| 30. | Jawaharlal Nehru University, New Delhi, India | M.Sc. Ecology and Environment |
| 31. | Jiwaji University, Vidya Vihar, Gwalior, Madhya Pradesh, India | 1-Year PG Diploma in Environmental Sciences |
| 32. | Mahatma Gandhi Gramoday Vishwavidyalaya, Satna, Madhya Pradesh, India | 1-Year Diploma in Yoga Environment |
| 33. | Mangalore University, Mangalagangothri, Mangalore, Karnataka, India | 1-Year PG Diploma in Environmental Science |

(continued)

**Appendix 3** (continued)

| S. No. | Name of the institution | Courses offered |
|---|---|---|
| 34. | Manonmaniam Sundaranar University, Abishekapatti, Tirunelvelli, Tamil Nadu, India | PG Diploma in Environmental Ecology and Environmental Laws |
| 35. | MS University, Baroda, Fatheganj, Vadodara, Gujarat, India | 1-Year Diploma in Environment Science |
| 36. | National Institute of Environment, 1/169 Vikas Nagar, Kursi Road, Aliganj, Lucknow, India | Correspondence Courses:<br>2-Year PG Diploma in Environment Management.<br>3-Year PG Diploma in Environmental Consultancy Services |
| 37. | North Orissa University, Baripada, Orissa, India | M.Sc. Wildlife Studies |
| 38. | Purvanchal University, Devkali Jasopur, Saraykhaja, Jaunpur, Uttar Pradesh, India | 1-Year Diploma in Environmental Science |
| 39. | Salim Ali Centre for Ornithology and Natural History, (SACON), Coimbatore, Tamil Nadu, India | Certificate Course in Ornithology and Advanced Research |
| 40. | Salim Ali School of Ecology and Environmental Sciences, Pondicherrry, India | M.Sc. Ecology and Ph.D. programme |
| 41. | School of Planning and Architecture, Indraprastha Estate, New Delhi, India | Ph.D. in Environmental Planning |
| 42. | St. Joseph's College, Bengaluru, Karnataka, India | PG Diploma in Environment Science |
| 43. | The Centre for Environmental Education, Ahmedabad, Gujarat, India | Courses in Environment Education and Field Trainings |
| 44. | University of Lucknow, Badshah Bagh, Lucknow, Uttar Pradesh, India | PG Diploma in Environmental Laws |
| 45. | University of Rajasthan, Jaipur, Rajasthan, India | 1-Year Diploma in Environmental Studies and Environment Engineering |
| 46. | Vasantdada Sugar Institute, Manjari, Tal Haveli, Pune, Maharashtra, India | PG Diploma in Environmental Science |
| 47. | Vikram University, Kothi Road, Ujjain, Madhya Pradesh, India | 1-Year PG Diploma in Environmental Management<br>1-Year PG Diploma in Environmental Biology |

*Note*: All the above-mentioned universities and educational institutes are also involved in multiple research activities including doctoral and post-doctoral programs

# Appendix 4

**Appendix 4** Key organizations from India and abroad working towards animal welfare, ecology, and wildlife biology and conservation

| S. No. | Name of the Organization | Aims and objectives |
|---|---|---|
| 1. | 21st Century Tiger, Petworth Road, Haslemere, Surrey GU27 3BG | It is a wild tiger conservation alliance with the Zoological Society of London. Initially concentrated its funds on projects in India, Sumatra and the Russian Far East but has expanded to include a project in Malaysia and one in Cambodia with the British Government funding |
| 2. | African Conservation Foundation (ACF) | A forum for sharing of information about fellowships, funding opportunities, travel grants, etc. of interest to students and professionals involved in environmental conservation in Africa |
| 3. | Animal Welfare Institute (AWI), Washington DC, USA | AWI has sought to alleviate the suffering inflicted on animals by people. Today, one of their greatest areas of emphasis is cruel animal factories, animals in laboratories including promotion of development of non-animal testing methods and prevention of painful experiments on animals, fight for protection of threatened and endangered species of fauna and flora, to preserve the ban on commercial whaling, to protect all marine life against the proliferation of human-generated ocean noise including active sonar and seismic air guns, minimize the impacts of all human actions detrimental to endangered species, including the destruction of natural forests containing ancient trees, and pollution of the oceans destroying every kind of marine life |
| 4. | Birdlife International, UK | It is a global partnership of conservation organisations that strives to conserve birds, their habitats and global biodiversity, working with people towards sustainability in the use of natural resources. It operates in over one hundred countries and territories worldwide. |
| 5. | Birds of Prey Foundation, USA | It is a nonprofit organization whose mission is to rehabilitate injured and orphaned raptors back into the wild. It is a largest raptor center in the Colorado, admitting over 500 injured and orphaned birds from all over the state each year |
| 6. | Conservation International (CI), USA | It is a non-profit organization in Washington DC, that seeks to protect earth's biodiversity hotspots as well as marine regions around the globe.It works in more than 40 countries, majority being the developing nations. |
| 7. | Defenders of Wildlife, USA | It is a national, nonprofit membership organization dedicated to the protection of all native animals and plants in their natural communities in the USA |

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|---|---|---|
| 8. | Disney Worldwide Conservation Fund (DWCF) | The funding enables nonprofit organizations to provide support for more than 45 species across the globe—from protecting the Critically Endangered Sumatran Rhino in Indonesia, to tracking northern jaguars in the foothills of Mexico, to studying the threats of the endangered Green Sea Turtle. Along with a focus on support for species and habitat conservation science, the DWCF encourages programs that engage local residents and benefit both human and animal communities |
| 9. | Earth Watch Institute, Boston, USA | It is working for today's most pressing environmental emergencies—climate change, declining ocean health, unsustainable resource management, and threatened culture by bringing together an inclusive community of scientists, corporate and non-profit partners, teachers, students, and everyday citizens. |
| 10. | Galapagos Marine Biodiversity Fund (GMBF) and the National Forest Foundation | Established in 2006 by the WWF Galápagos Program in collaboration with Ecoventura, an Ecuadorian-based tour operator which operates in the Galápagos Islands, and Aerogal, an Ecuadorian airline company with an aim to contribute to the conservation of the Archipelago by supporting projects related to marine conservation and education. |
| 11. | Global Environment Facility (GEF)UNDP Small Grants Program of CEE | Seeks to support initiatives which demonstrate community-based innovative, gender sensitive, participatory approaches and lessons learned from other development projects that lead to reduce threats to the local and global environment. The GEF SGP was launched in 1991by United Nations Development Program (UNDP) to assist developing countries in fulfilling their commitment towards the protection of the global environment. GEF UNDP SGP is currently working in 114 countries world-wide. The program was started in India from the year 1996–1997 |
| 12. | International Foundation for the Conservation of Natural Resources (IFCNR) | Established in 1995 in the Commonwealth of Virginia, describes itself as a independent NGO that represents a broad range of individuals, academic institutions, corporations, associations, industries, cultures, NGOs and government agencies bound together by the desire to promote responsible, sustainable, environmentally compatible, and socially just use and conservation of the earth's natural resources. |
| 13. | International Rhino Foundation | It is dedicated to the survival of the world's rhino species through conservation and research and provides technical and financial resources. It promotes the involvement of local communities in the conservation of rhinos and creates enduring (self-sustaining) rhino conservation programs through "facilitative" and "catalytic" approaches |

(continued)

**Appendix 4** (continued)

| S. No. | Name of the Organization | Aims and objectives |
|---|---|---|
| 14. | National Wildlife Federation (NWF), USA | It is working to protect the ecosystems that are most critical to native wildlife. NWF works to improve federal and state policies that will improve wildlife conservation on hundreds of millions of acres of public, tribal and private lands, including thousands of miles of streams, rivers, lakes and coastlines across America. The organization encourages Congress to pass legislation that includes adequate funding for natural resources and directs federal agencies to include climate science in their wildlife conservation management plans |
| 15. | Nature Conservancy, Arlington, VA, USA | It is the leading conservation organization working around the world to protect ecologically important lands and waters for nature and people |
| 16. | Rufford Foundation, UK | The Rufford Foundation is an independent grant-making trust. It supports nature conservation projects in developing countries undertaken by small to medium-sized organisations. The foundation no longer supports nature conservation projects in the UK. In addition there is a very limited amount of funding directed towards social welfare issues in the UK and overseas development |
| 17. | Smithsonian Institute, USA | It is an educational and research institute and associated museum complex, administered and funded by the Government of the United States and by funds from its endowment, contributions, and profits from its retail operations, concessions, licensing activities and magazines. While most of its 19 museums, zoos, and nine research centers facilities are located in Washington, D.C., others are also based at New York City, Virginia, Panama, and elsewhere. The Smithsonian Institution is the largest museum complex in the world |
| 18. | Society for Prevention of Cruelty to Animals (SPCA) International, New York, USA | SPCA International strives to assist the growth and impact of independent shelters through alliance building, information networking and national and international programs. Outreach programs that help thousands of animals, resulting in a drastic reduction of animal suffering and abuse throughout this country and the world SPCA. It provides financial support at the local level by awarding four to six emergency grants every month to selected animal welfare organizations which makes a big difference to struggling shelters, both in the USA and worldwide, and help to improve physical conditions, enhance spay and neuter programs and ultimately reduce euthanasia rates |

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|---|---|---|
| 19. | The Association of Zoos and Aquariums (AZA) | AZA is concerned about species survival and ecosystem health. An abundance of educational information, planning tools, databases, funding sources, awards, reintroduction programs, and specialized conservation projects have been created to advance animal conservation initiatives and strategies. AZA-accredited zoos and aquariums serve as conservation centers that are concerned about ecosystem health, take responsibility for species survival, contribute to research, conservation, and education, and provide society the opportunity to develop personal connections with the animals in their care |
| 20. | The British Trust for Ornithology's BTO-Hanson | The British Trust for Ornithology has existed since 1933 as an independent, scientific research trust, investigating the populations, movements and ecology of wild birds in the British Isles, specially the design and implementation of volunteer wild bird surveys |
| 21. | The Hoedspruit Endangered Species Centre, USA | It focuses on the conservation of rare, vulnerable or endangered animals and is actively involved in the breeding of endangered, vulnerable or rare animal species; the education of learners, students and the general public. Cheetah conservation is one of the core disciplines along with an establishment of captive-bred cheetahs back into the wild; the treatment and rehabilitation of wild animals that are brought to the centre |
| 22. | The International Union for Conservation of Nature (IUCN), Geneva, Switzerland | Helps the world find pragmatic solutions to the most pressing environment and development challenges and supports scientific research, manages field projects all over the world, and brings governments, United Nations agencies, companies and local communities together to develop and implement policy, laws and best practice. IUCN is the world's oldest and largest global environmental network—a democratic membership union with more than 1,000 government and NGO member organizations, and almost 11,000 volunteer scientists in more than 160 countries |
| 23. | The Wildlife Society (TWSI), Bethedsa, Maryland | It is an international non-profit scientific and educational association dedicated to excellence in wildlife stewardship through science and education in North America by advancing the science of wildlife management, promoting continuing education of wildlife professionals, and advocating for sound, science-based wildlife policy. The organization also encourages professional growth through certification, peer-reviewed publications, conferences, and working groups |

(continued)

**Appendix 4** (continued)

| S. No. | Name of the Organization | Aims and objectives |
|---|---|---|
| 24. | TRAFFIC—The Wildlife Trade Monitoring Network | It works to ensure that trade in wild plants and animals is not a threat to the conservation of nature. TRAFFIC is governed by the TRAFFIC Committee, a steering group composed of members of TRAFFIC's partner organizations, WWF and IUCN |
| 25. | United Nations Environment Program (UNEP) | To provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and people to improve their quality of life without compromising on future generations |
| 26. | Wetland International, Netherlands | Wetland International is a global organization that works to sustain and restore wetlands and their resources for people and biodiversity. It has 20 regional, national or project offices |
| 27. | Wildlife Preservation Society of Austaralia (WPSA) | It works to encourage the protection of, and to cultivate interest in, the Australian flora and fauna. The WPSA publishes a quarterly magazine Australian Wildlife and operates a 24/7 telephone wildlife answering service for members |
| 28. | Wildlife Trust | It is recognized as a worldwide authority in conservation and environment, having many scientific breakthroughs, including discovering the origin of the SARS virus. The organization has received prestigious Whitley awards often called the "Green Oscars" for the groundbreaking work by its scientific teams. Wildlife Trust was named "Best Wildlife Charity" by Reader's Digest in 2005 and has received the highest rating from Charity Navigator, an independent charity evaluator |
| 29. | Zoological Society of London (ZSL) | ZSL runs conservation programmes in Britain and across the world. The conservation of wild animals and their natural habitats with the help of local communities is fundamental to its mission. It also works with major natural resource industries assisting in biodiversity monitoring and advising on best practices |

Government Organizations in India

| | | |
|---|---|---|
| 1. | The Ministry of Environment & Forests (MoEF), Government of India | MoEF is the nodal agency in the administrative structure of the central government for the planning, promotion, co-ordination and overseeing the implementation of India's environmental and forestry policies and programmes related to conservation of the country's natural resources including its lakes and rivers, biodiversity, forests and wildlife, ensuring the welfare of animals, and the prevention and abatement of pollution. It also serves as the nodal agency for the United Nations Environment Programme (UNEP), South Asia Co-operative Environment Programme (SACEP), International Centre for Integrated Mountain Development (ICIMOD) and for the follow-up of the United Nations Conference on Environment and Development (UNCED). The Ministry is also entrusted with issues relating to multilateral bodies such as the Commission on Sustainable Development (CSD), Global Environment Facility (GEF) and of regional bodies like Economic and Social Council for Asia and Pacific (ESCAP) and South Asian Association for Regional Co-operation (SAARC) on matters pertaining to the environment. Wildlife Division in the ministry is responsible to provide financial and technical assistance to the state government for scientific management of the wildlife resources |
| 2. | The Zoological Survey of India (ZSI), Kolkata, West Bengal | It is the only taxonomic organization in the country involved in the study of all kinds of animals from Protozoa to Mammalia, occurring in all possible habitats from deepest depth of the ocean to the peaks of Himalaya |
| 3. | Society for Prevention of Cruelty to Animals (SPCA), New Delhi | Society for Prevention of Cruelty to Animals was established in every state via the notification of the Government of India under Prevention of Cruelty to Animals Rules, 2000, sub-section (1) of section 38 of the Prevention of Cruelty to Animals Act, 1960 (59 of 1960), under the Ministry of Social Justice and Empowerment to look into the related matters |
| 4. | Tiger Task Force | It was established after the infamous Sariska debacle on the Prime Minister's concern. It organized four consultancies, two in Delhi, for issues related to poaching and conservation and methodology of counting tigers, one in Nagpur where tribal and NGOs work together, and one in Bangalore for science and research |

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**Appendix 4** (continued)

| S. No. | Name of the Organization | Aims and objectives |
|---|---|---|
| 5. | The Animal Welfare Board of India (AWBI) | The first of its kind to be established by any government in the world AWBI was set up in 1962, in accordance with Section 4 of the Prevention of Cruelty to Animals Acts 1960 (No. 59 of 1960) to keep the law in force in India for the prevention of cruelty to animals under constant study and to advise the government on the amendments to be undertaken in any such law from time to time. |
| 6. | Indian Board for Wildlife (IBWL) or National Board of Wildlife | The IBWL is the apex advisory body under Section 5-A of the Wildlife (Protection) Act, 1972, set up by the central government to cater to the field of wildlife conservation in the country and is headed by the Prime Minister of India. Some resolutions adopted by the board include wildlife and forests shall be declared priority sectors, law enforcement for poaching, illicit trade in wildlife and wildlife products, destruction of the habitat, and such other illegal activities, tapping the potential in sustainable wildlife tourism and use of the revenue earned |
| 7. | The Wildlife Crime Control Bureau | It has been constituted through amendment of the Wildlife (Protection) Act, 1972 in 2008. The powers and function of the bureau have been defined under Section 38z of the Act |
| 8. | National Tiger Conservation Authority (NTCA) | It is a statutory authority with legal backing to ensure tiger conservation. On the basis of the recommendations of National Wildlife Board chaired by Prime Minister, a task force was set up to look into the matters of tiger conservation along with funding to tiger reserves in the country. Considering the urgency, Project Tiger has been converted into National Tiger Conservation Authority (NTCA) by making provision in the Wildlife Protection Act 1972, through an amendment in the year 2006 |
| 9. | Central Zoo Authority (CZA), India (Statutory Body under the Ministry of Environment and Forests, Govt. of India) | The CZA provides central assistance to various zoos to achieve prescribed standards for better upkeep and health facilities to zoo animals. One of the important achievement has been the creation of 5 rescue facilities in designated zoos namely at Vendalur (Tamil Nadu), Banerghatta (Karnataka), Visakhapattnam, Tirupati in Andhra Pradesh and Nahargarh in Rajasthan. An important project on creation of laboratory for conservation of endangered species in collaboration with Centre for Cellular and Molecular Biology (CCMB), Department of Biotechnology, Government of India and Andhra Pradesh state government has also been initiated with the objective of developing ex-situ gene bank of wild fauna |

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|---|---|---|
| 10. | The National Biodiversity Authority | Established by the Government of India to regulate, conserve and encourage sustainable use of bio-resources of India through the Biological Diversity Act, 2002. It records the biodiversity conservation efforts in the country to mark the International Day for Biological Diversity and informs the Convention on Biological Diversity (CBD) |
| 11. | Indian Council of Forestry Research and Education (ICFRE), Dehra Dun, Uttrakhand, India | Constituted by the Ministry of Environment and Forests, Government of India, to formulate, organize, direct and manage forestry research; transfer developed technologies to states and other agencies; and impart forestry education. The council has 8 Research Institutes and 4 Advanced Centres in different parts of the country to cater to the research needs of different bio-geographical regions |
| 12. | Environmental Information System (ENVIS) Centre | The focus of ENVIS since its inception has been on providing environmental information to decision makers, policy planners, scientists and engineers, research workers, etc. all over the country. A large number of nodes, known as ENVIS Centers, have been established in the network to cover the broad subject areas of environment with a focal point in the Ministry of Environment & Forests. ENVIS due to its comprehensive network has been designed as the National Focal Point (NFP) for INFOTERRA, a global environmental information network of the UNEP. In order to strengthen the information activities of the NFP, ENVIS was designated as the Regional Service Centre (RSC) of INFOTERRA under UNEP in 1985 for the South Asia Sub-Region countries |
| 13. | Centre for Environmental Education (CEE) | It aims to create environmental awareness in the communities, conduct widespread environmental education and training programmes through a very vast network |
| Non-Government Organizations | | |
| 1. | Association for Species Conservation in India (ASCI) | The organization is dedicated to generating resources from the Indian community, and professionals working overseas to assist specific protected areas under threat through direct financial and material help, innovative schemes to involve local-people and applied research to address urgent management and conservation issues |
| 2. | Bombay Natural History Society (BNHS), Mumbai, India | Aims to disseminate knowledge of flora and fauna by means of lectures, field-trips, literature and expeditions and, to study wildlife related problems and recommend management plans to conserve wildlife and its habitat. It conducts field research projects on bird migration and studies on the movement and population structure of Indian avifauna |

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**Appendix 4** (continued)

| S. No. | Name of the Organization | Aims and objectives |
|---|---|---|
| 3. | Centre for Science and Environment (CSE), New Delhi | Involved in research, investigative and educational work in the field of pollution, forest, wildlife, land and water use. *Down to Earth*—a fortnightly environment magazine; Children's magazine *The Gobar Times*; books; reports; computer database; audio visuals, etc. produced by the CSE impart knowledge about environment |
| 4. | Centre for Wildlife Studies (CWS), Bengaluru | It is a non-profitable charitable trust and the chief implementation partner for research, conservation and capacity-building projects supported in India by the Wildlife Conservation Society, New York. CWS is recognized as a scientific and industrial research organization by the Ministry of Science and Technology, Government of India |
| 5. | CPR Environmental Education Centre or C. P. Ramaswami Aiyar Foundation | Promotes environmental awareness to produce and disseminate basic educational and reference material on environment and to take up environmental projects. It works in the field of environmental education |
| 6. | Dasholi Gram Swarajya Mandal, Gopeshwar, Chamoli Dist, Uttar Pradesh | It aims to encourage forest conservation and the use of forest products for self employment. The world famous "Chipko Movement" under the leadership of Mr. Sunderlal Bahuguna was spear-headed by this organization. It gives a great deal of importance to forest conservation in the Himalayas |
| 7. | Friendicoes, Society for the Eradication of Cruelty to Animals, New Delhi | Rescue, feed and medicate all injured, abused and ownerless animals and promote adoption programmes for them. Humane education programmes for schools and slum areas, sterilization of stray dogs; running mobile clinics in slum areas are some other significant objectives of the society |
| 8. | Gandhi Peace Foundation-Environment Cell, New Delhi | It was set up mainly to promote the environmental activities of rural development agencies, to disseminate environmental information through publication of up-to-date reports on environmental issues, to organize workshops and seminars for environmental experts, policy-makers, individuals and organisations working towards the environment |
| 9. | Global Tiger Petrol (GTP) | GTP provides equipment such as binoculars, jeeps, high-speed patrol boats, jungle equipment and training to co-operate in local projects for reforestation, water conservation, alternative agriculture and energy technologies that save fragile habitat. GTP has worked closely with the Ranthambhore Foundation around the Ranthambhore National Park in Rajasthan, in Karnataka with the Institute of Climbers and Nature Lovers working in and around the Sundarbans Tiger Reserve and with villages in and around Sariska National Park |

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| 10. | Indian Association for Environmental Management (IAEM), Nagpur, Maharashtra | It aims at educating people on environment to encourage conservation and spread environment related knowledge |
| 11. | "Jumbo Wildlife" Fund | The Anil Kumbhle Foundation-Jumbo Fund works for elephant conservation programmes |
| 12. | Kalpavriksh, New Delhi | It is a citizens action group set up to inculcate understanding and concern on environmental issues, especially among the youth. It also aims to conduct research in environmental problems, to campaign on environmental issues and to evolve a holistic environmental perspective. It imparts environmental education in schools and colleges by forming a network of nature clubs, conducting bird-watching expeditions and nature trails and has also developed workbooks for school level students |
| 13. | "Narmada Bachao Andolan" (Save Narmada Movement) Dhule, Maharashtra | Under the leadership of Ms. Medha Patkar, it aims mainly to protest against the construction of dams in the Narmada Valley in general; struggling towards right to information and a new environmentally sustainable water policy. It helps the tribal get a substantial share of the government's development schemes/services and to enable them to undertake development activities. The activists undertake surveys of the affected villages and protest against land and forest issues and government interference in this regard |
| 14. | The Wildlife Research and Conservation Trust (WRCT), Nilambur | It is a non-profit public charitable trust. with a mission to conserve flora and fauna in the Indian subcontinent through field research and conservation actions |
| 15. | Travel Operators for Tigers (TOFT) | This is a campaign originally set up by a number of concerned Indian focused travel operators in the UK but its membership is on the rise from across the globe and India who believe in sustainable wildlife tourism leading to conservation of tigers through collective action and adherence to responsible guidelines and Codes of Conduct |
| 16.. | Wildlife Conservation Society (WCS) | It saves wildlife and lands through careful science, international conservation, education and management of the world's largest system of urban wildlife parks |
| 17.. | Wildlife Trust of India (WTI) | It is one of the non-profit key organization committed to conserve nature, especially endangered species and threatened habitats, in partnership with communities and government. The principal concerns of WTI include crisis management and provision of quick, efficient aid to individuals, species or habitats that require it the most |

(continued)

**Appendix 4** (continued)

| S. No. | Name of the Organization | Aims and objectives |
|---|---|---|
| Government Organizations in Rajasthan | | |
| 1. | Department of Forests, Government of Rajasthan, Jaipur, Rajasthan | This state department works for the conservation of its unique heritage, rich cultural and ethnical traditions of conservation of floral and faunal diversity and gene pool reserves through a network of protected areas along with conservation of rare and endangered species of flora and fauna by undertaking in-situ and ex-situ conservation measures and establishing linkages with the natural habitats of the species for their rehabilitation |
| 2. | The Rajasthan State Pollution Control Board, Jaipur, Rajasthan | It is a body corporate constituted under section 4 of the Water and Air (Prevention and Control of Pollution) Act, 1974 entrusted with the responsibilities of prevention, control and abatement of air and water pollution. Water Cess Act, 1977 has been enacted to make the State Board financially independent |
| 3. | The Environmental Information System (ENVIS) Centre, Rajasthan (RAJENVIS) | ENVIS Centre at Rajasthan State Pollution Control Board, Jaipur has been established under the ENVIS—project of the Ministry of Environmental and Forest, Government of India to facilitate generation and dissemination of information on various facets of the environment of Rajasthan |
| 4. | Centre for Environment Education (CEE), Rajasthan | CEE in Jaipur and Jodhpur were created in recognition of the importance of environmental education in India's overall environment and development strategy. The result of a unique partnership between government and a non-governmental institution, CEE was established as a Centre of Excellence in 1984, supported by MoEF. National Environment Education Programme for Schools (NEEPS), Environment orientation through School Education (EOSE), Small Grants Programme (SGP), National Green Corps (NGC) are some of the major programmes undertaken by the centre |
| 5. | Desert Regional Centre (DRC), Zoological Survey of India (ZSI), Jodhpur, Rajasthan | A Regional Centre of the ZSI, at Jodhpur was established in June, 1960 under the then Second Five Year Plan to survey the faunal diversity of Desert Biome |
| 6. | Central Arid Zone Research Institute (CAZRI),Jodhpur, Rajasthan | To arrest the desertification process and for scientific and sustainable management of the resources, Desert Afforestation Station was established at Jodhpur which was finally upgraded to CAZRI under Indian Council of Agricultural Research (ICAR), New Delhi. The CAZRI operates through headquarter at Jodhpur and branches in seven divisions for the respective agro-climatic zone to work on location-specific problems |
| 7. | Desert Medicine Research Centre (DMRC), Jodhpur, Rajasthan | It is one of the permanent institutes of Indian Council of Medical Research (ICMR), the apex autonomous body in biomedical research under the Ministry of Health and Family welfare, Government of India. This centre is particularly working on hematophagous insects and related diseases |

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|---|---|---|
| 8. | Rescue Centre at Nahargarh Biological Park, Jaipur, Rajasthan, India | One of the 5 Rescue Centres in the country established by on the Central Zoo Authority (CZA) of India after the Indian Government passed a law to ban on the use of certain animals like lion, tiger, panther, bear and monkey for entertainment purpose specially in circus. Its not a tourist spot or a zoo and visitors are not allowed |
| 9. | State Biodiversity Board | Formed under Biological Diversity Act, 2002, a committees of five ex officio members appointed by the state government which in consultation with the local bodies concerned and by order, prohibit or restrict detrimental activity against conservation and sustainable use of biodiversity. |
| 10. | The State Wildlife Advisory Board | It is a statutory body formed under Wildlife (protection) Act, 1972 under the chairmanship of the Chief Minister while the Forest Minister is the Vice-Chairperson. The board must meet twice yearly to advise the state government on wildlife conservation matters |
| Non-Government Organizations (NGOs) in Rajasthan | | |
| 1. | Godawan Society, Jodhpur | Works mainly for the conservation of bustards especially, the Great Indian Bustard |
| 2. | Hadouti Naturalists Society, Kota | Works in the Hadoti region of Rajasthan towards biodiversity conservation issues |
| 3 | Nature Club of Rajasthan, Jaipur | Works towards biodiversity conservation and creating awareness in youngsters and locals, popularization of conservation programs and environment education |
| 4. | Rajasthan Environment Preservation Society, Jaipur | Works towards pollution control, afforestation, ecological and environmental preservation. It promotes social forestry and plantation, cleaning of ponds, lakes and reservoirs. It also imparts environmental education and awareness, provide consultancy and encourage the use of renewable sources of energy |
| 5. | Revolutionary Action Conservation Society for Helping Animals (RAKSHA), Jaipur | It is a youth based activist group working for animal rights and welfare by protecting all animals from abuse such as beating, ill-treatment, captivity, and over-loading and against all kinds of cruelty. The main projects are 24 h Snake Helpline, adoption of stray dogs, raids on charmers, circuses, caged birds and amicable human–animal conflict solution. |
| 6. | Siddhartha Singh Natural History Trust, Jaipur | Founded by late Mr. Shantanu Kumar, a wildlifer and the then Director-General of Rajasthan Police, it provides support towards wildlife conservation. It has a huge library with hundreds of rare books, monographs and pictures |

# Appendix 5

**Appendix 5** Major international conventions for global biodiversity conservation and protection of wildlife and natural resources

| | | |
|---|---|---|
| 1. | The Convention on Biological Diversity (CBD) | Signed by 150 government leaders at the 1992 Rio Earth Summit, the Convention on Biological Diversity is dedicated to promoting sustainable development. Conceived as a practical tool for translating the principles of Agenda 21 into reality. The convention recognizes that, biological diversity is related more with people and their need for food security, medicines, fresh air and water, shelter and a clean and healthy environment, than plants, animals and microorganisms and their ecosystems. The CBD which now has 193 member parties, entered into force on 29 December, 1993 |
| 2. | The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) | It is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival and to safeguard certain species from over-exploitation. Today, it accords varying degrees of protection to more than 30,000 species of animals and plants, whether they are traded as live specimens, fur coats or dried herbs |
| 3. | United Nations Convention to Combat Desertification (UNCCD) | In 1977, the United Nations Conference on Desertification (UNCOD) adopted a Plan of Action to Combat Desertification (PACD). The United Nations Environment Programme (UNEP) concluded in 1991 that the problem of land degradation in arid, semi-arid and dry sub-humid areas had intensified, although there were "local examples of success". As a result, the question of how to tackle desertification was still a major concern at the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro in 1992. The Conference supported a new, integrated approach to the problem, emphasizing action to promote sustainable development at the community level. It also called on the United Nations General Assembly to establish an Intergovernmental Negotiating Committee to prepare, by June 1994, a Convention to Combat Desertification, particularly in Africa. In December 1992, the General Assembly agreed and adopted resolution 47/188 |
| 4. | Convention on Migratory Species (CMS) | The Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or Bonn Convention) aims to conserve terrestrial, marine and avian migratory species throughout their range. It is an intergovernmental treaty, concluded under the UNEP, concerned with the conservation of wildlife and habitats on a global scale. Since the Convention's entry into force, its membership has grown steadily to include 114 (as of 1 October 2010) Parties from Africa, Central and South America, Asia, Europe and Oceania. As the only global convention specializing in the conservation of migratory species, their habitats and migration routes, CMS complements and co-operates with a number of other international organizations, NGOs and partners in the media as well as in the corporate sector |

| | | |
|---|---|---|
| 5. | The Convention on Wetlands of International Importance or The Ramsar Convention | The Ramsar Convention is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources amongst the member countries. The Ramsar Convention is the only global environmental treaty that deals with a particular ecosystem, and the Convention's member countries cover all geographic regions of the planet. The Convention uses a broad definition of the types of wetlands covered in its mission, including lakes and rivers, swamps and marshes, wet grasslands and peat lands, oases, estuaries, deltas and tidal flats, near-shore marine areas, mangroves and coral reefs, and human-made sites such as fish ponds, rice paddies, reservoirs, and salt pans |
| 6. | The Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) | It came into force in 1982, as part of the Antarctic Treaty System, in pursuance of the provisions of Article IX of the treaty. It was established mainly in response to concerns that an increase in krill catches in the Southern Ocean could have a serious effect on their population and other marine life, particularly on birds, seals and fish, which mainly depend on krill for food. A "precautionary" approach has been implemented to minimise risk associated with unsustainable practices in conditions of uncertainty. This approach is complemented by the need to take into account ecological links between species and "natural" variability as opposed to "human-induced" variability or the "ecosystem approach". Conservation measures adopted by CCAMLR are based on scientific advice and require enforcement to be effective |
| 7. | The Convention Concerning the Protection of the World's Cultural and Natural Heritage | The World Heritage Convention is a successful global instrument for the protection of cultural and natural heritage. It was adopted by the United Nations Educational, Scientific and Cultural Organization (UNESCO) General Conference at its 17th session in Paris on 16 November 1972. In August 1974, Australia became one of the first countries to ratify the Convention. It aims to promote cooperation among nations to protect heritage around the world that is of such outstanding universal value that its conservation is important for current and future generations. It is intended that, unlike the seven wonders of the ancient world, properties on the World Heritage List will be conserved for all time. The Convention came into force in 1975 |

# Appendix 6

**Appendix 6** Database information systems on biodiversity conservation and management

- Amphibian Species of the World http://www.research.amnh.org/herpetology/amphibia/
- Biodiversity Action Network (BIONET) http://www.bionet-us.org
- Biodiversity and Biological Collections http://www.biodiversity.uconn.edu/BRC.html
- Biodiversity Conservation Information System (BCIS) http://www.bcis.ch/
- Biodiversity Support Program (BSP) www.bcnet.org/links.htm
- Biodiversity-World Resources Institute http://www.wri.org/
- Biological Resources Research Center (BRRC) www.brc.a-star.edu.sg/
- Biology Abstracts and Zoological Records (BIOSIS) http://www.york.biosis.org/
- BIOSIS: Publisher of Biological Abstracts and Zoological Record http://www.biosis.org/
- Birds of Prey Foundation www.birds-of-prey.org/
- Centre for Conservation Biology Network (CCBN) www.allacronyms.com/CCBN/Center_for_Conservation_Biology_Network/
- Centre for Marine Conservation http://www.cmc-ocean.org/
- Eco-Directory (EcoDir) http://www.rec.hu/
- Ecological Monitoring and Assessment Network (EMAN) http://www.cciw.ca/
- Envirolink's Endangered Species Act On-Line Resource Guide http://www.envirolink.org/
- ETI-Expert Center for Taxonomic Identification, Amsterdam http://wwweti.eti.bio.uva.nl/
- Expert Centre for Taxonomic Identification www.eti.uva.nl/
- FAOSTAT Forestry Statistics Database at FAO faostat.fao.org/site/630/default.aspx
- GEF Global Environment Facility www.thegef.org/
- Global Change Data and Information System (GCDIS) www.globalchange.gov.
- Global Land Cover Data for Biodiversity Analysis http://www.conservation.org/
- Global Observation of Forest Cover (GOFC) www.fao.org/gtos/gofc-gold/
- Global Terrestrial Observing System (GTOS) http://www.fao.org/
- GRID The Global Resource Information Database UNEP http://www.unep.org/
- Integrated Conservation Networking System (ICONS) http://www.iucn.org/
- International Centre for Antarctic Information and Research www.allacronyms.com/.../International_Centre_for_Antarctic_Information
- IUCN Flamingo Specialist Group. *Flamingo*, Bulletin of the IUCNSSC www.wetlands.org/.../NetworkofspecialistsFlamingoSpecialistGroup/Flamingo Bulletin/issue...
- IUCN Red List of Threatened Animals www.iucnredlist.org/
- Mammal Species of the World: Smithsonian Institute http://nmnhgoph.si.edu/
- Man and Biosphere Species Database http://ice.ucdavis.edu/
- Man and the Biosphere http://www.unesco.org/
- Woods Hole Research Centre http://www.whrc.org/
- MUSE Fish Databases www.mcz.harvard.edu/Departments/Ichthyology/researchcoll.html
- Natural History Museums and Collections (World wide) www.lib.washington.edu/Sla/natmus.html
- System-Wide Information Network for Genetic Resources data.gbif.org/datasets/resource/1430
- Taxonomic Database Working Group http://plants.usda.gov./
- The Biodiversity Forum (Bio-Forum) http://www.worldcorp.com/
- The Interagency Taxonomic Information System (ITIS) www.itis.gov/
- The Internet Biodiversity Service www.biologie.uni-hamburg.de/b-online/ibc99/iopaleo/default.htm

(continued)

**Appendix 6** (continued)

- The Nature Conservancy http://www.tnc.org/
- The Virtual Library of Ecology and Biodiversity (VLEB) http://conbio.rice.edu/
- The World Species List (WSL) worldwildlife.org/species/directory?sort=extinction_status&direction...
- TREE BASE: A Database of Phylogenetic knowledge www.treebase.org/
- United Nations List of National Parks and Protected Areas www.unep-wcmc.org
- United State Global Change Research Program http://www.usgcrp.gov./
- Virus databases on-line www.antiviralintelistrat.com/1/abbreviations
- WCMC Protected Areas Virtual Library (PAVL) http://www.wcmc.org.uk/
- Wildlife Crime Database http://www.wpsi-india.org/wpsi/index.php
- World Bank Monitoring Environmental Progress Database www.ciesin.org/lqi-is/guides/mep.html
- World Conservation Monitoring Centre (WCMC) http://www.wcmc.org.uk/
- World Data Center On Micro-organisms www.wdcm.org/
- World Information and Early Warning System on Plant Genetic Resources (WIEWS) apps3.fao.org/wiews/
- World Map: Measuring the Variety of Nature http://www.nhm.ac.uk/
- World Pollen Database www.ncdc.noaa.gov/paleo/gpd.html
- World Resources Institute (WRI) http://www.wri.org/
- World Weeds Database www.issg.org/database/reference/index.asp
- World Wetlands Network (WWN) worldwetnet.org

# Glossary

**Bhagavata Puran** The great epic focused on *Bhakti* (religious devotion) to the incarnations of Lord Vishnu particularly Lord Krishna. Lord Vishnu is the protector or the preserver God as per Hindu mythology

**Bharatvarsha** An older Hindi name for India

**Bherudeo** The small deity who protects the Goddess Durga as per Hindu mythology.

**Bittern** Concentrated salty water left in the salt pans following crystallization of sodium chloride

**Brahma** The Creator God as per Hindu mythology

**Brine** Salty water

**Chabutara** The open platform at the front of a house of olden times generally meant for feeding birds or social gatherings

**Danda** A wooden stick

**Darbar** A king's administrative office

**Dev bani** God's grove

**Dev van or banis** Patches of forests devoted to the God or a deity

**Dussehra** A major Indian festival which marks the victory of good over evil and is celebrated by burning the effigies of Ravana, the demon king of Sri Lanka and his brothers. Lord Rama fought with the Ravana who had abducted his wife. The famous epic *Ramayana* based on the life of Lord Rama aptly describes the fight

**Gauchar** A wasteland near the village used for cattle grazing

**Ghara** An earthen pot for securing drinking water

**Ghee** Clarified butter made of cow or buffalo milk

**Gramsabha** Village assembly

**J&K** Jammu and Kashmir

**Jag** The world

**Jagirdar** The owner of a large estate or landlord

**Jheel** A natural or man-made water reservoir or lake

**Johads** Traditional check dams

**Kakar banis** Forests marking the boundary between two villages often sanctified by religious belief

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**Keoladeo** Another name of "Lord Shiva"—the destructor God as per Hindu mythology
**Khus** *Vetiveria zizanoides*
**Kraunch** Sarus Crane
**Kulhadi bandh panchayat** Local rule banning cutting of green trees and the use of axes
**Kuraj Sanrakshan Vikas Sansthan** Demioselle Crane Conservation Development Institute
**Kyar** A salt pan
**Loksabha** The lower house of Indian Parliament
**Mandir** A temple
**Mawa** Boiled and condensed milk used for making traditional Indian sweet dishes
**Murraam** A layer beneath the sand which does not let the surface water go underground
**Orans** Sacred pastures or sparse woodlands protecting faunal and floral species of the region
**Parvat** A hill
**Pathar** The rocky area
**Rajput** The warrior clan from Rajasthan
**Reshta Salt** The fine salt deposited at the edges of salt pans due to wind action
**Rishi** The spiritual teacher who taught vedas to princes in traditional schools
**Sansad** Parliament
**Shamlat** The joint Government of Jaipur and Jodhpur which owned Sambhar Salt Lake during the Mughal Period
**Shikarbadis** Private hunting reserves of the erstwhile kings
**Shukracharya** Royal priest of the demon king as per Hindu mythology
**Uparmal** A high tableland
**Vidis** Grasslands near villages
**Visual Encounter Survey (VES)** A survey conducted by observers walking through a designated area for a prescribed time, visually searching in a systematic way while noting down the animals encountered along with the time elapsed
**Vrikshmitra** A friend of trees

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# Index




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# The Book and Its Audience

This is the first ever scientific documentation of the faunal wealth of the Indian desert state—Rajasthan, covering the species diversity, distribution, and conservation status. A scholarly contribution to the field of knowledge, this monumental work provides novel and vital information on the vertebrate faunal heritage of India's largest state.

Broadly falling under the Indo-Malaya Ecozone, the three major biomes of Rajasthan include deserts and xeric shrublands; tropical and sub-tropical dry broadleaf forests; and tropical and sub-tropical moist broadleaf forests. The ecoregions thus covered are North Western thorn scrub forests and the Thar Desert; Khathiar-Gir dry deciduous forests and the Upper Gangetic Plains moist deciduous forests, respectively.

Contrary to popular belief, the well-known Thar or Great Indian Desert occupies only a part of the state. In fact, for the convenience of study, Rajasthan can be seen as diagonally divided by Aravalli mountain ranges into arid and semiarid regions. The latter has a spectacular variety of highly diversified and unique yet fragile ecosystems comprising lush green fields, marshes, grasslands, rocky patches and hilly terrains, dense forests, the southern plateau, freshwater wetlands, and salt lakes.

Apart from the floral richness, the faunal abundance from fishes to mammals including the flagship and threatened species namely tiger, leopard, great Indian bustard and lesser florican, White-naped Tit, raptors, Demoiselle and Sarus Crane, chelones, bats, wild ungulates, small cats, bear, wolf, Smooth-coated Indian Otter, Spiny-tailed Lizard, Gaint Flying Squirrel, Gharial and Gangetic River Dolphin described in more than 20 chapters penned by top-notch wildlife experts, research scholars, and academics, makes this volume more palatable and wholesome.

Chapters covering fossil records; conservation of biodiversity via the age-old public science of the desert; anthropological account of communities and tribes; Sociocultural, mythological, and historical aspects of faunal conservation and the fauna in retrospect (covered in *Faunal Heritage of Rajasthan: General Background and Ecology of Vertebrates*, Volume-1, B.K. Sharma et al. (eds.), Springer, 2013); wildlife trade; ecotourism; climate and other environmental factors like Indira Gandhi Nahar Pariyojna (IGNP) believed to have changed the ecological face of western Rajasthan; protected area network; tiger reintroduction experiment; and

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community conservation are key attractions. The world famous heronry, tiger reserves, wildlife sanctuaries and some threat-ridden biodiversity rich areas shall certainly draw the attention of readers from around the world.

The last chapter highlighting issues and insights on conservation and management, initiatives, and gaps in research would help researchers from India and abroad to identify potential areas of future collaborative work. The strategies suggested herein can be a powerful tool for international conservational advocacy.

The elaborate content supported by rare photographs and paintings has implications for faunal ecology in similar habitats elsewhere on the Earth. Through this mammoth volume, editors have dearly embraced the state of Rajasthan as a whole with particular emphasis on the vertebrate faunal diversity and key aspects of its conservation management.

The original manuscript initially conceived and titled as *Faunal Heritage of Rajasthan, India: Ecology and Conservation of Vertebrates* was a bit too large to be presented as a single volume and so the same was split into two separate books/volumes entitled *Faunal Heritage of Rajasthan, India: General Background and Ecology of Vertebrates*, Volume-1 and *Faunal Heritage of Rajasthan, India: Conservation and Management of Vertebrates*, Volume-2. It is strongly advised that the two books are read and consulted in conjunction with one another rather a set of two closely related books to have an overall picture of the vertebrate faunal abundance of Rajasthan and its conservation management.

## Type of Work

Text and Reference Book

## Audience/Written For

Teachers; researchers; amateur and advanced students of zoology, environmental science, wildlife and conservation biology, animal behavior, wildlife organizations; freelancers, nature lovers; wildlife photographers, policy-makers; and citizens in general.

## Key words

Indian Desert State; Rajasthan; Faunal Heritage; Tiger Reserve; Arid Ecosystem; Bishnoi Community; UNESCO-World Heritage Site; Aravalli Hills; Faunal Conservation in Rajasthan; History of Faunal Conservation in Rajasthan; Hunting Tribes of Rajasthan; Tiger Reintroduction Program; Great Indian Bustard; *Panthera tigris*; Sambhar Lake; Protected Area; Community Conservation; Chambal Riverine System; Gharial; Legal Framework; Keoladeo National Park; Ecotourism; Nature Reverence.

# About the Editors

**Dr. B.K. Sharma (Chief Editor)** is Associate Professor and Head, Department of Zoology at R.L. Saharia Government P.G. College, Kaladera (Jaipur), Rajasthan, India. Dr. Sharma is a recipient of coveted national and international fellowships, awards and recognitions namely, Doctoral and Post-doctoral research fellowships of the Indian Council of Medical Research (ICMR), Council of Scientific and Industrial Research (CSIR) and Department of Science and Technology (DST), Government of India at Maulana Azad Medical College, New Delhi; Commonwealth Academic Staff Fellowship at University College London (UCL), UK; Visiting Fellowship under Indian National Science Academy (INSA) and German Research Foundation's (DFG) Bilateral Exchange Programme at University of Heidelberg, Germany; Royal Society's Incoming Fellowship at University of Nottingham, UK; Visiting Scientist under DST's Indo-Slovenian Joint Scientific and Technological Cooperation Programme (2011–2014); Country Advisor for India under "Development Partnerships in Higher Education (DelPHE) Programme" of the British Council, UK and Humane Education Award-2009 by the International Network for Humane Education (InterNICHE, UK) and Proefdiervrij—the Dutch Society for Replacement of Animal Testing. During 2010–2011, he was invited as a key member of the "Core Expert Committee to Consider Discontinuation of Dissection of Animals in Zoology/Life Science in Indian Universities and Colleges". The committee was constituted by the Ministry of Human Resource Development (MHRD), Government of India and the University Grants Commission (UGC)—apex body governing the Indian higher education system. A member of several national and international academic, scientific and professional bodies including the Indian Science Congress Association, American Association for Advancement of Science (AAAS) and International Union for Conservation of

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