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THE U.S. FISH AND WILDLIFE SERVICE – BNHS PARTNERSHIP FOR WILDLIFE RESEARCH AND CONSERVATION IN INDIA

Bombay Natural History Society

Editorial

The United States Fish and Wildlife Service (USFWS) has been one of the major funding agencies for wildlife related projects in India since the 1980s. Of the more than 30 major projects sanctioned in India till date under this scheme, some of which are on-going, the Bombay Natural History Society (BNHS) has been one of the main beneficiaries.

The role that the USFWS played in the wildlife research and conservation scene in India has been considerable in terms of personnel trained, species and ecosystems studied, and the awareness and conservation measures that resulted from the popular and scientific publications of these studies. A total of 27 researchers of the BNHS obtained their doctoral degrees while working in USFWS funded projects, many of whom now hold top positions in wildlife related institutes in India.

In this issue, we provide an insight into the USFWS and the role it played in India, and especially on the projects that it funded to the BNHS, along with the lists of scientific publications of these projects.

The Society is grateful to Mr. David Ferguson, presently SFC Coordinator, Division of International Conservation, U.S. Fish & Wildlife Service, for the out of the way help rendered to the Society and its biologists over the years, both in official and personal capacities. He also took an active part in helping our ENVIS Centre to prepare this document.

INTRODUCTION

The United States Fish and Wildlife Service's (USFWS) origins date back to 1871, when the United States Government established the U.S. Fish Commission to study the decrease of the nation's food fishes and to recommend ways to reverse the decline. Meanwhile, in 1885, the Government created an Office of Economic Ornithology in the Department of Agriculture. The Office studied the food habits and migratory patterns of birds, especially those that had an effect on agriculture. This office gradually grew in responsibilities and went through several name changes until it was finally renamed the Bureau of Biological Survey in 1905. In addition to studying birds and mammals, the Survey's responsibilities included managing the nation's first wildlife refuges, controlling predators, enforcing wildlife laws, and conserving dwindling populations of migratory birds. The Bureaus of Fisheries and Biological Survey were transferred to the Department of the Interior in 1939, and in 1940, they were combined and named the Fish and Wildlife Service. After further developments, and reorganisation in 1956, the Service was renamed the United States Fish and Wildlife Service.

For many years, the USFWS was the principal federal wildlife and fisheries research agency. In the 1940s, the Service's research biologists conducted some of the first investigations into the effects of the pesticide DDT on wildlife. The Service researchers also revealed the life cycle of the parasite that causes whirling disease in trout. In addition, their biologists developed many of the captive breeding techniques that have benefited such rare species as the Whooping Crane, California Condor and the Black-footed Ferret. In 1993, the Service's research activities, which were conducted at 14 research stations and their satellite offices around the country, were transferred to a new Interior Department bureau called the National Biological Survey. The Service's research function briefly became an independent agency and was eventually reorganized as part of the U.S. Geological Survey in 1996.

Today, the USFWS is the only U.S. federal agency whose primary mission is fish and wildlife conservation. It is unique among federal land managing agencies because it not only manages over 38 million hectares of its own land, but also has broad responsibilities for conserving fish and birdlife off its own lands. With three basic objectives: (1) to assist in the development and application of an environmental stewardship ethic for the U.S. society, based on ecological principles, scientific knowledge and a sense of moral responsibility; (2) to guide the conservation, development, and management of the Nation's fish and wildlife resources; and (3) to administer a national program to provide the public opportunities to understand, appreciate, and wisely use fish and wildlife resources. The Service strives to fulfill its mission to conserve, protect and enhance fish and wildlife and their habitats for the continuing benefit of the American people. To help carry out this mission, which involves migratory birds, endangered species, certain marine mammals, and freshwater and anadromous fish, it employs approximately 7,900 full-time employees at facilities across the country, including the headquarters in Washington D.C., seven regional offices, and nearly 700 field units and installations.

International Programmes

The USFWS has been formally involved in international wildlife matters since 1900 with passage of the Lacey Act. The Act regulated trade and commerce in foreign birds and animals by making import of illegally taken wildlife an offence under U.S. law, thus assisting other nations in protecting their own wildlife resources. The next action involving the Service internationally came about because many bird species fly thousands of kilometers on their annual migrations and cannot be effectively conserved by any single state or nation. Starting in 1916 with a treaty between the U.S. and Great Britain for Canada, and subsequently through similar treaties with Mexico, Japan and the former Soviet Union, the Service was given the lead responsibility for international migratory bird conservation. Additional international responsibilities were added over the years under more than 40 treaties, statutes, and agreements. Perhaps the broadest and most powerful single piece of legislation is the Endangered Species Act of 1973 which gave the Service the authority it needed to become a fully effective international conservation force, to work cooperatively with other countries on wildlife research and management programs and respond to requests for technical assistance.

The USFWS's major international conservation programs have been coordinated since 1976 by a small International Affairs Staff, which evolved to the Office of International Affairs, and was subsequently renamed the 'Division of International Conservation' in August 2000. The overall goal of these programs is to help cooperating countries develop their conservation capabilities, in order to meet their own environmental goals, needs and responsibilities on a sustainable basis. As part of this effort, the Service provides conservation education and technical training to local communities in the Caribbean, Latin America, Africa and Asia. In addition, it manages the grants established under the Multinational Species Conservation Fund for rhinoceros, elephants, tigers, great apes, and neotropical birds. It seeks to stem the global loss of wetlands, and establish guidelines for wise use of wetlands through an international wetlands convention.

In India, starting in the late 1970's, the USFWS linked with the Government of India in a joint program of wildlife conservation that started with a few modest efforts and blossomed into a strong collaborative relationship that is on-going to this day. Over the past two decades, besides a number of short-term activities and one-year grants under the Multinational Species Conservation Fund programme, the Service has provided support to over 30 research conservation projects identified by the Govt. of India as high priority issues. Accessing U.S.-owned Indian rupees, the Service has provided nearly Rs.26.4 crores (Rs.264 million) funds in financial support to these projects coupled with an additional $2 million for outside advisors, equipment, and U.S. training. All of these projects have been designed to address relevant conservation issues, collect basic biological data, provide options for management, and strengthen institutional capacity. Numerous institutions and organizations in India benefited from these programmes. The BNHS (16 projects) was one

of the first institutions recommended by the Govt. of India for cooperative activities because of their strong reputation and capabilities in the study of India's natural systems and wildlife species. Other institutes were the Wildlife Institute of India, Dehra Dun (7 projects), Center For Environmental Education, Ahmedabad (1 project), Center For Wildlife Studies, Mysore (3 projects), Centre For Wildlife Studies, Aligarh Muslim University, Aligarh (1 project), The Nilgiris Wildlife and Environment Association, Udagamandalam (1 project), Jainarayan Vyas University, Jodhpur (1 project), Punjab University, Chandigarh (1 project), and the Institute For Restoration of Natural Environment, Nagercoil (1 project).

Many Indian wildlife biologists were 'born' as a result of the USFWS projects, some of them now play a crucial role in the wildlife research and conservation scenario in India. Likewise, the infrastructure of some institutes grew through the funding and the training the staff received while working on the research projects. This would be especially true for the BNHS, and its off-shoot, the Salim Ali Centre for Ornithology and Natural History (SACON). In this issue of *Buceros*, we provide an insight into the projects that were funded to the BNHS by the USFWS, and give a list of the scientific publications that resulted from them.

For more information on the U.S. Fish and Wildlife Service, visit their website: <www.fws.gov>

PRESENT POSITIONS OF BIOLOGISTS WHO WORKED IN THE BNHS-USFWS RESEARCH PROJECTS

Note: Only biologists who served more than a year find place in the list

Name	Institution	Post/Designation
A.J.T. Johnsingh	Wildlife Institute of India, Dehra Dun.	Faculty
Ajay Desai	-	Wildlife Consultant
Asad R. Rahmani	BNHS	Director
Ashok Verma	BNHS	Finalising doctoral thesis
B. Rammanohar	Government School, Tamil Nadu	Teacher
Bharat Bhushan	Yeshwantrao Chavan Academy of Development Administration	Associate Professor
C. Chakrapani	University of Agricultural Sciences, Bangalore	Scientist
C. Nanjappa	Vehicle Research and Development Establishement, Ahmednagar	-
C. Sivasubramanian	Government College, Tamil Nadu	Lecturer
C.R. Ajithkumar	-	Scientist
C.R. Biju	Cochin University, Kerala	Senior Research Fellow
Deen Dayal Mittal	Forest Department (on contract)	Guide
Eric D'Cunha	Indian Adventurers, Kanha	Senior Naturalist
G. Uma	Environmental Information System Centre – Environmental Protection Training and Research Institute, Hyderabad	Project Coordinator
Gargi Rana	BNHS	Finalising doctoral thesis
Godfred Ponraj	PREPARE, Chennai	Manager
Goutam Narayan	Pigmy Hog Conservation Programme, Basistha	In-Charge
H.S.A. Yahya	Centre for Wildlife Sciences, Aligarh Muslim University, Aligarh	Chairman
Hemant Datye	-	Shares Business
J.K. Tiwari	Seawater Farms, Eritrea	Ecologist
Jugal Kishore Gajja	Forest Department, Rajasthan	Forest Range Officer

Name	Institution	Post/Designation
K. Raju Thomas	Panangad Fisheries College	Senior Research Fellow
K. Sampath	Government School, Tamil Nadu	Teacher
K. Shankar	Wildlife Institute of India, Dehra Dun	Faculty
K. Venkataraman	Zoological Survey of India, Chennai	Scientist-SG
K.K. Mohapatra	TERI, New Delhi	Programme Officer
Lalitha Vijayan	Salim Ali Centre for Ornithology and Natural History, Coimbatore	Principal Scientist
Lima Rosalind	Centre for Environment Education	Programme Officer
M. John George	Mar Thoma College for Women, Perumbavoor	Lecturer
Md. Nayerul Haque	-	Computer software engineer
N. Baskaran	Indian Institute of Science, Bangalore	Project Officer
N.R. Nadarajan	-	-
N. Ramesh	-	-
N. Sivaganesan	Salim Ali Centre for Ornithology and Natural History, Coimbatore	Scientist
N.K. Ramachandran	-	Teacher (Maldives)
Niketa Prakash	BNHS	Doctoral Student
Oomen Varkey	-	Business
P. Balasubramanian	Salim Ali Centre for Ornithology and Natural History, Coimbatore	Scientist
P.A. Azeez	Salim Ali Centre for Ornithology and Natural History, Coimbatore	Principal Scientist
Prakash Rao	WWF-India	Senior Programme Officer
R. Pandian	Government College, Tamil Nadu	Lecturer
R. Sugathan	-	Wildlife Consultant
Ramesh Kumar	Panchayat Union, Sembanarkoil	Chairman
Ranjit Manakadan	Bombay Natural History Society	Senior Scientist
Ravi Sankaran	Salim Ali Centre for Ornithology and Natural History, Coimbatore	Scientist
Rishad Naoroji	Godrej Group of Companies	Director
S. Alagarrajan	Private School	Teacher
S. Balachandran	BNHS	Senior Scientist
S. Bhupathy	Salim Ali Centre for Ornithology and Natural History, Coimbatore	Scientist

Name	Institution	Post/Designation
S. Muralidharan	Salim Ali Centre for Ornithology and Natural History, Coimbatore	Scientist
S. Swaminathan	BNHS	Senior Research Fellow
S.A. Hussain	Biodiversity Initiative Trust, Mangalore	Trustee
S.P. Maremuthu	-	-
Salim Javed	Aligarh Muslim University, Aligarh	Lecturer
Satish Kumar	Aligarh Muslim University, Aligarh	Lecturer
Syed Asad Akhtar	BNHS	EIA Scientist
T. Sundaramoorthy	C.P.R. Environmental Education Centre, Chennai	Education Officer
U. Sridharan	Ministry of Environment and Forest, Eastern Regional Office, Pondicherry	Joint Director
Usha Ganguli-Lachungpa	Forest Department, Sikkim	Scientific Officer
V. Krishnamurthy	-	Wildlife Consultant
V. Natarajan	Government School, Tamil Nadu	Teacher
V.C. Ambedkar	BNHS	Retired
V.P. Prasad	Botanical Survey of India	Botanist
V.S. Vijayan	Salim Ali Centre for Ornithology and Natural History, Coimbatore	Director
V.T. Sridharan	Government College, Tamil Nadu	Lecturer
Vibhu Prakash	BNHS	Principal Scientist
Y. Nageswara Rao	-	Computer Software Engineer

STUDIES ON THE MOVEMENT AND POPULATION STRUCTURE OF INDIAN AVIFAUNA (1980-1986)

The project titled *Studies on the Movement and Population Structure of Indian Avifauna*, popularly called the *Avifauna Project*, was the first U.S. Fish and Wildlife Service funded project of the BNHS. The rich avifaunal communities of the Indian subcontinent and their migratory patterns and habits had been systematically studied since the late 1950s and some sense about the status of various species and populations as well as the importance of various habitats was becoming apparent. As a leader in the field of avifaunal migration studies, the BNHS launched this five-year project to obtain additional baseline data and further investigate migration routes, stop-over locations, and important factors affecting the migratory phenomenon; to train a number of multidisciplinary biologists who would form the core of an experienced team for future work; and to establish a network of banding (ringing) stations in important locations throughout the Subcontinent to aid in monitoring bird movements into and from India to their breeding grounds in the Palaearctic region.

Year-round banding/ringing and research efforts were established at sites representing two major habitats which had been identified previously as being of vital importance to migrants from and to their breeding grounds and in their dispersal within India: Keoladeo, Bharatpur, a well-known bird sanctuary in the Gangetic Plain of north-central India and Point Calimere Sanctuary along the south-eastern Tamil Nadu coast, representing a forested, estuarine, salt-water profile. The initial avian population studies at the two sites provided an opportunity to compare two ecosystems freshwater and marine – and generated subsequent long-term ecological research studies by the BNHS on each area under separate project names and objectives.

In addition to the two major field stations, three seasonal and six short-term ringing stations were operated under the project at Harike Lake, Punjab; Chilka Lake, Orissa; Dihaila Jheel, Madhya Pradesh; Shivalik Hills, Punjab; Shimla Hills, Himachal Pradesh; Marine National Park, Gujarat; Kodaikanal Hills, Tamil Nadu; Western Ghats in Goa, Karnataka, Kerala and Tamil Nadu, and Kabar Tal, Bihar. Collaborations were extended to several state governments, overseas research groups, local amateur conservation groups, by way of supplying bird rings, training facilities, and environmental education outreach activities. Many of these field stations continued, or still continue, to be monitored under various other projects of the Society after the project came to a close.

The original project was for five years and was then extended for an additional two years (1979-1986). During the period this project was in operation, over 100,000 birds of 300 species, both migrant and resident, were ringed and data on many ecological parameters collected. As a result of the studies and recommendations, a reliable monitoring system of avian species and estimation of waterfowl migration was established and several major bird sites

were identified and afforded protection. The Point Calimere and Bharatpur field stations also served as the training grounds for many of the Society's biologists in wildlife studies, some of whom still serve the Society in various capacities.

The scientific staff and publications of the project were as follows:

Principal Investigator
Salim Ali

Co-Investigators
J.C. Daniel &
A.N.D. Nanavati

Project Scientist
S.A. Hussain

Biologists

R. Sugathan	D. Ambrose#	S. Asad Akhtar
Asad R. Rahmani#	Ajay Saxena#	S. Balachandran
H.S.A. Yahya#	Ranjit Manakadan#	R. Pandian
P.K. Gupta#	Vibhu Prakash	S. Alagarrajan
S. Subramanya#	V.C. Ambedkar	P. Balasubramanian
K. Krishna Kumar#	Eric D'Cunha#	V. Natarajan
Asrarul Haque#	Sushant Chowdary#	S. Faizi#
V.T. Sridharan#	G. Gopa Kumar	G. Agoramoorthy#
K.K. Mohapatra	T. Maya Muthu#	Santhana Krishnan#
O.V. Oomen Varkey	S.P. Maremuthu	M. Ayyadurai#

U.S. Advisers/Consultants
George Jonkel (Wildlife Biologist) USFWS

served for a short period.

The publications listed below also include the papers that were the outcome of two other related projects that followed the *Avifauna Project*, i.e., the *Bird Migration* and *Bird Banding Training* projects.

Theses

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* Balachandran, S. (1990). Studies on the coastal birds of Mandapam and neighboring islands (Peninsular India). Ph. D. Thesis. Annamalai University, Chidambaram.

* Rao, P. (1998). The bird communities of the tropical dry evergreen forests of Sriharikota. Ph.D Thesis. University of Bombay, Mumbai.

Scientific Papers

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* Balachandran, S., Mohapatra, K.K. & S.A. Hussain (1995). Moult in three species of bulbuls in Eastern Ghats. *J. Bombay nat. Hist. Soc.* 92 (2): 151-159.

* Balachandran, S. & V. Natarajan (1997). Biometrics, moult, age structure and subspecies of Broadbilled Sandpiper *Limicola falcinellus* wintering at Great Vedaranyam Swamp in south-east India. *Stilt* 31: 23-25.

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Miscellaneous Notes

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* Akhtar, S.A. & J.K. Tiwari (1993). Food piracy by a White Stork *Ciconia ciconia. J. Bombay nat. Hist. Soc.* 90(1): 90-91.

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* Balachandran, S. (1988). Some observations on unusual feeding behaviour of Whitebreasted Waterhen (*Amaurornis phoenicurus*). *J. Bombay nat. Hist. Soc.* 85(3): 615-616.

* Balachandran, S. (1990). Bird records from Mandapam and neighboring islands, Tamil Nadu. *J. Bombay nat. Hist. Soc.* 87 (3): 456-457.

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* Balachandran, S. (1995). Comments on "The Occurrence of Black Tern *Chlidonias niger* at Point Calimere by Vivek Menon". *J. Bombay nat. Hist. Soc.* 91(3): 453-454.

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* Balachandran, S. & V. Natarajan (1992). Possible occurrence of four subspecies of Lesser Sand Plover *Charadrius mongolus* at Point Calimere Wildlife Sanctuary, Tamil Nadu. *J. Bombay nat. Hist. Soc.* 89(1): 118-119.

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* Balachandran, S. & L. Rosalind (1992). Occurrence of the Southern Ashy Wren Warbler *Prinia socialis* at the Point Calimere Wildlife Sanctuary. *J. Bombay nat. Hist. Soc*. 89(3): 377.

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BIRD MIGRATION PROJECT (1986-1991)

With the BNHS having collected a large volume of data on bird migration and with ringing operations having been conducted between 1967 to 1972 and then from 1980 onwards at selected sites in India, the need was felt that not only should the data from the previous years' work including the most recent 6 years under the BNHS project titled *Studies on the Movement and Population Structure of Indian Avifauna* be collated and analyzed, but that the on-going research should be expanded to a wider network and cooperation increased with other organizations. Thus, the 5-year project titled *The Study of the Migration Pattern of Indian Birds and Avifauna Migration Study Data Bank*, better known as the *Bird Migration Project*, was launched.

Under this project, bird ringing was continued at the permanent field station established at Point Calimere Wildlife Sanctuary, Tamil Nadu with subsidiary field stations for ringing established at various locations to cover the major ecological regimes of the Subcontinent. These included stations at Mandapam, Tamil Nadu; Pulicat Bird Sanctuary and Sriharikota Island, Andhra Pradesh; Kaliveli Lake, Tamil Nadu; Kachchh, Gujarat; Harike Lake, Punjab; Chilka Lake, Orissa; Kabartal, Bihar; Madhav National Park, Madhya Pradesh; Dihaila Jheel and Karera Bustard Sanctuary, Madhya Pradesh; Dachigam National Park, Jammu & Kashmir; Tirupati Hills (Eastern Ghats), Andhra Pradesh; Kodaikanal and Palni Hills, Tamil Nadu; Khijadia Bird Sanctuary, Jamnagar, Gujarat; and Shivaliks, Punjab. Apart from these above stations, bird ringing was also carried out in different parts of the Western Ghats, Shimla in the western Himalayas, and at Nandur-Madhmeshwar near Nasik in Maharashtra.

Over 1,92,041 birds belonging to 565 species were ringed during the project period. Substantial data on species composition, distribution, dispersal as well as migratory movements of the region's avifauna was gathered. Recoveries of the ringed birds indicated long distance migration patterns as well as trends in migration strategies of individual species. Disturbances and threats to major bird habitats were identified and recommendations made for mitigating measures for the same to the appropriate authorities. Many bird ringing demonstrations and training programmes were held for schools, research organizations, naturalists, and Forest Department personnel. Efforts were made to expand cooperative activities with Russia under an existing migratory bird treaty including sharing of ringing data and to promote complementary bird ringing programmes in neighboring countries such as Sri Lanka.

The large data base from the earlier ringing efforts (over 3,00,000 birds ringed) as well as the data collected during this project had largely been registered on hand-written data sheets. Editing and programming for computer storage and retrieval in preparation for analysis required an enormous, time-consuming and on-going effort that extended beyond the life of this project.

Though not included as an objective of this project, it became obvious during the project's implementation that not only was there a need for more trained bird ringers but standards and rules for the collection and management of migratory bird movement information were imperative. Using established bird ringing systems and manuals from North America and Europe as guides, BNHS began efforts to create an Indian Bird Ringing Manual and standardized bird ringing system.

The scientific staff of the project were as follows:

Principal Investigators
S.A. Hussain & J.C. Daniel

Scientists

S. Balachandran
Vibhu Prakash
Prakash Rao
V.C. Ambedkar
K.K. Mohapatra
Lima Rosalind
Bharat Bhushan#
S. Asad Akhtar
J.K. Tiwari
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U.S. Adviser/Consultant
George Jonkel (Wildlife Biologist) USFWS

Served for a short period.

BIRD BANDING TRAINING PROJECT (1997-2001)

Marking birds with numbered, metal leg bands for future identification, has long been a technique used by wildlife managers and researchers. Such techniques have been found useful in determining routes, departure and arrival times, distances traveled, pauses for food and rest, weather influences, rates of travel, and many other details of birds during migration. But because in most species, less than 1% of banded birds are recovered, there is a need to band large numbers in order to get a substantial recovery. During the BNHS *Avifauna* and *Bird Migration* projects in the 1980's, it became evident that with the limited number of paid staff that could be supported in these projects, the number of birds banded each year (approximately 25,000 per year) would not provide sufficient feedback for using the data in a meaningful way. Since other countries such as the United Kingdom and the United States are able to conduct large banding programs of a million birds per year with the assistance of organized networks of volunteer groups and individuals, the Society set out to develop a similar network of volunteers who could help in banding a larger number of birds.

At the end of the *Bird Migration* project in 1992, the Society prepared a 3-year follow-on proposal that would continue the bird migration studies and establish and train a network of personnel in bird banding and survey techniques. However, the proposal did not receive official approval until 1997 and after some further delay, the project started in 1998. Five main field training centres were established at Parambikulam Wildlife Sanctuary, Western Ghats, Kerala (forest birds), Sri Venkateswara National Park, Tirupati, Eastern Ghats, Andhra Pradesh (forest birds), Pulicat Bird Sanctuary, Andhra Pradesh (waterbirds), Point Calimere Wildlife Sanctuary, Tamil Nadu (waterbirds), Nandur-Madhmeshwar Waterbird Sanctuary, Nashik, Maharashtra (forest and water birds), and Chediatappu, Rutland, Mount Harriyut, Alexandra Island, South Andaman (forest and water birds). Training programmes of 10-days duration each were held at the various locations throughout the duration of the Project.

The project is due to end in March 2002, with approximately 180 personnel having received training to date. These include students, forest department personnel, college teachers, and a variety of interested personnel from bird watching or natural history organizations.

The scientific staff of the project were as follows:

Principal Investigator
J.C. Daniel

Scientist
S. Balachandran

U.S. Advisor/Consultant
James Siegel (Wildlife Biologist) USFWS*

* Denotes partial participation

Note: The publications of the *Bird Migration* and *Bird Banding* projects have been merged with those of the *Avifauna Project* as they are more or less extensions of the first project.

KEOLADEO NATIONAL PARK ECOLOGY STUDY (1980-1990)

The Keoladeo National Park (KNP), Bharatpur, Rajasthan, formerly known as the Keoladeo or Bharatpur Ghana Bird Sanctuary, is one of the most important man-enhanced waterfowl refuges in the world. It is especially known for the wintering population of the Siberian crane (*Grus leucogeranus),* which unfortunately has declined drastically over the years. KNP is perhaps the most studied of all wildlife sanctuaries in India as a result of a decade-long (1980-1990) BNHS effort. Recognizing the unique importance of this area and the need for scientific management to maintain optimal conditions for the rich variety of flora and fauna, especially birdlife, a five year project was initiated. At first, the focus was to establish a hydrobiological research station within the sanctuary from which studies could be made on the ecology of the flora and fauna, the impact of cattle grazing, removal of trees and other human perturbations, as well as to study specific interrelationships between various organisms and their environment. When a suitable site within the sanctuary could not be found, temporary research facilities were established outside and emphasis shifted to the collection of field data. This process succeeded in providing a wealth of basic biological data on various aspects of the wetland system's dynamics, and also led to many new questions about what was happening and how the system functioned. The studies continued through a turbulent period when the area was declared a national park in August 1981 and local villagers were not allowed to graze their cattle, resulting in bloodshed a year later when Forest Department officials began to enforce the ban and 6 villagers were killed.

Immediately following the first project, a second five-year study was launched to substantiate findings and inferences made through continuous monitoring of various parameters as well as to expand investigation into some new subject specific areas that were found to be critical to the functioning of the system. These included work on the mammalian, reptilian, birds of prey, fish, and Siberian crane populations. During this latter phase of the studies, the issue of contaminants was also addressed with the establishment of a fully operational on-site laboratory to conduct heavy metal and pesticide residue analyses.

The overall multidisciplinary studies resulted in the collection of fundamental data on the ecosystem of the Park from the level of its physico-chemical parameters to the fauna at the apex of the food chains, identified the critical factors which govern the system, particularly the influx of water from the adjacent Ajun Bund with its rich fish fauna, and provided management recommendations from a long-term perspective, many of which have been adopted and incorporated by the Rajasthan Forest Department park managers. The studies constitute one of the major contributions to science in understanding the ecology of a tropical man-enhanced wetland system. They also revealed the need for additional studies and conservation efforts on key components of the system. Some of these issues, particularly related to birds of prey, were taken up by subsequent projects between BNHS and the USFWS and are described in separate sections of this report.

The scientific staff and publications of the project were as follows:

Principal Investigators

Salim Ali & J.C. Daniel (1980-1985)
V.S. Vijayan (1986-1991)

Co-Investigator

Robert B. Grubh (May-Nov. 1981)

Biologists

Lalitha Vijayan	Deen Dayal Mittal	Vidya Prakash#
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P.A. Azeez	N.R. Nadarajan	R. Kannan#
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C. Sivasubramanian	S.A. Hussain#	C. Chakrapani#
N.K. Ramachandran	Vibhu Prakash#	Ajith Galvankar#
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Neil B. Armantrout (Fisheries Biologist), U.S. Bureau of Land Management
Lester Busch (Hydrologist), USFWS
Henry J. Sather (Wetland Specialist), USFWS
Ron Sauey (Ornithologist) International Crane Foundation
Darrell Stiger (Architectural Engineer), USFWS

Served for a short period.

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STUDY OF THE ECOLOGY OF CERTAIN ENDANGERED SPECIES OF WILDLIFE AND THEIR HABITATS: GREAT INDIAN BUSTARD (1981-1987)

Recognizing the enormous environmental changes occurring in India precipitated by the exploding human population and the lack of information on the interrelationships between environment and biota, an umbrella project to focus on specific endangered species as indicators of ecosystem health was devised. The plan was to accumulate information useful for management of various natural systems as well as to produce trained field biologists. As more trained personnel became available, other species and ecosystems could be added for study. Initially, the Great Indian Bustard and the Asian Elephant were selected. Subsequently, other bustards species and several rare species of other birds were also studied.

The Great Indian Bustard (*Ardeotis nigriceps*) (GIB), endemic to the Indian subcontinent, was once widespread in the semi-arid open scrubland and grassland plains. Popular as a game bird owing to its excessively wary behaviour and palatable meat, the GIB underwent a drastic decline in numbers due to hunting and habitat destruction by about the middle of the 20th century. Concerned about its plight, the BNHS developed a 5-year research and conservation-oriented project (later extended for an additional year) to obtain precise data on the present distribution, to examine the viability of the remaining habitats, to study the ecology and behaviour, and to prepare a conservation management plan for the GIB.

GIB habitats were extensively surveyed throughout its known range and resident populations at Karera, Madhya Pradesh, Nannaj, Solapur district Maharashtra, and at Rollapadu in Andhra Pradesh were intensively studied for habitat usage and food habits. Based on these observations and monitoring, recommendations for the conservation of the GIB and its habitat were submitted to the Government of Madhya Pradesh for Karera Bustard Sanctuary relating to the threats faced by the sanctuary from expanding agriculture, the canal of the Sind River Project, and overgrazing. Similarly, a conservation strategy for the bustards in Maharashtra was submitted to the Government of Maharashtra. Many protected areas for the GIB were declared or were designed on the recommendations of the project staff.

Based on the indepth studies and extensive surveys carried out, conservation efforts undertaken, and the publications of the project, the GIB project could be regarded as one of the most important research-cum-conservation oriented projects of the BNHS.

The scientific staff and publications of the project were as follows:

Principal Investigator
Salim Ali

Co-Investigator
J.C. Daniel

Project Scientist
Asad R. Rahmani

Scientists

Ranjit Manakadan
Bharat Bhushan#
Eric D'Cunha#
Jugal Kishore Gajja#

Served for a short period.

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STUDY OF THE ECOLOGY OF CERTAIN ENDANGERED SPECIES OF WILDLIFE AND THEIR HABITATS: LESSER FLORICAN AND BENGAL FLORICAN (1984- 1989)

A 1980 international symposium on bustards and the BNHS study of the Great Indian Bustard and its habitat drew attention to the tenuous status of the two other endemic bustard species in the Indian subcontinent, the Bengal Florican (*Houbaropsis bengalensis*) and the Lesser Florican (*Sypheotides indica*). In spite of being popular game birds for a long time, very little was known about the status and conservation needs of the Lesser Florican, except that its numbers had declined drastically over the previous few decades, and even less was known about the elusive Bengal Florican, perhaps due to its natural rarity, remoteness of habitats, and very shy nature. The Bengal Florican was known to have a limited distributional range restricted to grasslands along the foot of the Himalayas, but continuing loss of habitat was isolating populations to existing sanctuaries and national parks. Though known to have a much wider distribution, the Lesser Florican's status was obscure due to the fact that it only became easily visible during the breeding season when the males display. It too seemed to be suffering from loss of habitat and poaching.

In 1984, the Endangered Species Project was amended with a 5-year addendum to study the ecology and status of the Bengal and Lesser floricans and to develop information for use in future conservation management plans. Major field stations were established at Manas Wildlife Sanctuary, Assam and Dudhwa National Park, Uttar Pradesh for the Bengal Florican and at Sailana, Madhya Pradesh for the Lesser Florican.

The project revealed that the Bengal Florican is perhaps the rarest member of the bustard family with an estimated 250-300 individuals in India. Apart from a few exceptions, it is restricted exclusively to some protected areas. While this species has lost most of its former habitats to spreading cultivation, human habitations and livestock grazing, the remnant habitats are not unduly threatened and the bird is not under immediate threat of extinction. Proper protection and management practices including controlled and timely burning and/or cutting are essential for these grasslands. The Lesser Florican, though not least in numbers, is the most endangered, mainly because its breeding habitat is under severe threat from land-use changes. Protection and rational utilization of the grasslands are the most important strategies for conservation of this species.

The scientific staff and publications of the project were as follows:

Principal Investigator
Salim Ali

Co-Investigator
J.C. Daniel

Project Scientist
Asad R. Rahmani

Scientists

Goutam Narayan
Ravi Sankaran
Lima Rosalind
Usha Ganguli-Lachungpa#
Usha Bhutia #
Galden Lachungpa #
S.H.A. Yahya#
P.K. Gupta#
Meena Haribal#

Served for a short period.

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STUDY OF THE ECOLOGY OF CERTAIN ENDANGERED SPECIES OF WILDLIFE AND THEIR HABITATS: JERDON'S COURSER AND MOUNTAIN QUAIL (1985-1989)

The addendum to the Endangered Species Project for studying the Bengal Florican *Houbaropsis bengalensis* and Lesser Florican *Sypheotides indica* also included options to investigate the status of several other species of Indian avifauna listed as rare, namely Jerdon's Courser (*Cursorius bitorquatus*), Mountain Quail (*Ophrysia superciliosa*), Blewitt's Owl (*Athene blewitti*), and the Pinkheaded Duck (*Rhodonessa caryophyllacea*). The Jerdon's or Double Banded Courser, only listed from a few restricted areas in eastern India, had not been recorded since 1900. Mountain Quail had last been recorded in 1876 from the western Himalayas. The last known specimen of the monotypic Pinkheaded Duck from northeastern India died in captivity in 1935 and Blewitt's Owl or Forest Owlet from Central India, one of the least-known endemic species of India, had not been recorded since 1864. While literature searches for the 4 species were carried out, field investigations were only carried out on Jerdon's Courser and Mountain Quail due to financial restraints and lack of experienced field personnel. The Pinkheaded Duck is thought to be extinct, but the Forest Owlet was subsequently rediscovered (not part of this project) in 1997 in a dry deciduous forest of Maharashtra.

Though considered to be extinct by some investigators because of the inability of a number of surveys to locate the Jerdon's Courser, researchers in the BNHS questioned this possibility, given the vastness of the potentially suitable habitat in the lower Indian peninsula. With little prior biological work having been done on this bird, the BNHS investigation focused on the area described by observers of the bird in the late 1800's where it had last been recorded. Using copies of a color illustration showing both the Jerdon's and Indian Courser (a similar species) translated into the local language along with a bird field guide to ascertain local informants' depth of knowledge, the BNHS researchers' painstaking and methodical legwork and contact with local bird trappers, paid off on a January night in 1986 when the first sighting of a Jerdon's Courser was verified. It was subsequently seen again in its natural habitat and photographed. However, owing to its extreme rarity and nocturnal habits, its biology could not be studied in spite of all efforts. The area where the first Courser was rediscovered was declared a sanctuary on the recommendations of the BNHS and a planned canal that would have effectively bisected the new sanctuary was rerouted.

Another "mystery" bird that generated much interest among ornithologists and naturalists was the Mountain Quail, though opinion regarding its current status remained divided. The only information on this bird was scanty and relied on details that had been provided by hunters and collectors in the late 1800's supplemented by some additional reports in the 1940's and 1950's. After reviewing the available literature on this bird and interviewing individuals who had some experience in the search for the Mountain Quail, the BNHS conducted a brief survey in March 1987 in areas around Mussoorie (Uttar Pradesh, now Uttaranchal), especially where the

quail had been previously recorded. The Mountain Quail's recorded habitat was steep grassy slopes, and the areas visited were found to be very disturbed and lacked tall grass. BNHS concluded that the search would require a full time effort by a survey team which would preferably be linked to a larger project such as a study of pheasants in the Kumaon hills.

The scientific staff and publications of the project were as follows:

Principal Investigator
J.C. Daniel

Biologists
Bharat Bhushan (Jerdon's Courser)
Ravi Sankaran (Mountain Quail)

Theses

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A STUDY ON THE ECOLOGY OF GRASSLAND OF THE INDIAN PLAINS WITH PARTICULAR REFERENCE TO THEIR ENDANGERED FAUNA (1991-1995)

Grasses and their value have been recognized since time immemorial as the present day cereal crops are the cultivated varieties of their wild ancestors. It is estimated that nearly 40% of India's land surface is covered by grasslands or steppe-like habitats. Grasslands evolved under a system of grazing, drought and periodic fire and almost all the existing grasslands are maintained by any or a combination all of these factors. However, due to a huge, ever-increasing, domestic livestock population and a poorly-defined grazing policy, grasslands have been under tremendous grazing pressure and most of the so-called grasslands are currently in various stages of degradation and destruction. In fact, grasslands appear to be one of the most threatened ecosystems in the Indian subcontinent. Among the 500-odd national parks and sanctuaries in India, very few of them have good grasslands and there is no pure grassland sanctuary in the country. As a chain reaction, the associated grassland fauna and flora are also under threat. For example, of the about 1300 odd species of birds reported for the Indian subcontinent, more than 150 species are exclusively or partially restricted to grasslands and/or open areas.

It was not until the 1980's, when the BNHS took up projects on the Great Indian Bustard and the Lesser and Bengal Floricans and attention was drawn to the fragility and vulnerability of these species, that grassland habitats started to get any widespread recognition of their value. The bustard projects also revealed that governments generally tended to view grasslands as wastelands, either to be converted to agriculture or planted with trees. Such conversions had a severe impact on the birds and other fauna, which are dependent on grasslands for their survival.

Starting in 1990 and using the skills and information gathered during the bustard and florican studies, the Society launched a 5-year ecological study of the grasslands of the Indian plains which included inventory, surveys and evaluation of the grasslands, inventories of vertebrate fauna, detailed studies on the ecology of indicator species such as Blackbuck *Antilope cervicapra*, Chinkara *Gazella bennetti*, bustard and florican, and effects of livestock grazing on the breeding success of indicator species. Major field stations were established at Rollapadu Wildlife Sanctuary, Andhra Pradesh; Nannaj, Maharashtra; Rampura grasslands, Madhya Pradesh; Banni grasslands Kutch, Gujarat; and Dudhwa National Park, Madhya Pradesh. Additional short term surveys and studies were frequently carried out in the Thar Desert (Rajasthan). Besides grassland birds, studies were also carried out on the grassland flora, insect populations, and on some mammals such as the Indian Wolf *Canis lupus*, Blackbuck, Indian Fox *Vulpes bengalensis* and Black-naped Hare *Lepus nigricollis nigricollis*. The Society collaborated with the Centre of Wildlife and Ornithology, Aligarh Muslim University to carry out the project.

Six major grassland sites were studied in detail with numerous scientific publications

and papers being produced. The project emphasized the need for a well-defined grazing policy, called attention to the drastic environmental changes brought on by the development of the Indira Gandhi Nahar Canal project in the Thar Desert, reinforced the importance of rotational grazing, control of free-ranging livestock, total protection of some grassland plots to serve as seed banks, and genetic improvement of livestock. The survival of the Lesser Florican was shown to be intimately interlinked with the protection of grasslands during the monsoon when this species breeds. Similarly, the conservation of the Bengal Florican and the production of thatch for villagers have common strategy, i.e. proper management of terai grassland.

The scientific staff and publications of the project were as follows:

Principal Investigator
Asad R. Rahmani

Co-Investigator
Jay Samant

Scientists

Y. Nageswara Rao
Ranjit Manakadan
C.R. Ajithkumar
V. Natarajan
Jugal Kishor Tiwari
Salim Javed
Satish Kumar

USFWS Consultant
Mark Behan (Professor), University of Montana

Theses

* Javed, S. (1996). Structure of bird communities of terai forest in Dudwa National Park. Ph.D. Thesis. Aligarh Muslim University, Aligarh.
* Kumar, S. (1998). Ecology and behaviour of the Indian Grey Wolf (*Canis lupus pallides* Sykes, 1865) in the Deccan grasslands of Solapur (Maharashtra), India. Ph.D. Thesis. Aligarh Muslim University, Aligarh.

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ḅ Occurrence of *Ciconia episcopus* (Boddaert) in Kutch, 103.

ç Great White Pelican *Pelecanus onocrotalus* recoveries from Kutch and Rajkot Districts of Gujarat, 104.

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ECOLOGY & BEHAVIOUR OF RESIDENT RAPTORS WITH SPECIAL REFERENCE TO ENDANGERED SPECIES (1990-1994)

Raptors or birds of prey are generally considered to be good bio-indicators of the ecosystems in which they occur, as they form the apex of the food-chains among birds and are very sensitive to changes in the food chain and their habitats. Declines in populations can often be related to habitat disturbance or environmental pollution. Depletion of populations would thus signify a serious threat to both habitat and other species of avifauna, and perhaps humans. There are over 100 species and subspecies of raptors known to occur in the Indian Subcontinent, either as resident breeding species or as winter migrants. Previous work by the BNHS through projects such as the *Avifauna* and *Keoladeo National Park Ecology* studies in the 1980s revealed that the status of most of these species was poorly known. But these projects succeeded in providing some strong qualitative information identifying a number of problems and pressures affecting this group of birds' abundance and distribution. Data collected also pointed to the fact that many species were becoming rare or endangered.

After evaluating the specific information and data collected on raptors, the BNHS designed a 3-year project (which was later extended to three-and-a-half years) known as the *Birds of Prey* project to: 1) collect information on the distribution and status of raptors, especially resident species considered endangered or of specific indicator value; 2) assess the conservation status of these populations including threats, identification of key areas and factors necessary for their long-term conservation; and 3) prepare management plans for effective conservation of species and habitats identified as endangered. A fourth objective to organize a captive breeding programme for the rehabilitation of any particular species considered necessary was dropped due to cost and priority considerations.

Surveys of raptors were carried out in 34 protected areas in different biogeographic zones of the country to get information on status and distribution of resident raptors. Additional surveys were conducted on forests adjacent to protected areas including the Andaman Islands, and also along highways all over the country. Sites or regions where the raptors were studied in more detail included Keoladeo National Park (Rajasthan), Western Ghats, Mudumalai Wildlife Sanctuary (Tamil Nadu), and Corbett National Park (Uttar Pradesh, now Uttaranchal). This project was the first of the Society's projects where biologists of the USFWS participated at every stage of its implementation. It also represented the first time a member volunteer of the Society worked full time with a project. A new raptor species, Grey-faced Buzzard *Butastur indicus* was added to the checklist of the raptors of the Indian subcontinent. Two resident species, namely Lesser Spotted Eagle

Aquila pomarina and the Lesser Grey-headed Fish-Eagle *Ichthyophaga humilis* were found to be highly threatened, requiring immediate attention. Range extensions for some species were recorded, as was the noticeable decline in numbers of other species. Additionally, the studies at Corbett and Keoladeo revealed that there was a high percentage of nesting failure with indications that pesticide contamination was responsible, or a factor. Three areas of unusual raptor concentration were located, Velavadar National Park, Saurashtra and Banni Grasslands, Kutch in Gujarat, and Rollapadu Wildlife Sanctuary in Andhra Pradesh.

Note: The original proposal accepted by the Ministry of Environment & Forests, Government of India was titled, *Conservation of Birds of Prey with particular emphasis upon Restoration of the Endangered Species*. This proposal, as suggested in this title, had a strong captive breeding component. The USFWS felt that the captive breeding programme was premature, and the BNHS agreed to drop it and changed the title to *Ecology and Behaviour of Resident Raptors with Special Reference to Endangered Species.*

The scientific staff and publications of the project were as follows:

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Paul Spitzer (Raptor Biologist), The Centre for Northern Studies
N. John Schmitt (Wildlife Illustrator)

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WINTERING ECOLOGY OF RAPTORS IN AREAS OF UNUSUAL CONCENTRATION (1996-1999)

One of the findings of the Society's *Birds of Prey* project (1996-1999) was the identification of several areas of unusual raptor wintering concentrations including Keoladeo National Park in Rajasthan, Velavadar National Park and Banni Grassland in Gujarat, and Rollapadu Wildlife Sanctuary in Andhra Pradesh. The site at Velavadar is perhaps the largest known roost for harriers in the world. While very little information on the wintering ecology of raptors was available, it was known that winter densities of raptors are influenced by food availability and that wintering species tended to segregate, either geographically or ecologically from the majority of resident species, perhaps to avoid competition.

In 1996, as a follow-up to the *Birds of Prey* project, the Society embarked on a 2-year project (subsequently extended to 3 years) to identify the major causes of such large raptor concentrations and their effect on the ecosystems they occupied. The project looked at food and perch requirements of raptors at high densities to help in the formulation of management plans for these areas, so that the habitat continued to attract raptors in high numbers. Several raptors were fitted with radio transmitters to follow their movements. The major field stations of the project were Keoladeo National Park (Rajasthan) and Velavadar National Park (Gujarat).

ECOLOGY OF RARE RAPTORS (1997-2001)

A second outgrowth of the Society's *Birds of Prey* project (1996-1999) was the identification of a number of raptor species whose status was rare or endangered. Only one nest of the endemic Lesser Spotted Eagle *Aquila pomarina* had been discovered in India in 1986 after 80 years. This and other rare species such as the Lesser Grey-headed Fish-Eagle *Ichthyophaga humilis*, Black-crested Baza *Aviceda leuphotes*, Jerdon's Baza *Aviceda jerdoni*, Crested Goshawk *Accipiter trivirgatus*, Rufous-bellied Eagle *Hieraaetus kienerii,* and some species from the Great Nicobar Island, such as the Nicobar Serpent-Eagle *Spilornis minimus*, were the subject of a 3-year ecological study by the BNHS, initiated in 1997.

Due to various problems, work did not commence until 1998, when field stations were established at Keoladeo National Park, Rajasthan and Buxa Tiger Reserve, West Bengal. Project staff were given intensive training in raptor identification and field research techniques by the U.S. Fish and Wildlife Service collabarotors. Additional studies were taken up at Pattanur, Kerala and in the Nicobars. Important ecological information on a number of rare and endangered raptor species was collected and is helping to

formulate management options for these species and their habitats.

STUDIES ON THE EFFECT OF ENVIRONMENTAL CONTAMINATION ON RAPTORS WITH SPECIAL REFERENCE TO SHAHEEN *FALCO PEREGRINUS PEREGRINATOR* (1997-1999)

A third outgrowth of the Society's *Birds of Prey* project (1996-1999) was the recognition that population declines of raptors could be related to the increase in the use of pesticides, as has been shown in other parts of the world. As predators near the top of their food chain, raptors are likely to be affected even by sub-lethal levels of pesticide contamination through egg shell thinning and breakage. The Keoladeo National Park, Rajasthan is surrounded on all sides by agricultural fields where pesticides and insecticides are used extensively. Raptors from the park regularly utilize the food resources available in the agricultural fields and in the process could ingest harmful chemicals through their prey species. The 1980-1990 BNHS ecological study of Keoladeo National Park, Rajasthan had documented breeding failure in the raptor populations and provided evidence that lethal levels of DDE, aldrin and dieldrin were detected in the tissues of Sarus Crane *Grus antigone*) and Ring Dove *Streptopelia decaocto*. Raptors in general have been shown to be more sensitive to a given level of DDE than birds of other families. Aldrin and dieldrin are more toxic than DDT and cause mortality of both adults and embryos. It was felt that monitoring nesting success of various raptor species could give an indication of the effect of pesticidal contamination on breeding success, the first process to be affected by chemical contamination. In addition, the periodic analysis of the tissue of raptors and their prey species would reveal the level of pesticidal load, which could be a cause of population decline.

The BNHS received sanction for a 2-year project at Keoladeo National Park to look at contaminants in 1997. The major objectives and the project methodology were modified to focus on other raptor species at the Park when permission to catch Shaheen could not be obtained and the project got underway in 1998. Nesting success was monitored and habitat and food availability were ruled out as reasons for the decline and breeding failure in the raptor populations. Permit difficulties led to a small sample size being available for contaminant analysis, producing inconclusive results. However, pesticide loads found were often not significant and may not be a contributory factor to the decline of populations.

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Served for a short period

Note: The publications of the three above mentioned projects have been merged with those of the *Birds of Prey* project as these are more or less extensions of the first project.

ECOLOGY OF POINT CALIMERE WILDLIFE SANCTUARY (AN ENDANGERED ECOSYSTEM): 1986-1991

The Point Calimere Wildlife Sanctuary is situated on a low promontory on the Coromandel coast in Thanjavur District, Tamil Nadu in the extreme southeastern coast of the Indian peninsula at the meeting place of the Bay of Bengal and Palk Strait. Long recognized as a major refuge for wintering shore birds, it prompted a 1962 invitation from the Government of Madras to Dr. Salim Ali to assess its suitability for a bird sanctuary. Thus began a 40-year BNHS association with the Sanctuary leading to the establishment of one of the two major field stations of the 1980-1987 *Avifauna Project* of the Society. As part of that project, extensive baseline data was collected on the Sanctuary and its environs. From the information gathered, it was revealed that behind the seemingly tranquil exterior of the Sanctuary, there were multi-faceted pressures confronting this small relict forest, threatening its very existence, such as destruction of vegetation, over-exploitation of timber, fisheries and freshwater resources, and the impact of a heavy influx of a large itinerant human population. Scientific information on the overall ecology of this area was felt to be vitally needed to make management decisions to protect the sanctuary before it was destroyed. This was the genesis of the three-year project titled *Ecology of Point Calimere Wildlife Sanctuary - An Endangered Ecosystem.*

The Point Calimere Sanctuary is part of a coastal, marine-influenced ecosystem made up of a unique mix of a number of different interwoven geologic and floristic systems, including tropical dry evergreen forest, mangrove swamps, grassy openings, open mudflats, coastal low-lying grazing lands, and sand bars, all of which are influenced by weather and climatic conditions. Freshwater pools created within the forest are during the monsoons plus the influence of five freshwater channels emptying into the vast Great Vedaranyam Swamp (part of the Sanctuary), play a significant role in the availability of food sources and utilization of the Sanctuary by wildlife. The BNHS study identified several objectives: to try to determine the impacts of wood cutting, forest litter collection and other forest products collection; to look at the impact of the operating of an industrial salt works and bromide plant in the sanctuary, especially on flamingos; to carry out habitat-related studies on the isolated blackbuck population and other mammalian species; to look at the impact of forest degradation on selected migrant and resident land birds; to study vegetation ecology and ecosystem dynamics; to carry out socio-economic studies on local communities adjoining the Sanctuary; and to establish an interpretation centre for the Sanctuary.

The findings and recommendations of the BNHS have added much to the knowledge of the Point Calimere area and its recognition as an area of national and international importance for wildlife, especially migratory birds. It has all the requisite criteria to be recognized as a wetland of international importance as per the Ramsar Convention; it is an important site for the preservation of biodiversity of tropical dry evergreen forest type; from the ethnobotanical standpoint, it is evident that most of the plant species are used in tribal medicine; the open coastal low-lying

grazing lands are of paramount importance for the survival and sustenance of the blackbuck population in the sanctuary; the salt works in the sanctuary should not be expanded; fire wood and other forest product collections inside the sanctuary should be controlled and alternate sources of firewood for local communities should be developed; livestock grazing within the sanctuary should be limited and controlled; and the protective status of the entire sanctuary and adjacent Great Vedaranyam Swamp should be upgraded.

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Served for a short period.

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ECOLOGY OF HILL STREAMS OF THE WESTERN GHATS WITH SPECIAL REFERENCE TO FISH COMMUNITY (1996-1999)

With its great variety of ecological conditions, and its position at the confluence of three biogeographic realms, the India subcontinent has a tremendous diversity of plant and animal species. However, this biodiversity is under constant threat because of various human activities. Few natural systems worldwide have been more modified than the freshwater aquatic systems and among them, hill streams are in the most precarious condition as far as their ecological status is concerned because of their unstable physical characteristics. Sound management of these resources requires an understanding of the condition of fish communities and their habitats, and of the factors influencing them. Paradoxically, due to some lapse in Indian environmental law, most freshwater aquatic systems in the country, unless they fall within a formally declared protected area, have no governmental regulatory agency responsible for their welfare and hence their management or protection.

The Western Ghats form a practically unbroken relief dominating the west coast of the Indian peninsula for almost 1600 km. Unique in several ways, including containing most of the remaining tropical rain forests of peninsular India, home to several endangered and endemic species of flora and fauna which have attracted studies of some aspects of this fragile ecosystem, the freshwater streams and their highly adapted and often endemic fish fauna have been basically ignored from the standpoint of scientific investigation. What was known from work conducted in the first half of the 20th century was primarily on the taxonomic and zoogeographic aspects, including information that about 40 species of freshwater fish were either seriously threatened or rare and merited immediate protection. Beset by a multitude of human induced perturbations in the latter half of the century (i.e., subsequent to the earlier studies), their current status and distribution were largely unknown.

In 1995, with sparse historical information available and no champion for their cause, hill streams and their fish fauna finally began to get attention with the BNHS breaking new ground by introducing a three-year study proposal for looking at the hill stream fishes of the Western Ghats. The original project design was altered somewhat after the project was underway with the objectives to assess the current status, distribution, habitat conditions and ecology of the hill stream fishes in Kerala, evaluate the changes in fish assemblages by comparing with past records, develop index areas for long-term monitoring of changes in fish fauna and their habitats, and suggest conservation management guidelines to maintain aquatic habitats and fish assemblages.

A total of 39 rivers, 2 national parks, and 9 sanctuaries were surveyed during the project, concluding the most extensive survey of fish fauna of Kerala in recent times. The project identified threats facing these fish populations from activities such as deforestation, agricultural practices, construction of dams and canals, use of explosives, and introduction of exotic species. For each of the threats, conservation measures necessary to protect

the fish fauna and their habitats were suggested.
The scientific staff and publications of the project were as follows:

Principal Investigator
Jay S. Samant#

Co-Investigator
C.R. Ajithkumar

Research Fellows
C.R. Biju
K. Raju Thomas

U.S. Advisor/Consultant
Neil B. Armantrout (Fisheries Biologist), U.S. Bureau of Land Management

Served for a short period

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STUDY OF THE ECOLOGY OF CERTAIN ENDANGERED SPECIES OF WILDLIFE AND THEIR HABITATS: THE ASIAN ELEPHANT (1983-1992)

Paired with the Great Indian Bustard for initial study under the Endangered Species umbrella project, the Asian elephant (*Elephas maximus*) was selected as an apex animal because of its size and its interaction with its habitat, particularly in its quest for food, to influence the direction of development of its biotic environment. It has been one of the causes for the process of change in its ecosystem, a function viewed as no longer acceptable in an environment managed by man. But as a species able to live in a wide spectrum of vegetational types, the elephant acts as an indicator species of the condition of its biotic environment. A sub-optimal habitat is unable to meet the demands made on it by a population of elephants.

The Asian Elephant had never been extensively studied in the field and population counts had only been made in two areas of distribution. Based on some preliminary surveys among India's Forest Department, the opinions were that of the five major elephant populations in the country, all were declining and becoming isolated from each other due to loss of habitat from increased governmental sponsored and local encroachment.

Due to these reasons, the Society developed a project proposal to assess the pressures on elephant populations and monitor causative factors, particularly environmental factors, habitat status, movements, range and impact of human usage. A second part of the project was to monitor elephant populations on a continuous basis in selected habitats to collect information for the development of a management plan for sanctuaries. The Society's attempt to launch this 5-year project under the Endangered Species Project was delayed due to lack of trained staff. In 1983 the senior field scientist and two junior field scientists initiated training and studies on elephants and other wildlife at Kalakadu-Mundanthurai Wildlife Sanctuaries, Tamil Nadu. The following year, the studies were shifted to the three contiguous Nagarhole National Park, Bandipur Tiger Reserve (both in Karnataka) and Mudumalai Wildlife Sanctuary (Tamil Nadu). Mudumalai was then identified as a suitable representative of the entire area which supported a large elephant population in a contiguous terrain, and was also an ideal area to study cattle and human pressure on the elephant habitat. Because of the delays in implementing the project, it was extended an extra year to 1987.

During the course of the project, several issues on elephants arose which caused the Government of India to approach the BNHS for help. The first involved management of crop raiding elephants along the Tamil Nadu-Andhra Pradesh border. The second requested help for a similar set of substantial crop raiding problems but also included cases of manslaughter by elephants from Karnataka moving into Tamil Nadu and then into Andhra Pradesh. The BNHS was additionally asked to do a survey of elephant damage in Meghalaya in northeastern India.

By 1987, besides accumulating considerable data on the biology of elephants, population dynamics, social behaviour, movement patterns and home range, the project revealed several problems

which elephants were facing: poaching, man-elephant conflicts, fire, critical areas, cattle grazing, settlements, habitat improvement, and reserve forests and private forests. In order to address these challenges as well as collect more data on some old issues, a new project was developed. Titled *Ecology of the Indian Elephant*, this 5-year project (1987-1992) provided additional attention to the work carried out in the Nagarhole –Bandipur–Mudumalai sanctuaries and looked more extensively at the situation in Andhra Pradesh where elephants had moved into new areas, intensively studied the ecology of the elephant population at Dalma Wildlife Sanctuary, Bihar (a unique situation of 47 elephants living in a small area of 193 sq. km of degraded forests), and collected more information on man-elephant conflicts in Meghalaya.

The project as a whole can be divided into two phases. The period 1984-1990 covered a baseline data study which included population, feeding ecology, habitat utilisation, elephant-vegetation interaction, evaluation of critical micro-habitats for elephants, ranging and spacing behaviour, and social organization. The second phase, which overlapped with the first, focused on man-elephant conflicts and aberrant elephant movements. Six elephants including one large male makhna, a known crop raider were captured and fitted with radio-collars to monitor their movements. Recommendations applicable to the study areas were shared with the Forest Department and action has been taken by them on several suggestions. The USFWS sponsored two workshops during this period to provide training in analysis of mapping and animal data and in the use of computers in elephant telemetry and habitat analysis. At the request of the Tamil Nadu Forest Department, BNHS researchers led two successful efforts to move elephants from areas outside protected areas back into protected areas using immobilization and translocation techniques.

The scientific staff and publications of the project were as follows:

Principal Investigator
J.C. Daniel

Project Officer
A.J.T. Johnsingh (April 1983-August 1984)
V. Krishnamurthy (1987-1992)

Scientists
A.A. Desai
N. Sivaganesan
S. Ramesh Kumar
Hemant S. Datye#
Bharat Bhushan#

Research Fellows
N. Baskaran#
M. Balasubramanian#
S. Swaminathan#

U.S. Advisor/Consultant
Christen Wemmer (1997-1992) Wildlife Biologist, Smithsonian Institution

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ECOLOGY OF THE SHOLA AND ALPINE GRASSLANDS OF INDIA WITH SPECIAL REFERENCE TO THEIR ENDANGERED FAUNA (2000-2003)

It is generally agreed that grasslands originated from woodlands through deforestation, abandoned cultivation, and burning. However, what can be described as more natural grasslands are thought to have evolved in areas where edaphic and climatic factors prevented the growth of tree/shrub species, and also areas where wild herbivores prevented the growth of trees by grazing and browsing. In India, such 'natural' grasslands are few and are restricted to the alpine regions of the Himalayas in the north (above 3000 to 3600 m elevation) and certain protected areas in the high ranges of the Western Ghats in the south (above 1800 m). Though relatively few of these natural areas have been given any formal protection, they are characterized by their often large numbers of endemic and endangered flora and fauna which are under constant threat from man-induced perturbations.

During the implementation of the Society's 5-year project on *Grassland Ecology*, it became obvious that these two important grassland systems were not being addressed. The Society's current 3-year project which started in 2000, to study the high elevation grasslands of the Western Ghats called Shola grasslands and the alpine grasslands in the Himalayas, is designed to rectify this. Two field stations have been established: one in Mukurti National Park, Nilgiris, Tamil Nadu to study Shola grasslands, and a second one in Sikkim to study alpine grasslands of the Himalayas. Factors such as floristic composition, seasonality, structure, productivity, and distribution are being looked at in relation to elevation, moisture, temperature and disturbance gradients. The conservation status of these grasslands is being evaluated using birds as indicators. In addition, key habitats for endangered fauna of the alpine grasslands are being identified, effects of domestic and wild herbivore grazing on selected rare plant taxa are being evaluated, and information for the long-term protection of some important sites are being gathered.

With the help of techniques such as GAP Analysis to evaluate these grasslands from the biological diversity perspective, it is hoped that BNHS suggestions and recommendations for conservation of these areas will help in the development of a management plan to ensure their long-term protection.

The scientific staff of the project are as follows:

Principal Investigator
Asad R. Rahmani

Scientist
Usha Ganguli-Lachungpa

Research Fellows
Peeyus Kutty
Ashfaq Ahmed Zarri

U.S. Advisor/Consultant
Mark Behan (Retd. Professor), University of Montana

Publications/Reports
None as yet

List of Fish and Wildlife Service Supported Projects in India

This is a fairly complete list of the major projects we have funded in India under the SFCP and USIF program. The list does not mention many of the "smaller" activities like training, publications, EE activities etc, nor any of the grants given under the Rhino-Tiger, Asian elephant and Great Ape Conservation acts.

With Bombay Natural History Society

1. Hydrobiological (Ecological) Research Station, Keoladeo Ghana Sanctuary, Bharatpur. BNHS. 1980-1985. Two one-year extensions,1986, 1987. (Rs. 3,712,439).

2. Studies on the Movement and Population Structure of Indian Avifauna. BNHS. 1980-1985. Two one-year extensions, 1986, 1987. (Rs. 3,892,260).

3. Study of Ecology of Certain Endangered Species of Wildlife and Their Habitats (Great Indian Bustard and Asian Elephant). BNHS. 1981-1987. (Rs. 2,671,109).

4. Study of Ecology of Certain Endangered Species of Wildlife and Their Habitats (Bengal and Lesser Floricans, Jerdon's Courser, Mountain Quail, Pink-headed Duck, and Blewitts Owl). BNHS. 1984-1989. (Rs. 2,008,891).

5. Ecology of Keoladeo National Park, Bharatpur, India. BNHS. 1987-1990. One eight month extension, 1991. (Rs. 6,477,257).

6. The Study of The Migration Pattern of Indian Birds and Avifauna Migration Study Data Bank. BNHS. 1987-1992. (Rs. 5,975,509).

7. The Ecology of Point Calimere Sanctuary (An Endangered Ecosystem). BNHS. 1987-1990. (Rs. 2,807,638).

8. Ecology of the Indian Elephant. BNHS. 1987-1992. (Rs. 5,041,753).

9. Conservation of Birds of Prey with Particular Emphasis on Restoration of the Endangered Species. BNHS. 1989-1992. (Rs. 4,982,000).

10. A Study of The Ecology of Grasslands of Indian Plains With Particular Reference To Their Endangered Fauna. BNHS. 1990-1995. (Rs. 5,463,931).

11. The Habitat and Population Dynamics of Wolves and Blackbucks In The Velavador National Park. BNHS. 1988-1991. (Rs. 433,000).

12. Ecology of Hillstreams of the Western Ghats with Special Reference To Fish Community. BNHS. 1995-1998. (Rs. 2,877,737).

13. Wintering Ecology of Certain Raptors in Areas of Unusual Concentration. BNHS. 1996-1998. (Rs. 2,610,500).

14. Ecology of Some Rare Raptors in India. BNHS. 1997-2000. (Rs. 4,442,347).

15. Studies On The Effect of Environmental Contamination On Raptors With Special Reference To Shaheen Falco pelearinoides.

16. BNHS. 1997-1999. (Rs. 1,598,600).

17. Bird Banders Training Programme. BNHS. 1997-2000. (Rs. 2,421,705).

18. Ecology of Shola and Alpine Grasslands. BNHS. 1999-2002. (Rs. 4,491,874).

With Wildlife Institute of India

1. Development of the Wildlife Institute of India. WII. 1988-1993. (Rs. 8,191,782 plus $266,000).

2. Endangered Tortoise and Freshwater Turtle Breeding and Rehabilitation Project. WII. 1990-1993. (Rs. 1,355,000).

3. The Status, Ecology and Conservation of the Indian Giant Squirrel (Ratufa indica). WII. 1991-1996. (Rs. 3,223,629).

4. Ecology And Genetics Of Capra sibirica In India. WII. 1994-1997. (Rs. 1,132,000).

5. Scientific Collaboration With U.S. Fish and Wildlife Service (Development of the Wildlife Institute of India - Phase II). WII. 1995-2000. (Rs. 55,600,000 and US$1,150,000).

6. Conservation Of The Indian Wolf (Canis lupus pallipes). WII. 1995-2002. (Rs. 5,765,700 and US$153,300).

7. Planning and Development of Interpretive Facilities In Selected Areas In India. WII. 1996-2001. (Rs. 11,991,600).

With The Center For Environmental Education

1. Indo-US joint Effort To Further Environmental Education In The Schools of India By Development and Use of Television Programming. CEE, State University of New York at Syracuse (SUNY). 1987-1990. (Rs. 2,689,200).

With The Center For Wildlife Studies

1. Ecological Relationships And Resource Use In The Carnivore-Herbivore Community Of Nagarahole National Park. CWS. 1986-1988. One year no-cost extension 1989. (Rs. 358,814).

2. Ecology and Management Of Large Carnivores. CWS, National Geographic Society (NGS), Wildlife Conservation International (WCI). 1989-1992. Three year no-cost extension 1992-1995. (Rs. 987,100).

3. Ecological Status and Conservation of Tigers in India. CWS, Wildlife Conservation International (WCI). 1995-1998. (Rs. 1,530,000.

With Centre Of Wildlife And Ornithology

1. Distribution, Status, Ecology And Behaviour Of Indian Storks, With Special Reference To Endangered Species. CWO. 1993-1996. (Rs. 2,646,767).

With The Nilgiris Wildlife And Environment Association

1. Ecology And Population Dynamics Of The Nilgiri Tahr In The Nilgiris. NWEA. 1992-1995. (Rs. 985,820).

With Jainarayan Vyas University

1. Status Survey, Distribution and Habitat Evaluation Of Least Known Indian Primates, And Sociobiological Investigations Of Selected Primate Taxa With Special Reference To Conservation And Management. JNV. 1994-2001. (Rs. 15,000,000).

With Panjab University

1. Ecology of Hillstreams of Himachal Pradesh and Garwhal Regions with Special Reference to Fish Communities. Panjab Univ. 1997-2001. (Rs. 4,289,040).

With the Institute for Restoration of Natural Environment

1. Conservation and Restoration of Biodiversity of Tropical Freshwater Wetlands of Kanyakumari Plains in Peninsular India. IRNE. 1999-2002. (Rs. 5,238,791)