Implementation of Regular Veterinary Care for Captive Sumatran Elephants (*Elephas maximus sumatranus*)

Christopher Stremme, Anhar Lubis and Mohammad Wahyu

*Veterinary Society for Sumatran Wildlife Conservation – Elephant Health Care Program Medan, North Sumatra, Indonesia*

**Background**

As a result of capturing elephants from the wild in order to reduce human elephant conflicts during the period between 1985 and 2000, today there are about 600 captive elephants throughout Sumatra (Lair 1997; PHKA 2006). These elephants are kept in about 320 government run Elephant Training Centres (ETC), zoos, recreation and safari parks, and timber companies. Due to a lack of funds, a lack of dedicated and experienced camp managers and veterinarians, and a lack of ideas about how to integrate captive elephants in a conservation strategy, in most locations this captive population lacks sufficient maintenance, health and welfare management, resulting in poor health conditions and losses (Lair 1997; Lewis 1998; IEF 2001; Suprayogi *et al.* 2001; PHKA 2006).

In order to improve management conditions for captive Sumatran elephants, in November 2006 the Sumatran NGO, Veterinary Society for Sumatran Wildlife Conservation (VESSWIC) started its Elephant Health Care Program (EHCP) for which it receives funding from the UK based charity, Elephant Family. The EHCP is implemented by three veterinarians, who are employed full time and who have been working in the healthcare of Sumatran elephants for more than three years prior to starting EHCP. This program aims to implement regular health care for captive Sumatran elephants. Due to funding limitations at the moment the EHCP is active with regular veterinary care only in the provinces of North Sumatra, Aceh and Lampung. Presently in other areas the EHCP can only provide veterinary support by formal request of the responsible governmental departments in special cases. All activities are conducted in cooperation with the agencies for Forest Protection and Nature Conservation on the provincial and national levels (BKSDA and PHKA).

**Area of activity**

VESSWIC is based in Medan, the capital of the province of North Sumatra, and from there reaches out to provide regular veterinary care to seven locations in the provinces of North Sumatra, Aceh and Lampung which manage a total of 127 elephants (see Table 1).

**Table 1.** List of locations where elephants are being managed and details of managed elephants.

<table>
<thead>
<tr>
<th>Location</th>
<th>Province /District</th>
<th>Male</th>
<th>Female</th>
<th>Distance from Medan [km]</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETC Holiday Resort</td>
<td>North Sumatra/Labuhan Batu</td>
<td>7</td>
<td>13</td>
<td>380</td>
</tr>
<tr>
<td>Forest Park Brastagi</td>
<td>North Sumatra/Tongkah</td>
<td>0</td>
<td>2</td>
<td>65</td>
</tr>
<tr>
<td>CRU Tangkahan</td>
<td>North Sumatra/Langkat</td>
<td>1</td>
<td>6</td>
<td>105</td>
</tr>
<tr>
<td>UPG Aras Napal</td>
<td>North Sumatra/Langkat</td>
<td>2</td>
<td>2</td>
<td>125</td>
</tr>
<tr>
<td>ETC Saree</td>
<td>Aceh/Aceh Besar</td>
<td>14</td>
<td>14</td>
<td>580</td>
</tr>
<tr>
<td>ETC Teladan</td>
<td>Aceh/Aceh Besar</td>
<td>4</td>
<td>1</td>
<td>590</td>
</tr>
<tr>
<td>ETC Way Kambas</td>
<td>Lampung</td>
<td>40</td>
<td>21</td>
<td>1600</td>
</tr>
<tr>
<td>Total numbers</td>
<td></td>
<td>68</td>
<td>59</td>
<td></td>
</tr>
</tbody>
</table>
Health management

The locations listed in Table 1 in North Sumatra and Aceh are visited at least once per month to conduct regular health-checks and treatments (Fig. 1). Regular visits to ETC Way Kambas are conducted at three-month intervals. The ETC Way Kambas, in contrast to all other locations, has its own veterinarian; therefore not all veterinary work has to be conducted directly by the VESSWIC veterinarians, who focus more on providing continuing material and technical support, backing up the implementation of more structured veterinary care and preventative schemes, and support for the diagnosis and treatment of special cases. More frequent visits to all of the camps are conducted if special medical cases need more intensive attention, or an emergency response is requested.

Preventative schemes

Parasites - During every visit microscopic investigations of faeces are conducted. Deworming is undertaken at 3 to 4 month intervals with different kinds of anti-parasitic drugs (see Table 2) according to the intensity of infestation and the parasite species.

Table 2 Anti parasitic drugs

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dosage [mg/kg BW]</th>
<th>Route of administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albendazol</td>
<td>10 – 12</td>
<td>oral</td>
</tr>
<tr>
<td>Triclabendazol</td>
<td>7.5 – 10</td>
<td>oral</td>
</tr>
<tr>
<td>Ivermectin</td>
<td>0.1</td>
<td>subcutaneous or oral</td>
</tr>
<tr>
<td>Ivermectin</td>
<td>0.2</td>
<td>rectal</td>
</tr>
<tr>
<td>Niclosamid</td>
<td>50 – 75</td>
<td>oral</td>
</tr>
</tbody>
</table>

Tetanus - Tetanus vaccinations for all elephants were initiated at the beginning of 2006 using horse toxoid vaccines, following dosage recommendations for horses. The first vaccination is repeated after 4 weeks and after this the elephants are re-vaccinated once a year. Post vaccination serum titre evaluations are planned, and a Memorandum of Understanding between the Indonesian Veterinary Research Agency (BALITVET), the agencies for Forest Protection and Nature Conservation (PHKA) and VESSWIC is underway.

Nutrition - In the ETC Holiday resort the availability of natural fodder is very poor due to the encroachment of the ETC area by oil palm plantations, and the supplemented food is monotonous, therefore it seems obvious that the diet in this location is lacking energy, minerals and vitamins. To improve the nutrition in this location a special high energy supplement containing minerals and vitamins is cooked (composition listed in Table 3).

Table 3 Elephant diet supplement

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount per elephant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>2 kg*</td>
</tr>
<tr>
<td>Sticky rice</td>
<td>1 kg*</td>
</tr>
<tr>
<td>Corn</td>
<td>1 kg*</td>
</tr>
<tr>
<td>Palm sugar</td>
<td>1 kg</td>
</tr>
<tr>
<td>Vitamin-mineral powder</td>
<td>60 g</td>
</tr>
</tbody>
</table>

*weight before boiling

This supplement is provided once a week for all elephants and three times per week for nursing mothers. In addition, during every visit in all locations about 50 bundles of bananas and 5 pineapples or papayas are provided per elephant.

Figure 1. Training for local vets and vet technicians during a field visit.
Body-condition monitoring – Body measurements are taken twice a year and the body condition evaluated with standardised body condition formula and recorded, to document the general health and nutritional condition of all elephants. 

Unfortunately regular blood samples of all elephants cannot be analysed yet due to budget limitations, therefore blood analyses are only used as a diagnostic tool in elephants showing some signs of illness.

Treatment of diseases and disorder

The most frequent disease and disorders that the VESSWIC veterinarians have documented and which needed intervention in captive Sumatran elephants during the past years were: wounds, endo- and ecto-parasites, foot diseases, keratoconjunctivitis, stereotype behaviour and malnutrition

Wounds – Fights between elephants left unattended or chained close to wild elephant habitat, sharp foreign bodies from items such as old nails, sharp metal or glass debris thrown away in the surroundings, and improper use of management and restraint tools such as ropes, chains, elephant hooks, and unhygienic handling of darting equipment during the capture of wild elephants often cause serious wounds and abscesses needing treatment (Mikota et al. 2003). If treatment is administered immediately after the occurrence, usually the wounds are simple to treat and heal easily. Besides washing the wound with clean water, it is flushed with antiseptic solutions, deeper wounds or abscesses are also stuffed with antibiotic tablets, and large superficial wounds are covered with antiseptic ointment. Whichever drugs are used for wound cleaning and disinfections, the most important issue is to continue the treatment twice a day until the wound is healed, usually about 10 days to 6 weeks. If wounds are not immediately noted or regarded as serious and reported to the veterinarian by the mahout, delayed treatment can cause complications like swellings, myasis (maggot infestation) and generalized infections, needing more intensive and longer lasting treatment with systemic antibiotics and NSAPs (see drugs listed in Table 4). Handling and management advice to mahouts and camp managers about the above mentioned wound-causing reasons reduce their occurrence.

Parasites - Regular microscopic investigations (Fig. 2) of faeces (flotation and sedimentation) detected that different roundworms species (Strongyloides sp., Strongylidae Ascaridae) and Trematodes (Fasciola sp., Paramphistomidae) are the most frequent endo-parasites, and macroscopically elephant lice (Haematomyces elephantis) were detected to be the most frequent ecto-parasite. Permanent burdens for most elephants are different blood sucking flies. Whether these flies transmit other diseases (bacterial and/or protozoan) has not been investigated and would need further research.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dosage</th>
<th>Treatment intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Povidone-Iodine 1% and 10%</td>
<td>Ad libitum / local</td>
<td>Twice a day</td>
</tr>
<tr>
<td>Peroxide 2,5%</td>
<td>Ad libitum / local</td>
<td>Twice a day</td>
</tr>
<tr>
<td>Povidone-Iodine ointment</td>
<td>Ad libitum / local</td>
<td>Twice a day</td>
</tr>
<tr>
<td>Penicillin-Streptomycin 200.000 IU – 200 mg/ml</td>
<td>10.000 IU – 10 mg/kg BW / i.m.</td>
<td>At 24 h intervals for 7 days</td>
</tr>
<tr>
<td>Amoxicillin LA 150 mg/ml</td>
<td>12 mg/kg BW / i.m.</td>
<td>At 48 h intervals for 7 days</td>
</tr>
<tr>
<td>Oxytetracyclin LA 200 mg/ml</td>
<td>12 mg/kg BW / i.m.</td>
<td>At 72 h intervals for 7 days</td>
</tr>
<tr>
<td>Ibuprofen 400 mg/tablet</td>
<td>5 mg/kg BW / p.o.</td>
<td>Twice a day for 5-10 days</td>
</tr>
<tr>
<td>Etamidon (NSAP drug combination)</td>
<td>5 ml/100 kg BW / i.m.</td>
<td>At 24 h intervals for 3-7 days</td>
</tr>
<tr>
<td>Dichlofention (Gusanex Spray)</td>
<td>Ad libitum / local</td>
<td>Twice a day</td>
</tr>
</tbody>
</table>
Foot diseases – The most frequent foot disease needing treatment was Pododermatitis, injuries of the footpad (Fig. 3), improper wear of the footpad resulting in double layers and potential infections between these layers, caused by unhygienic and permanently wet areas where the elephants are kept. Cracked toenails due to overgrown nails were rarely found and rarely required treatment. For treatment of Pododermatitis, the foot is washed with water and affected areas flushed with disinfectant solutions, overgrown toenails and footpad layers are trimmed down to the extent possible. Overgrown tissue of collagen fibre from deeper layers is trimmed to its physiological layers until blood vessels appear. All infected and necrotic material is removed. Bordering areas of overgrown collagen fibre and epidermis are trimmed to the area where the connection between epidermis and corium appears. This is repeated regularly (about every 2-3 weeks) until recovery, because the connective tissue from the corium and digital cushion grows faster than the epidermis and hinders complete healing if not trimmed. Trimmed areas are treated with antiseptic and astringent solutions, like Kaliumpermanganat 1 - 2%, Coppersulfate 3%, and Formalin 5%. Treatments are done twice a day for several weeks until completely healed. Advice about regular checks of toenails and footpad, conducting pedicures and promoting awareness amongst the camp staff about general hygienic management of the elephant stabling areas have reduced cases of Pododermatitis.

Keratoconjunctivitis – This problem is often found and is characterized by increased tears, inflammation of mucous membranes, slightly milky discolored cornea and appearance of milky, opaque spots on the cornea. Dusty, dry and hot surroundings often cause this disorder, but it seems that often bacterial infection, suspected to be transmitted by flies, can be the main reason for this disorder or at least complicate a climate induced keratoconjunctivitis. In some cases healing can happen without any treatment and the first minor signs must not necessarily be treated immediately but the condition of the surroundings should be improved. If increased signs of this illness are not treated it can lead to corneal ulcers, total blindness and total loss of the eye. For local treatment with antibiotic eye-ointment chloramphenicol ointment was found to be most effective. When using eye-ointment it is crucial to repeat the treatment several times a day (at least 3 times a day or more often) to be effective. If local treatment cannot be administered reliably (due to the unreliability of mahouts or reduced acceptance of the elephant) systemic treatment can be given. Oxytetracyclin LA 12 /kg i.m. repeated four times in 72 hour intervals was found to be effective.
Stereotype behaviour - In all locations visited some elephants were found that exhibited stereotype behaviour, often weaving. This can be described as permanent repetition of the same movements in the same rhythm without attaining a specific result. This is usually caused by stress and boredom due to a lack of occupation or social contacts and interaction.

Although a sufficient number of elephants of both gender and various ages are managed in all camps, the animals are managed in a way that they stay alone more than 90% of the day. During the day the elephants are brought to areas where they are chained for foraging, and in the evening (sometimes also in the morning) taken for a bath then chained with their supplemental fodder somewhere near the campsite. Although often the elephants can hear and sometimes can see each other, they cannot have direct contact with each other. Usually the elephants only have regular direct contact with each other during bathing and then the elephants still need to be under the command of their mahouts and cannot freely socialise with each other. In none of the camps is time regularly given to the elephants for free roaming and socialisation. In almost all camps visited the regular workloads and occupation for the elephants are very low or nonexistent. This management structure leaves the elephants unoccupied and bored after they have eaten their food as they are unable to interact socially due to their restriction.

Unfortunately knowledge about elephant behaviour and mental wellbeing is very low amongst the camp staff; therefore stereotype behaviour is not recognized as a problem that needs to be addressed. Education about elephant behaviour and different management systems are crucial to build awareness amongst mahouts and camp managers about the mental wellbeing of elephants. Improvements happen slowly and depend on the long-term continuation of regular education and advice about this subject.

Malnutrition – Beside the visual appearance of unnatural bony and skinny body condition, values of total blood protein is used to determine malnutrition. Adult animals with a total blood protein below 7.0 g/dl (mean standard for blood protein: 7.9 – 8.4 g/dl and standard deviations are: 0.6 – 0.8 g) are regarded as suffering from malnutrition (ISIS 2002).

In all locations with more than ten individuals, some elephants were found to be suffering from malnutrition. Besides a general lack of food availability, this problem is often related to management and handling insufficiencies such as the following:

- Available resources for supplementary fodder are not used sufficiently, e.g. lacking in quality and variability, or amounts not equally distributed.
- Natural food resources in and around the camp are not sufficiently utilized.
- Elephants are not moved often enough from the places where they are tethered.
- In the past no regular de-wormings (if at all) were conducted, therefore a very high infestation with endo-parasites exists.

For treating malnutrition it is crucial to somehow influence the above mentioned management weaknesses, to raise awareness about this amongst the camp staff and to
mprove utilisation of existing resources. Regular anti-parasitic treatments have been implemented (see above) since the EHCP started and contribute to the reduction of malnutrition. It appears that animals suffering from chronic malnutrition exhibit physical weakness and sometimes show signs of mental depression leading to a lack of interest in intensively and actively searching for food, as well as reduced appetite to consume available food, which might be less tasty. Providing Vitamin injections, high-energy food supplements and sweet fruits usually help overcome this condition (Fig. 4).

**Other less frequent diseases**

The above described diseases represent not all but only the most frequent diseases and disorders needing medical intervention in Sumatra. Beside these there are also single cases of gastrointestinal diseases (colic, constipation, diarrhea), tetanus infections, sunburns, navel infections, tail bites followed by amputation, hyperkeratosis, dermatitis, *E. coli* infection, etc. needing treatment during the past years (Fig. 5).

**EEHV and TB** – Infections with the Elephant Endotheliotropic Herpes Virus and Tuberculosis (TB) caused by *Mycobacterium tuberculosis* have been reported during the past years by colleagues working with captive elephant populations in other countries (Binkley 1997, Dunker & Rudovsky 1998, Richman *et al.* 2000, Fickel *et al.* 2001, Fowler 2006, Mikota 2006, Montali *et al.* 2001). These diseases, which are considered to be able to badly affect captive populations, have so far not been reported in Sumatran elephants. But this absence of evidence is just the result of a lack of any investigations or research about these two important diseases in Sumatran elephants and should not be misunderstood as evidence of the lack of these diseases in the Sumatran elephant population.
Unfortunately, it is not unlikely that Sumatran elephants are also affected by TB and/or EEHV. Indonesia ranks third in the list of 22 high burden tuberculosis countries, having more than 530,000 new human infections and more than 91,000 people dying from tuberculosis in 2005 (WHO 2007). Therefore it is not impossible that TB might occur amongst mahouts and due to daily close contact between mahouts and their elephants it might be transmitted to elephants.

During the past years the VESSWIC-EHCP veterinarians have found three young elephants (age below 6 years) with wart like skin lesions, two adult elephants with small round lesions in the mouth mucosa, and post-mortem findings in one two-year-old pre-mortem healthy looking elephant calf that suddenly died, that looked very similar to findings described from other authors in elephants that were confirmed positive for EEHV. Of course these findings do not confirm existence of EEHV in Sumatran elephants and could also be caused by other diseases, but it seems sensible during the next years to establish sufficient cooperation between responsible governmental agencies and international and national institutions, organizations and specialist groups to conduct research regarding these two diseases amongst Sumatran elephant populations.

Staff training

To successfully conduct veterinary work good cooperation between camp staff (mahouts, veterinary technicians and camp managers) and the VESSWIC-EHCP veterinarians is crucial. Therefore amongst the camp staff a good understanding about elephant biology, behaviour, welfare needs, and how proper healthcare management contributes to this is important. The camp staff’s willingness to cooperate with the VESSWIC-EHCP veterinarians depends very much on trust and belief in the veterinarians’ work and recommendations for improvements and modifications of established management structures and/or handling procedures. This trust did not automatically exist at the beginning of the VESSWIC-EHCP work, but was built due to reliable and regular visits. It was also possible because the VESSWIC-EHCP team not only provides pure veterinary care but during every visit also conducts some training and/or information sessions for the camp staff.

Mahouts – No structured education and training scheme exists for the mahouts in Sumatra. Once people are recruited for the job of mahout they have to try to learn somehow from the more senior mahouts in the camps how to handle and train elephants. Although after some time many mahouts develop reasonable to good skills of handling the individual elephant they are in charge of, knowledge about elephant biology, behaviour, different management and handling systems, basic knowledge about health care and medical procedures and treatments is very limited. The VESSWIC-EHCP team tries to address this issue by training sessions using slide shows, video films and practical demonstrations about the following subjects:

- Elephant biology and behaviour
- Basic elephant anatomy and physiology
- Prevention and treatment of basic medical problems
- Different elephant handling, training and restraint techniques
- Training elephants for medical procedures (e.g. foot care, mouth inspection, blood sampling, rectal intervention, treatments)

Veterinary technicians – the local “paramedics” have undergone basic education in a government or government licensed school about the basics of veterinary management, disease and treatments. But this education focuses on livestock and does not include any special elephant related training. Often this occurred a long time ago and, as there is no continuing education and often only few if any medical supplies exist in the camps, much of the previously gained knowledge has been forgotten. The VESSWIC team tries to address this issue by training sessions using slide shows, video films and practical demonstrations about the following subjects:

- Elephant anatomy and physiology
- Elephant diseases
- Obtaining samples and analyses
• Treatment schemes and drug dosages
• Record keeping
• Elephant handling and management
• Waste management/camp hygiene

**Local veterinarians** – Only a few of the government departments in charge of elephants have their own veterinarians. However, even when they do, none of them stay in the camp permanently and for the most part they have more administrative than veterinary duties. Nevertheless the VESSWIC-EHCP veterinarians try to involve these colleagues, as well as interested local colleagues, as much as possible in the veterinary work. Veterinarians from other areas in Sumatra have been invited and have volunteered with the VESSWIC-EHCP team in the past. Beside this, the VESSWIC-EHCP team has presented its work for elephants in national veterinary meetings and workshops to raise awareness amongst local colleagues about the veterinary needs and problems of elephants in Indonesia.

**Veterinary student education** – VESSWIC-EHCP veterinarians have been invited as guest lecturers by the veterinary faculties of the universities in Banda Aceh and Bogor to lecture about elephant diseases and health management. Currently VESSWIC-EHCP has started to involve veterinary students from the veterinary faculty in Bogor as volunteers in the fieldwork to gain hands on experience in elephant health management. As VESSWIC has received a request from the Veterinary faculty in Bogor to conduct more regular lectures and courses about elephant health care, VESSWIC is now seeking the necessary resources to design and implement a structured student training course about veterinary management of elephants, more intensively involving students in field work.

**Mahout welfare**

Salaries of the mahouts are very low, and living conditions in the camps are mostly very basic and monotonous, not providing many possibilities for recreation and information exchange. The possibility for the VESSWIC-EHCP to assist with these conditions is very limited due to budget considerations, but with some basic support tries to attain improvements for the camp staff with the following activities.

**Mahout uniforms** – Every year a basic uniform set consisting of trousers, shirt, etc. for each mahout in the 7 locations is provided.

**Social networking and information meetings** – During these meetings newspapers are distributed, information about situations/problems in other elephant camps (elephant and non elephant issues) and other actual news from Sumatra is exchanged and discussed. Snacks, drinks and cigarettes are provided during these informal meetings, which are attended not only by the mahouts but by their whole families.

**Incentives** – Small stipends are paid as a type of reward to mahouts who have performed extraordinary care for their elephants requiring increased work loads for the mahout, such as reliably and successfully continuing treatments advised by the veterinarians, providing intensive care for mothers and new born calves during the first weeks after birth, successfully training the elephant for special medical procedures, etc.

**Conclusion**

The captive population of the Sumatran elephant (*E. m. sumatranus*) today represents approximately 20% of the overall population of this subspecies. If carefully managed this genetically valuable population can play an important role for the conservation of this unique subspecies by focusing on conservation and self-sustainability. The experience of the VESSWIC-EHCP activities show that there is a chance to implement sufficient veterinary care, and that changes in handling and management can be accomplished for these captive elephants if support is long term, focused and conducted in close cooperation with camp staff and government agencies in charge.

For the future the VESSWIC-EHCP team hopes to be able to intensify its activities in the current areas of the project and enlarge such support to camps in other areas in Sumatra. The VESSWIC-EHCP team also hopes to accomplish a more intense knowledge exchange with other
colleagues in Indonesia about elephant veterinary care, and conduct courses for students on this subject in order to increase the number of colleagues able and willing to provide veterinary care for Sumatran elephants.

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Corresponding author’s e-mail: stremme@gmx.net
Asian Elephants are Losing Their Seasonal Traditional Movement Tracks: A Decade of Study in and Around the Rajaji National Park, India

Ritesh Joshi and Rambir Singh

1Pant Institute of Himalayan Environment & Development, Garhwal Unit, Almora, India
2Department of Science and Technology, Govt. of India, Technology Bhavan, New Delhi, India

Introduction

Rajaji National Park (RNP) was notified in 1983 by amalgamating three erstwhile wildlife sanctuaries namely, Rajaji, Chilla and Motichur. The park is a prime habitat of Asian elephants and is the northwestern most limit of distribution of Asian elephants and tiger in the Indian subcontinent. The Shivalik foothills are one of the world’s most spectacular landscapes, encompassing the tall grasslands and the Shorea robusta (Sal) forests. This entire belt is the natural home of Asian elephants (Elephas maximus) besides many other mega wild animals like tiger, leopard, spotted deer, sloth bear etc. The Ministry of Environment and Forests, Government of India has declared this area as an Elephant Reserve (RNP) with the sole aim of conserving Asian elephants in their natural habitat.

The Shivalik landscape is one of the last few places in the world where Asian elephants exist, hence is in urgent need for conservation. This protected area (PA) in India’s lesser Himalayan region falls under sub tropical moist deciduous forest type with extensive stands of Shorea robusta (Sal), Mallotus philippinensis (Rohini), Acacia catechu (Khair), Adina cordifolia (Haldu), Terminalia bellirica (Bahera), Ficus bengalensis (Bar), Dalbergia sissoo (Shisham) etc. besides many other important fodder plant species. From tourism point of view it appears to be one of the most successful National Parks in India and its development has helped boost the economy of Uttarakhand State, which lies in the Lesser Himalayan region. However, presently many of the traditional routes are denied to elephants, which are replaced by industrial area, human settlements and road network etc.

Since Independence, forests were cleared and felled and bought under the plough on a large scale. Construction of projects of public utility, for hydrel, irrigation, roads etc. entailed deforestation of large tracts and colonisation brought in its wake have resulted in significant shrinkage in the habitat of wild animals (Singh 1969). Presently, elephant habitats are destroyed by various developmental activities or for human needs. Shrinkage of habitat has forced competition among the same species for the food, shelter and other basic requirements.

The status of the elephant in the adjoining countries is equally poor. Nepal, which has the lowest country population, has lost over 80% of its elephant habitat on account of human settlement. Bangladesh, Myanmar, Cambodia, Vietnam, Laos and Sri Lanka etc. are also rapidly losing natural forest cover, specially the elephant habitats. In Thailand in spite of the elephant having been a protected species since the 18th century, over exploitation of the habitat and the pressure of human population has made the species highly vulnerable (Daniel 1996). The present study is a part of our long-term study on the behavioural biology of Asian elephant in and around the RNP area.

Study area

Rajaji National Park [29°15' to 30°31' North Latitude, 77°52' to 78°22' East Longitude] is spread over an area of 820.42 km² in and around the Shivalik foothills, which lies in the Lesser Himalayas and the upper Gangetic plains (Fig. 1). Spread across Hardwar, Dehradun and Pauri districts of Uttarakhand state, Rajaji National Park has been designated as a reserve area for the “Project Elephant” by the Ministry of Environment and Forests, Government of India.
with the sole aim of maintaining a viable population of Asian elephants in their natural habitat. The Shivalik hills offer the most prominent geomorphic features of this tract. The river Ganges has cut across these hills at Hardwar. The Chilla forest area of the Rajaji National Park lies to the East of the river Ganges and is attached by the Garhwal Forest Division. The study is ongoing in Hardwar (District-Hardwar), Chilla (District-Pauri) and Motichur (District-Dehradun) forest ranges of the RNP. The altitude lies between 302 - 1000 m asl.

Methods

For studying the movement pattern of elephant three forest ranges were selected and surveyed in-depth for about 10 years. The traditional movement tracks along with feeding grounds of elephants were searched and observed and plotted on a map. Different forest blocks of concerned forest ranges were chosen one after another sequentially and searched for elephants for about 10 – 12 h (depending upon weather conditions) in a single day search. The observations started at early hours in the morning being the best time to search and observe the elephant in open areas and four hours in the afternoon i.e. before the sunset. Field binocular was also used for observing their movement behaviour without disturbing the animal from an adequate safe distance.

The data collected is part of the animal monitoring activities. The daily record is based on direct sighting of animals, indirect evidences like feeding sign and footprints (Santiapillai & Suprahman 1986; Ramakrishanan et al. 1991; Dawson & Dekker 1992). The direct sightings were noted in duly prepared proformas, recording the group composition, age and sex, if observed in groups and also the place of sighting, time and vegetation type.

![Figure 1. Map of the study area.](image-url)
Besides, villagers of adjoining areas, Gujjars (where available), staff of Forest Department, the researchers from various scientific institutions and non-government organizations and other individuals working on this problem, were interviewed.

Identification of the elephants is important to verify their movement as in the same area there is a possibility that the same group was observed in the different forest beats so, for each individual bearing distinctive features, identification marks were noted like shape of the ears, tusk size and shape, scars and tubercles on the body, tail length, total number of individuals (all ages separately), body mass and nature of group or solitary bull.

**Results and discussion**

Movement is one of the most important ecological factors that represent the home range as well as habitat utilization of an animal. Both movement and migration depends upon the availability of natural food and water. Changes in season and scarcity of water and natural fodder species force wild animals to leave a place for a few months and reach new feeding grounds for fulfilling their feeding, water and other routine requirements. There are seasonal variations in fodder species as RNP area falls under sub-tropical moist deciduous forest vegetation type. Elephants use the whole of the park area as their natural habitat but mostly they leave some of the areas having less vegetation cover and water for a few months and move towards other ranges richer in fodder species and natural water. Although at that time a few of them (mostly solitary bulls) use the same feeding grounds or move frequently in all the forest beats of the park as a general rule of migration of any species. Selected range wise movement pattern of the elephants is described below.

**Hardwar forest range**

With the onset of winter from the month of mid-October, when there is slight scarcity of fodder species elephants move towards the Dholkhand forest range, which is situated towards south-east/north and towards Kansrao forest range, situated south-east / north through crossing Motichur forest range. Study revealed that elephants move from Hardwar forest range to the adjoining ranges on the arrival of winter and also at the onset of summer period especially from the month of March to June, which are also known as the forest fire months. But the movements of a few of the solitary bulls and occasionally groups (very rare) have been observed in whole of the range. Most of these movements are obviously being restricted by various villages, temples, railway tracks etc. that are present in the vicinity or inside the park area. Hardwar forest range is partially covered on one side by villages (Nai Basti-Bhimgoda, Lodha Mandi, Ravli-Mehdood, Roshnabad, Aeh tampur Aanaeki and Aurangabad), therefore, instances of man-elephant conflicts are relatively more in this area, than in other ranges. These conflicts may be in any form viz. crop raiding, manslaughter etc. Dudhia forest beat due to its closeness to the Haripur Kala village and river Ganges is one of the most sensitive areas as far as elephant casualty is concerned.

During the study period, occasionally the movement of solo bulls was observed in this part of the park. Despite the fact that Dudhia area is rich in *Dalbergia sissoo* (Shisham) and *Acacia catechu* (Khair) forest, being the preferred food item of elephants. Group movement is restricted in this forest pocket due to the high level of anthropogenic and developmental activities. Generally, the solo adult bulls follow the city route to reach the Dudhia forest and river Ganges by crossing the railway track and Hardwar–Dehradun National Highway (Fig. 2). They enter the city from northern Kharkhari forest beat and move towards Chilla area after the sun set and re-enter the northern Kharkhari forest beat before dawn. During this long journey of about 2 km elephants crossed many of the minor routes along with various colonies. Besides, solo bulls from Chilla forest also enter this forest beat after passing through the island in between the river Ganges. This track falls under Chilla – Motichur corridor and is one of the important habitats as far as the elephants’ conservation is concerned.

During field observations it came to our notice that, this pocket of the area is very sensitive for
the movement of the elephant mainly due to huge scale anthropogenic activities. During 1999 to 2002 few cottages have been constructed in this area inhabited by about two dozens of sadhus and likes. On the other hand this pocket has been part of the traditional route for the elephants to interchange the forest. Due to rapid development and construction activities in Haripur Kala village situated peripheral to the island and in adjoining areas; the elephant movements have been disturbed. The residents of the area inferred that seven years ago an adult tusker was killed by electrocution by a villager. However, no human casualty has been reported till now.

A large mammal like the elephant could be expected to cover considerable distances even within a short period, and families of a clan seem broadly coordinated in their seasonal movements (Sukumar 1989). In the dry months i.e. from January to April, when no rainfall occurs, the groups seek the neighbourhood of streams and shady forests. From the month of July, after the first showers, they start roaming and feed on the fresh grass. This grass in hill tracts becomes long and coarse by July and August, and the elephants then show upward movements. The reason for the elephants and other animal’s migration in to the high land continuous and uninterrupted hilly terrain, is for grazing, assured food, ideal breeding grounds and thick population (Sinha 1981).

Elephants also use the Ghasiram and Mundal water streams for visiting river Ganges especially when their local movement is frequent in and adjoining forest beats, which are attached to river Ganges along with few bridges, which are in Ganga canal of Chilla hydro electric power plant (Fig. 3). Few of the groups were also reported to use the Shyampur and Chiriapur forest ranges of Hardwar forest division during rainy season as east Ganga canal is in full flow during this period. At the same place elephants move towards river Ganges through crossing the Hardwar-Bijnor National highway. It is interesting to mention here that currently only bull elephants cross this track and no groups were reported during the last 2 years. In the past 4-5 years elephant groups were reported in the same area but rapid developmental activities have restricted the frequent movement of elephant groups towards river Ganga in this part.
During the last 4-5 years, the State Government has constructed about four flyovers on Hardwar – Bijnor National Highway. As a result of anthropogenic activities, about 18 km of forest existing on both sides of the highway has got disturbed. Besides, agricultural expansion near river Ganges has lead to the loss of forest, which has also hindered the traditional movement of elephants. This forest stretch is one of the major corridors for elephant movement and presently has got disturbed due to habitat loss around the national highway. Sometimes a few of the male elephants associate to enter the forest near river Ganges through this route.

Elephants cross the National Highway in the evening hours and come back to the forest area in early morning hours. Besides, elephants also utilize the Gaziwali bridge, Shyampurwali bridge and Pili bridge situated peripheral to the canal road in Ganga canal for their outside movement and to feed on the cultivated crops in nearby villages. During the study period all the villages suffering from crop raiding have been investigated. The affected villages are Jagjeetpur, Mishrpur, Panjneri, Ajeetpur and Jaipota in the western side of the conservation area and all these villages are situated peripheral to river Ganges. Villages Kangri, Ghaziwali, Shyampur, Sajanpura, Pili and Rasiabad are located peripheral to the forest area and National Highway whereas villages Gaindikhata, Lahadpur, Chiriapu, Vasuchandpur and Naurangabad are also situated adjacent to the forest area and National Highway south west of the conservation area.

The villages along the river Ganges are situated on land that was once part of the elephant’s home range. Therefore, the increasing elephant – man conflict is unfortunate but inevitable. The electric fence erected along with these villages and river Ganges has presently got damaged due to lack of proper maintenance. It was observed that elephants are utilizing their traditional feeding grounds in few of these areas, which are presently denied to them and are replaced by human settlements.

Figure 3. Ghasiram water stream - one of the oldest natural corridors for elephant movement in between Chilla-Motichur area.