

A STRATEGY FOR CONSERVATION OF THE HABITAT OF NORTH-WESTERN POPULATION OF INDIAN ELEPHANTS

K.N. SINGH*

The North-Western region of the Himalayas is endowed with a variety of flora and fauna. The flora encompasses a spectrum of vegetation types ranging from moist Shiwalik Sal forest to North tropical moist deciduous forest. The fauna consists of a well-preserved number of tigers occupying the apex of food chain, population of elephants and large populations of other fauna.

The habitat of North-Western population of Indian elephant is situated mainly in the sub-montane region of present Uttaranchal State and Uttar Pradesh (U.P.). Whereas Uttaranchal is represented by Corbett National Park, buffer area of Corbett, Sona Nadi Wildlife Sanctuary, Rajaji National Park, Haldwani, Tarai Central, Lansdowne, Ramnagar, Dehra Dun, Haridwar and Shiwalik Forest Divisions, U.P. is represented by Shiwalik Division and Bijnor Plantation Division. An occasional small migratory population is also found in Dudhwa National Park and Pilibhit Forest Division. This population moves across Nepal border between Dudhwa National Park and forests in Nepal. Bijnor Plantation Division and Shiwalik Division of U.P. are in continuity with other Divisions of Uttaranchal situated in the sub-montane region of Himalayas and Shiwaliks. The habitat of Dudhwa National Park and Pilibhit Division is typical Tarai.

Elephant habitat in the sub-montane region has two national parks namely Corbett National Park and Rajaji National Park. The main species of the habitat of sub-montane region and Tarai is Sal (*Shorea robusta*), interspersed with grasslands and large to small rivers, rivulets, nalas and 'sots', crisscrossing each other. The grasslands vary in size. While in Rajaji National Park where the general size of the grasslands is a few hectares, Corbett can boast of having the grasslands spread in hundreds of hectares. The main tree species, though is sal yet at places it is well mixed with a number of other associates like Bakli (*Anogeissus latifolia*), Asna (*Terminalia alata*), Jamun (*Syzygium cumini*), Dhauri (*Lagerstroemia parviflora*), Bahera (*Terminalia bellirica*), Jhingan (*Lannea coromandelica*), Haldu (*Adina cordifolia*), Phaldu (*Mitragyna parviflora*), etc. The main middle storey tree species is Rohini (*Mallotus philippensis*), of late a favourite food and fodder dish for elephants.

Since the Asian elephant today ranges over a wide spectrum of vegetation types, its conservation can be integrated with the conservation of biological diversity. Elephant, being a huge animal with large requirement of food and fodder, creates a significant impact on its own ecosystem. On the other hand, major disturbances in the ecosystem have in themselves

* Ex-P.C.C.F, U.P., Lucknow (Uttar Pradesh).

threatened the very existence of the elephant. Since a major portion of habitat is sal forests, the management practices of these forests in the past have greatly affected its survival. In the future too, significant or drastic changes in management practices would accordingly affect the elephant's survival. It has been observed that pure sal forests are not very supportive to the survival of elephants, on the other hand the forests having good mix of sal with other species, coupled with good floral ground cover and huge grasslands in between, have proved ideal for their living. Elephants also as a rule do not inhabit the areas above 760m alt. They also do not leave their Northern-most Tarai forests to come down to deeper part of Indo-Gangetic plains. As per the 1999, census the total population of elephants in the present U.P. and Uttaranchal is depicted in Table 1.

The most serious threat to the conservation of North-Western population of Indian elephant is the fragmentation of habitat. Thanks to the large scale development works taken up zealously and vigorously after independence, such as construction of dams and reservoirs, power houses, canals, power channels, roads, railway lines and power transmissions lines etc. The habitats have also been used for the rehabilitation of Tehri dam oustees, resettlement of a number of villages and ethnic communities. Besides this, the land was leased or transferred out for a variety of purposes including agriculture. Existence of a whole army ammunition dump at Raiwala in Motichur range is also a case in point. Along with the development projects also came up the residential colonies for those working on the projects, followed by the trading communities

Table 1

Population of Elephants in U.P. and Uttaranchal as per Census of 1999.

Forest Division	Male	Female	Juvenile	Total
Corbett National Park	96	215	144	455
Corbett Buffer Area	28	35	13	76
Sona Nadi Wildlife Sanctuary	19	45	24	88
Rajaji National Park	115	216	114	445
Dudhwa National Park	3	2	-	05
Bijnor	24	20	11	55
Tarai (Central)	3	3	1	7
Lansdowne	54	88	34	176
Ramnagar	16	9	1	26
Haldwani	37	92	48	177
Dehra Dun	10	21	13	44
Haridwar	80	135	95	310
Shivalik	15	12	7	34
Kotdwar	9	3	1	13
Total	509	896	506	1711

interacting with them. On top of everything, a few thousands hectares of land was encroached upon. In consequence of all this, what happened is that whereas in the pre-independence era there was a total genetic continuity in the entire elephant population lying in the sub-montane tract from the river Yamuna to river Sharda, after independence this genetic continuity was broken as the habitat was fragmented into a number of pieces, a few of them not being more than of a few hundred hectares in area. A few other pieces, though comparatively bigger in size, have fallen apart from each other and lack continuity. What we really are required to do is to connect these isolated pockets of habitat through some sort of corridors. In earlier periods some corridors did exist but they could not sustain the huge biotic pressure from outside as well as from within. These corridors are to be restored.

Apart from fragmentation, the important threats to habitat are reduction in the density of forest cover, putting large areas including grasslands under monoculture, immense grazing pressure of domestic animals, recurrence of fire incidences, illicit felling, huge biotic pressure in terms of extraction of firewood, thatching grasses, Bhabar grass, mining of boulders and sand; drying up of water sources and ruthless lopping of trees by Gujjars. Unchecked proliferation of towns and cities has further generated tremendous pressure on the habitat.

Though poaching of elephants was not unknown, yet incidences were few and far between. The recent spurt in poaching cases of elephants for ivory in the Corbett Tiger Reserve has added a new dimension to the problem of conservation.

Restoration of corridors

After independence, all along the major rivers of the elephant habitat colonization of various types and sizes have come up like along the Yamuna, Ganga, Malan, Khoh, Ramganga, Kosi, Goula and Sharda. The worst hit case has been the one along the Ganga, right from Rishikesh to Haridwar, though other rivers have been no exception. The coming up of a reservoir, two dams and a residential colony at Kalagarh and also related structures on both sides of the river Ramganga is an example where at the stage of project formulation, forest land as habitat of animals was given the least priority. So is the case with the Yamuna. All along the Kosi river in a stretch of 20 km, coming up of pucca structures in the form of houses, residential complexes, hotels and resorts have obstructed the free movement of elephants from Corbett Reserve to the areas of Ramnagar Forest Division. Again, pucca structures along the Goula river at Haldwani - Nainital road have broken the continuity of the forests of Ramnagar Division with Haldwani Division. Likewise, construction of a barrage on the Sharda river and related structures have again broken the continuity of the habitat and free movement of elephants. Large-scale clearfelling of forests along India-Nepal border on the Nepal side has almost completely stopped the free movement of elephants between the Tarai forests of Nepal and Dudhwa National Park, Lakhimpur Kheri and Pilibhit forests in Uttar Pradesh. The details of obstructions along the major rivers and the possibilities of restoring the necessary corridors are discussed below.

River Yamuna : A 13 km long power channel and tunnel from Kulhal to Khara

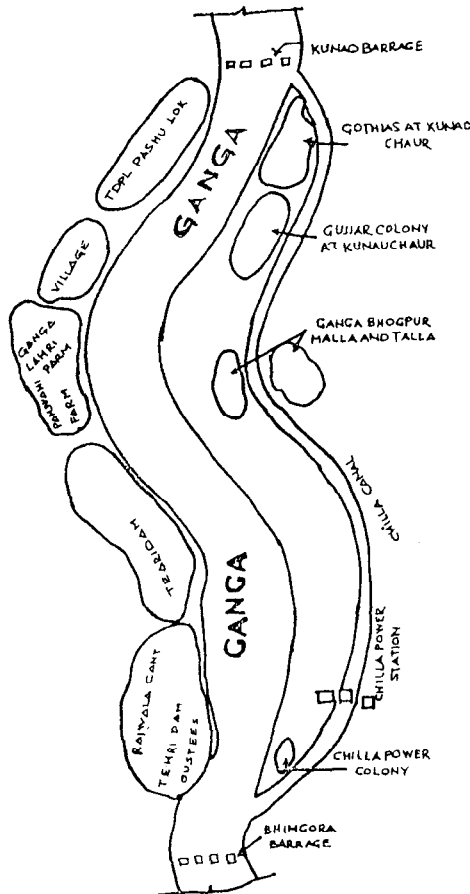
has created obstruction in movement of elephants. A power station of 72 MW at Khara has further compounded the problem. The busy New Delhi-Dehra Dun highway has also restricted the free movement of elephants from forests of Rajaji National Park into the forests of Shiwalik Division. Practically for the last so many years, elephants have not crossed the Yamuna on account of the habitation and cultivation of adjoining areas in Himachal Pradesh. So the creation of any corridors facilitating the movement beyond the Yamuna is totally ruled out.

River Ganga : The entire right bank of the Ganga from Kunao barrage to Haridwar has seen a variety of major to minor type of constructions and establishments come up, like the huge IDPL complex near Rishikesh, the Pashulok, a number of fenced agricultural farms like Gangalehri farm, Panjwani farm, ever growing villages like Gohri Mafi and others, Raiwala cantonment, a colony for Tehri dam oustees, an army ammunition dump, another small colony of Tehri dam oustees adjoining the ammunition dump in the West and a number of ashrams and dhams between Motichur and Haridwar. All these structures make it impossible for the elephants to move from either side of the Ganga to the other side of it in Rajaji National Park. This is an ironic situation where the elephants in the same park can not move across the Ganga. The tragedy is further aggravated by the existence of a pucca deep canal from Kunao barrage to Chilla. This canal is about 14 km in length, originates at Kunao barrage, feeds the turbine of Hydro Electric Power Station at Chilla and again falls into the Ganga. Near Chilla on the left bank of the canal is situated the residential colony of Hydro Electric Department. So in this stretch of

about 14 km all along this canal elephants are deprived of free movement to approach the Ganga for their requirements of water during summer and otherwise too. The canal goes underground where it crosses the Beenj Rao in a stretch of about 200 m. The elephants cross over the canal through this patch to reach the Ganga. However, the observation of the dung reveals that even this patch is used either by single elephants or only small herds as the entire patch is too open and exposed, devoid of any vegetal cover. On the right bank of the canal there are a few resettlement colonies of Ghotias and Gujjars. The canal has steep banks throughout and a few narrow bridges over it at certain points. Any attempt on the part of elephants to cross over the canal is impossible, sometimes resulting in accidents and deaths when some desperate attempts are made by elephants or other animals. The narrow bridges too do not serve any purpose as far as the movement of elephants is concerned. Interestingly, seldom have elephants been observed using these narrow bridges. There are a few long tunnel-shaped subways under the Chilla canal. These subways are sometimes used by elephants but observations have revealed that these are preferred only by the single animals. Movement of the herds along these long tunnel-like structures is very restricted. There have been so many suggestions coming from different quarters regarding facilitation of movement of elephants over the Chilla canal including widening of the bridges, but nothing has materialized.

The settlements and constructions on either bank of the river Ganga have been depicted in Fig. 1. What is most desired is linking up of the forests of Rajaji National Park on the left bank of the Ganga of

Fig. 1



Man-made creations on either side of the River Ganga

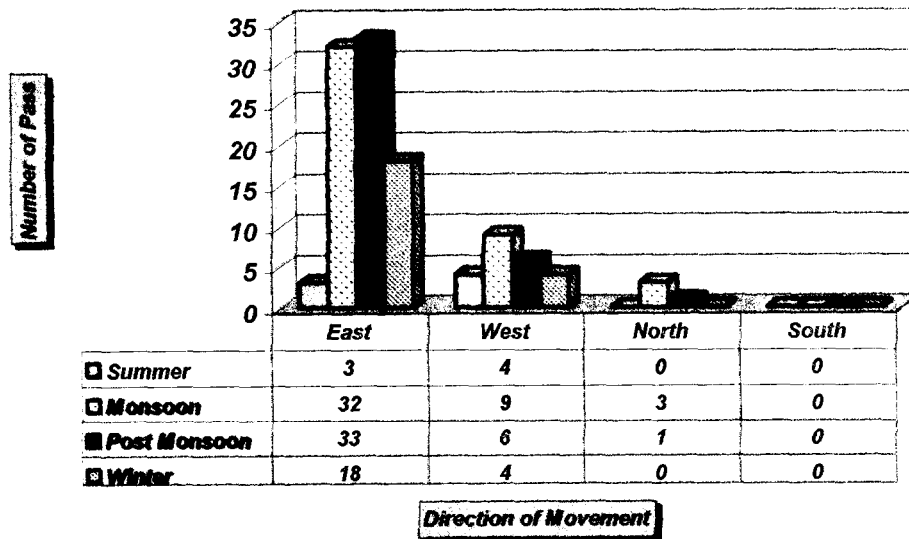
Chilla Range with the forests on the right bank of the Ganga in Motichur Range. A number of considerations have been given and after careful observation it has been concluded that theoretically, a few corridors are possible but only one of them seems reasonable on practical grounds.

Chilla-Motichur Corridor No. 1 : This corridor connects Motichur-Johara Blocks to Chilla Sanctuary via Dudhai Block.

Between the two fragmented parts of the parks on either side of the Ganga lies one ammunition dump and a small resettlement colony of Tehri dam oustees on the Western side of river Ganga. The area is presently open and almost devoid of vegetation, So the elephants have to use this disturbed open area to pass through or use the open space of the Motichur Rao. The bed of the Motichur Rao is very uncomfortable being full of boulders. Elephants do not prefer to use it, yet on the basis of the observation of dung, it has been concluded that single elephants or small herds of elephants do take this passage under the cover of night. So far as movement along some path through the ammunition dump and resettlement colony of Tehri dam oustees is concerned, again it is observed that most of the movement either relates to single elephant or small herds of animals. The ammunition dump area is well fenced yet occasional raids are reported. The seasonal distribution of elephant's movement in this corridor was also observed and it was found that most movement was East-bound followed by West and South. There was hardly any movement worth notice towards North. These observations are depicted in Fig. 2. The frequency distribution of elephants was also studied for this corridor and it was found that the most of the movements were in November followed by July and February. These observations are depicted in Fig. 3.

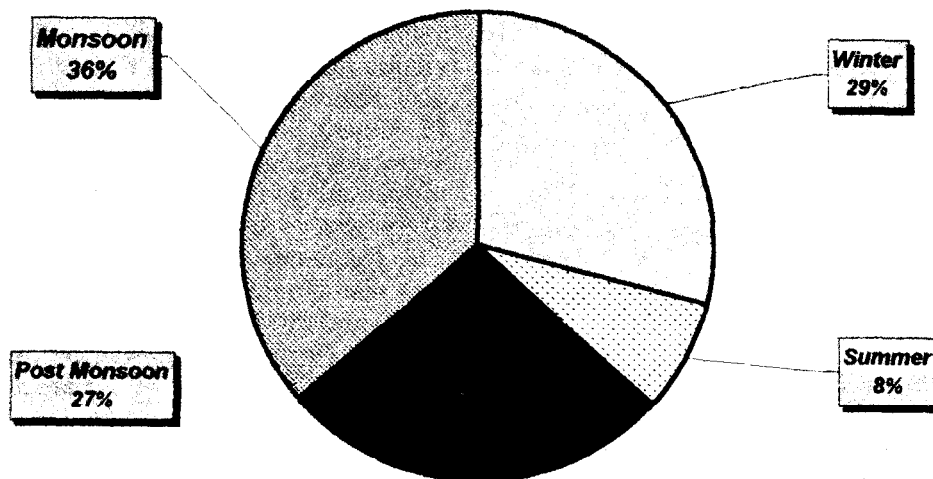
Serious efforts were made to restore this corridor by persuading army authorities to shift the ammunition dump to some other place. The army officers did not agree on technical grounds as well as on account of non-availability of alternate land. The land offered by the Forest Department did not suit to them, thus the

Fig. 2



Seasonal distribution of movement of elephants in Corridor No. 1, Rajaji National Park

Fig. 3



Number of elephants passed in different seasons through Corridor No. 1, Rajaji National Park

whole matter came to a dead end. Resettlement colony of Tehri dam oustees has about 22 houses and adjoiningly situated is the land given to them for agricultural purposes, as every oustee was

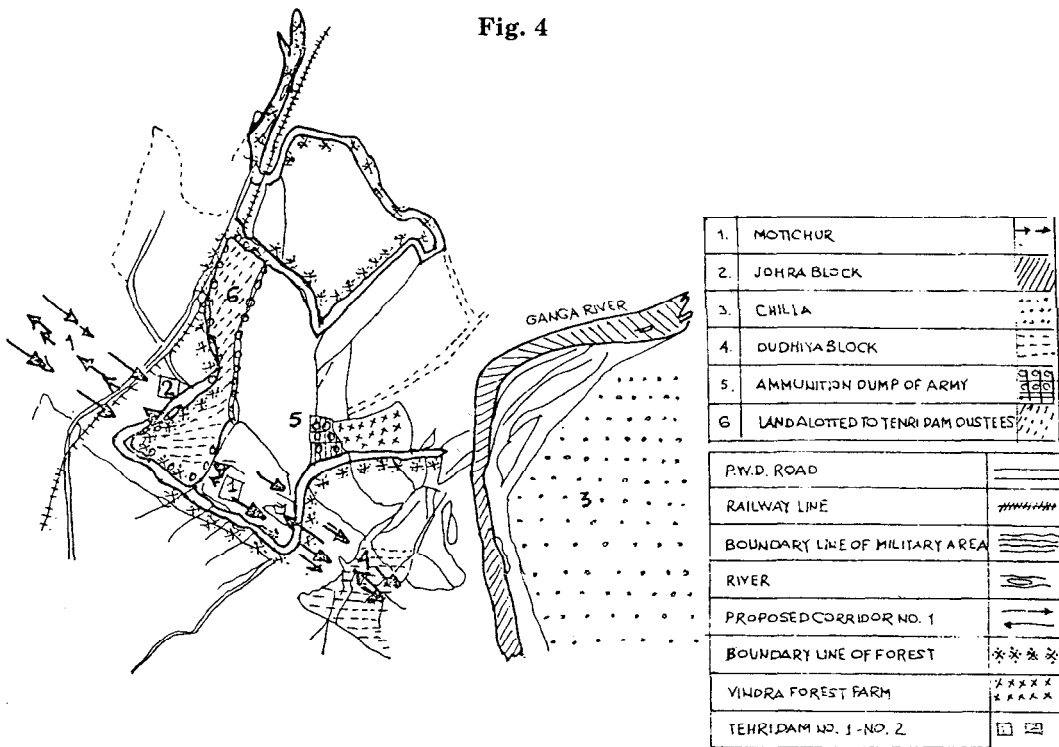
awarded 2 acres of land in lieu of displacement at the time of settlement. These people may be persuaded to opt for some other piece of land if compensated handsomely, but still the real stumbling

block remains the shifting of the ammunition dump of the army. Any possible restoration of this corridor would depend upon the nature of the decision taken in future by defence authorities. The matter is very ticklish and an easy solution is hard to find. Besides, the solution would mean incurring huge expenses and nobody knows who would bear it. The proposed corridor is indicated in Fig. 4.

The second possible corridor to connect the forests of Chilla and Motichur Ranges lies near Satyanarayan. Restoration of this corridor would also require large-scale displacement of the people of Gohri Mafi village. Though the villagers are eager to move to safer places on account of perpetual heavy floods

during every rainy season, yet the cost of compensation may be too great to bear. The elephants as a rule do not ever use this corridor for their movement for crossing over to Motichur Range but interestingly crops in and around Gohri Mafi village are raided by elephants then and now.

Beenj Rao Corridor : As stated earlier, this corridor links the forest areas on both sides of the Chilla canal with each other and facilitates movement of elephants across the canal. The canal goes underground for about 200 m where it crosses the Beenj Rao. Theoretically, elephants can move to the river Ganga for their requirements of water, but again observations of dung have revealed that the corridor is being seldom



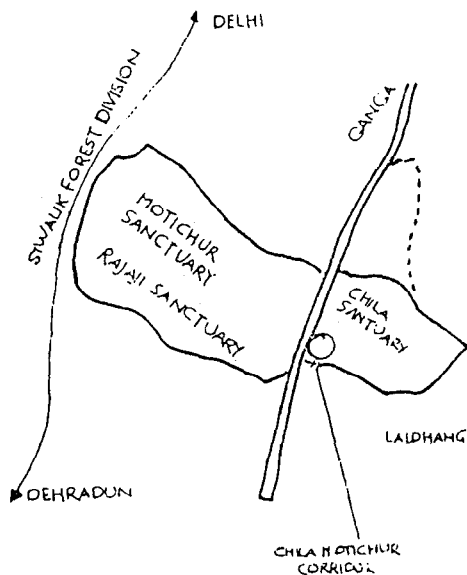
Proposed Rajaji National Park Corridor No. 1

used by big herds of elephants. This corridor is either used by single elephants or small herds. The reason is that the corridor is devoid of any vegetal cover and disturbed with too much of vehicular traffic. This corridor is indicated in Fig. 5.

All the three possible corridors have been shown in Fig. 6.

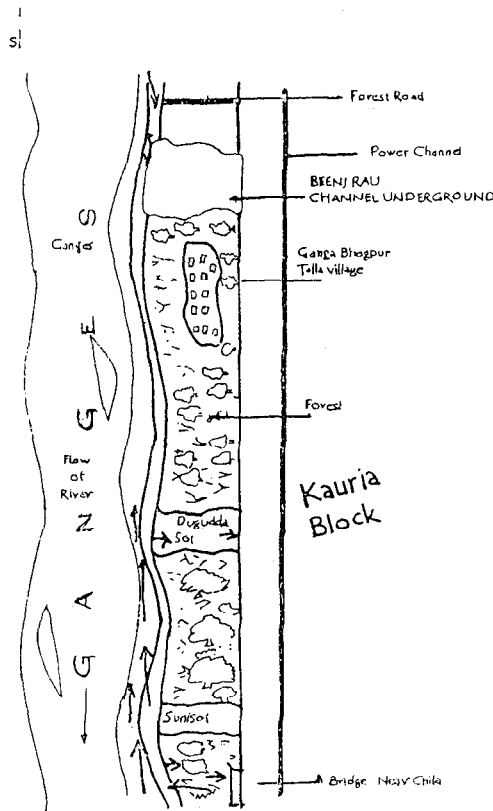
River Malan and Khoh : The construction of pucca houses on the bank of river Malan from Kadva Ashram to Kalal Ghati coupled with construction of 3 m wide canal in 1980 has threatened the use of area as unobstructed tribal path. The concrete houses fringing the banks of the Malan (Kadva Ashram to Kalal Ghati), besides 3 m wide canal has made the passage useless for the elephants. Thus Malan proves to be a great bottleneck between Laldhang and Sona Nadi Sanctuary. The Kotdwar - Lansdowne

Fig. 5



Corridor No. 2 in Rajaji - Corbett National Parks

Fig. 6



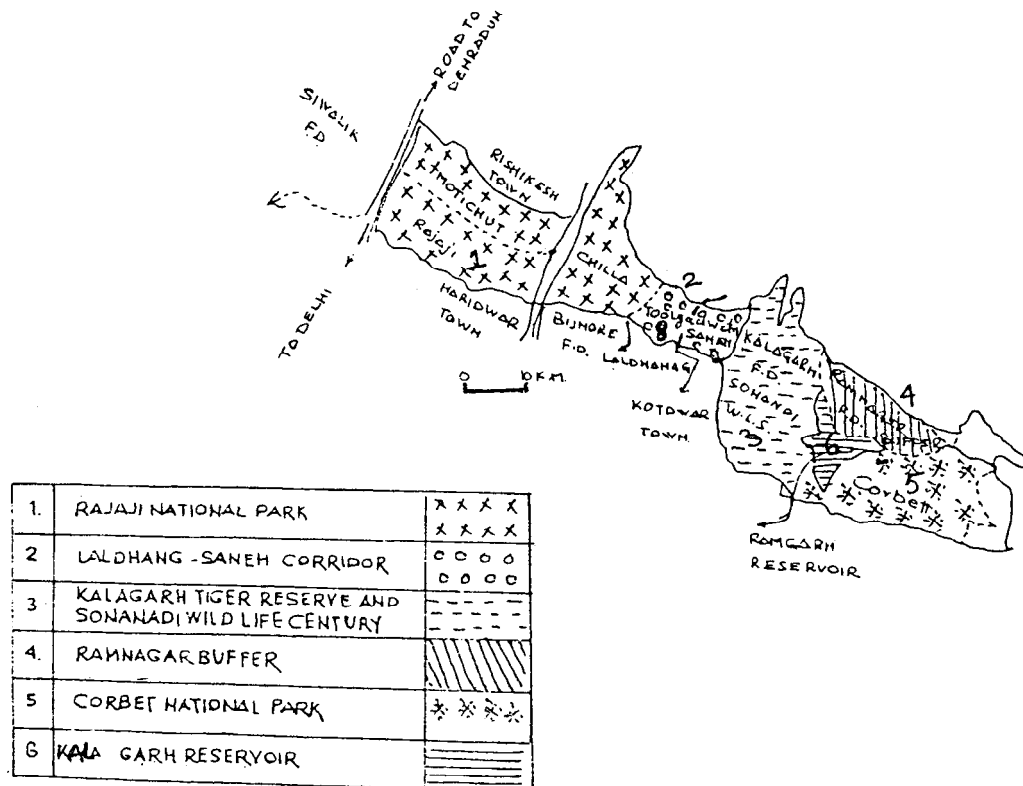
Beenj Rao Corridor

road constructed parallel to the Khoh river has resulted in steep edges and walls which impede crossing of the Khoh river by elephants, as they find it difficult to negotiate steep edges and walls. However, observations of the dung indicate that there are a few points from where elephants do cross over. The hills along with Malan river are frequented by elephants and their movement has been noticed on both sides of the river. The observations taken in 1989 and the data collected from 1989 to 1999 confirmed that elephants cross over the river. Forty-two observations revealed the passage of 22 herds and 14 single elephants. In another observation, 485

dungs indicated the passage of more animals but without having been physically noticed. Restoration of the corridor between Malan and Khoh rivers would include Toot - Gadhera Block. Thus preservation of bottleneck type of corridors between Malan and Khoh and between Lal Dhang and Saneh (Fig. 7) is possible if following measures are taken :

- (1) All forestry operations to be carried out with due consideration for elephants facilitating their movement unobstructed.
- (2) Restoration of bamboo and other fodder species of the elephants.
- (3) Strict regulations of rights and concessions exercised by the people. If possible they should be stopped in Toot - Gadhera 1 and 2, Giwain 1, 2, 3, Sukhrau 1, 2.
- (4) Rehabilitation of Gujjars in the migratory passages of elephants, particularly those who are in the very heart of the corridor.
- (5) Reduction of biotic pressure from the corridor area through proper eco-development measures.
- (6) Persuading the villagers not to grow cash crops prone to raids by elephants.

Fig. 7



Lal Dhang - Saneh Corridor

- (7) Mass-scale education and consciousness programme for villagers and agriculturists.

River Ramganga : The resident elephant population of Corbett migrates to Ramnagar - Khoh as well as Kosi - Gaula regions by crossing the rivers Khoh and Ramganga at Tootgadhwa and Gaujera, respectively. In 1974, when the Ramganga reservoir was formed submerging the Ramganga valley upto Dhikala and Sona Nadi valley up to Hathikund, the normal migratory routes namely (a) Sona Nadi - Dudhia - Boxar, (b) Halduparao - Tumeria - Dhikala and (c) Bailla Nallah - Gaujera - Phulai were blocked and the elephant population of Khoh-Ramganga and Ramganga-Kosi regions were cut off from each other. The elephants had therefore to struggle to explore new routes of migration which they succeeded to do by April 1975. This route is along the trek passing through Bailla Nallah Comptts. 1,

3, 7, 8, 14, 15 and 20, Gaujera Compartments 7, 8 and 10, then to the Park through Kanda Compartments 4, 3 and 2. Data about the movement of elephants collected during 1998-99 revealed that the elephant population of both regions crosses the reservoir at Gaujera during April-June, when the water level of Ramganga reservoir is low. Thus no corridor is suggested along Ramganga river.

River Kosi : A 20 km long corridor which connects the Corbett Tiger Reserve and Ramnagar Forest Division, is being used for the movement of elephants since long lime. The details of man-made obstructions which are coming in the way of free movement of the pachyderms are mentioned in Table 2.

The migrating routes from Tiger Reserve to Ramnagar Forest Division through the above corridor are (a) Dhikala

Table 2

Detail of obstruction in corridors

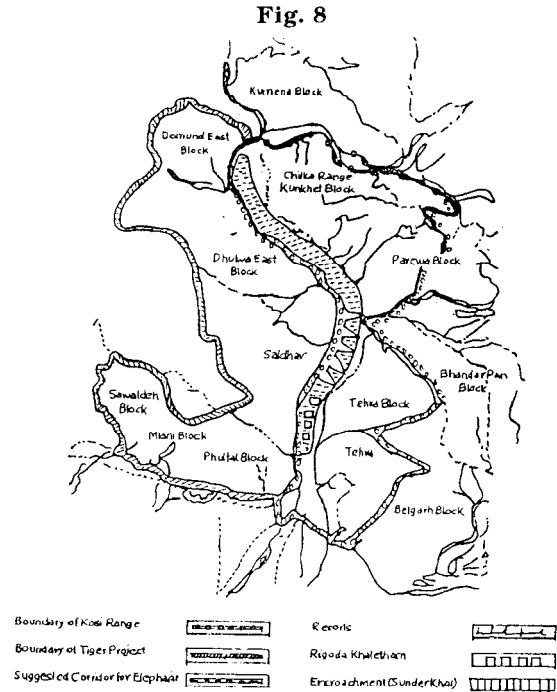
Obstruction in Corridor	Year of establishment	Remarks
Ringoda Khatta Village Encroachment	Old 1974-75	8-10 ha near Amdanda gate 73-84 ha of land has been encroached in compartment Dhulwa 9A, 9B, 11A and 11B and is presently under cultivation and habitation and is known as Sundarkhal
Tiger Top Resort, Dhikuli	1985-86	-
Corbett River Side Resort	1986-87	-
Claridges	1987-88	-
Corbett Village	1995-96	-
Jungle Camp	1995-96	-
Painama	1995-96	-
Temple Tiger	1995-96	-
New Constructions	1995-96 onward	-

- Sarpduli - Dhangarhi - Sitabani and (b) Dhikala - Paterpani - Jamnagar - Malani - Bijrani - Ramnagar Division.

There are roughly two dozen small hotels and resorts all along the Kosi, between Ramnagar and Dhangarhi. They are all pucca or semi-pucca fenced up establishments and more or less block the free passage of animals to the Kosi. The small village of Ringora-Khatta near Amdanda gate falls right into the corridor B i.e. Dhikala - Paterpani - Jamuna Gwad, and probably that is the reason the villagers of Ringora complain of frequent elephant raids on their agricultural fields. The village Dhikuli situated at a distance of 10 km from Ramnagar towards Dhangarhi has grown into a big and prosperous village and offers a number of resting places, restaurants and refreshment facilities for the tourists. The encroachment of Sunder Khal is about 25 year old. Primarily the forest land was encroached by small farmers for small gains but over the years it has grown almost into a village and hits right across the corridor A, i.e. Dhikala-Sarpduli-Dhangarhi and Sitabani.

This corridor along the Kosi (Fig. 8) is very precious and needs to be protected. This again is a massive task as lots of economic interests of the people, local as well as outsiders, are involved. The encroachment at Sunderkhal could not be vacated despite the best efforts of the forest department. Clearing of this corridor from obstructions is a monumental task requiring stupendous political will, cooperation of the local people and administrative acumen.

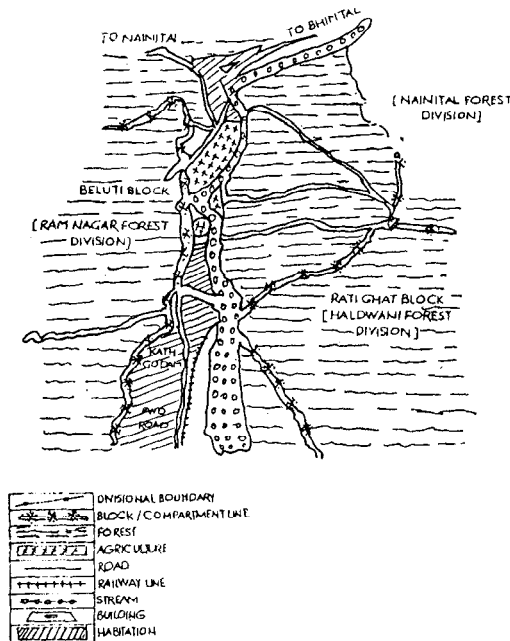
River Gaula : Elephants used to cross Gaula from Ramnagar Division to



Man-made obstructions on the bank of River Kosi and suggested elephant corridors

Haldwani Division via Haldwani-Nainital PWD road until the 1970s, but man-made obstructions on either side of the road have completely blocked the migration of elephants. A map showing the details of physical structures between Kathgodam and Ranibagh is given in Figure 9. Kathgodam is a junction of three Forest Divisions namely Haldwani, Ramnagar and Nainital. Between Ramnagar Forest Division and Nainital Forest Division from Kathgodam to Ranibagh there is a thin non-forest strip is comparatively wider and more inhabited. On either side of the non-forest strip in which above detailed structures and agricultural fields are situated. In between Ramnagar Division and Haldwani Forest Division from Kathgodam southwards, the non-forest strip between Kathgodam and Ranibagh,

Fig. 9



Man-made obstructions on the bank of
Gaula River

there are steep hill forests especially in Nainital Division i.e. on right side. Contour map indicates an average rise of 2050' with horizontal distance of about one mile. The road running from Haldwani to Nainital remains highly busy round the clock. Distance from Hanuman Mandir to Shitla Devi Mandir is about half a kilometre and detailed survey reveals that this stretch of land is not suitable as a corridor for elephants. Prior to the 1970s, the population migrating from Tiger Reserve through Kosi used to cross the Gaula on Haldwani-Nainital road near the barrage but after construction of barrage, the route has been obstructed and elephant population coming from Kunkhet, Parewa, Bhandarpani, Pawalgarh, Sadni, Musabangar, Nihal started crossing Gaula at Khamia and Bindukhatta. Gaula Block

and Lalkuan Block were very good habitats of elephants. After encroachment in Khamia Block and Bindukhatta, the migration routes explored by elephants during the 1970s have further been blocked and the two populations viz. Kosi-Gaula and Gaula-Sharda have been cut off. For free movement of elephant and to save them from genetic drift, following corridors are proposed :

Khamia Block Corridor :

I – About 2,182.47 ha of land in Khamia Block is encroached. If this encroachment is evicted and protected then it will serve as a good corridor for elephants migrating on either side of Gaula.

II – Adjacent to Khamia Block there is about 500 ha of government land which has been leased out. This area, if made available after cancelling the lease, could serve as a good corridor for the migration of the two populations locked on either side of river Gaula.

River Sharda : 230.31 ha area of the habitat on the bank of the Sharda has been diverted for construction of barrage. The construction of barrage was completed in 1992. The present survey reveals that the elephants use Chela forest of Sharda Range during summer and winter season. This population moves to Kalaunia and further to Dogaddi Range of South Pithoragarh division and also moves to Kilpura Range of East Tarai Forest Division. During harvest season these elephants also move to the nearby villages of Chini forests and Kakrali forests and damage the agriculture crops of Ambagh, Naikoth at Gandakhali village. There are 66 small 'tapus' (islands) with forest in the bed of Sharda river. Sometimes elephants are also seen in these 'tapu' forests which are near Nepal forests. Prior to construction of the barrage,

elephants from Chela forest used to visit Nepal forests, and vice-versa, but presently their movement beyond Kakrali forests has been obstructed because of settlement of villagers near Kakrali, Purnagiri and Batangad Nala. Now the people are cultivating the area between Kakrali-Purnagiri road and Sharda river. During harvest season when elephants raid the agricultural crops, farmers use fires at night to frighten away the elephants. In recent years more and more people are visiting Purnagiri temple, so there is lot of rush on this road during Mela season i.e. from April to June. Due to construction of barrage on Sharda river, the points from where elephants were crossing the river have grown deeper making the task difficult for elephants.

The possible corridor for elephants may be Chela forest to Dwa, Kakrali Naghan and there to Nepal via Batnagad Nala. Till 1964, elephants used to migrate to Dudhwa via Nepal but due to large-scale green felling in Nepal and rehabilitation of ex-army personnel on Indo-Nepal borders, the migration to Dudhwa National Park is now stopped.

The migrating elephant population of Berdia-Chhuria sector in Nepal and Shivalik sector in India are believed to have used to Laggabagga corridor for inward and outward movement to Tarai forests of Pilibhit and Lakhimpur. A few elephants have also been observed to move into Katarniaghat Sanctuary from the forest areas of Royal Berdia National Park in Nepal. The connectivity of Dudhwa with Katarniaghat is very weak. Only stray bulls have been observed rarely taking this route for movement. The local migration of elephants in Dudhwa is observed to be through river basins of

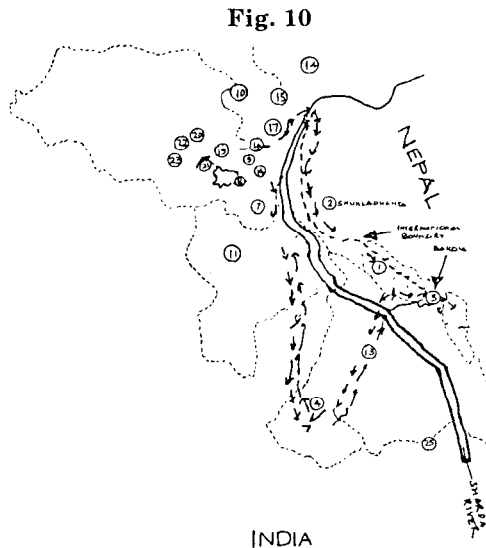
Newra, Nagraul, Suheli etc. Today the elephant occurs in isolated sub-populations, the most significant and irreparable break in its range being the cultivated areas close to the Sharda river which were earlier forested. The population in the Tarai, East of Sharda (Dudhwa population) is totally isolated from rest of the population by a distance of about 120 km.

(a) The forests of Pilibhit are connected to Kishanpur Sanctuary via the forests of Khutar (Shahjahanpur) and Bhira (South Kheri) ranges which form the forest buffer around Kishanpur Sanctuary. This connectivity to Kishanpur is potentially important for the movement of elephants from Dudhwa to Suklaphanta Sanctuary in Nepal. However, the problems related to biotic pressure and encroachment are needed to be assessed and addressed.

(b) The Laggabagga corridor of about 590 ha which connects Pilibhit and Suklaphanta Sanctuary in Nepal is a keystone corridor allowing movement of elephant population from Dudhwa and Kishanpur right up to Nepal. Large tracts of this corridor, denuded owing to encroachment, need to be restored. This area is also under heavy biotic pressure and illicit felling.

(c) The Belha corridor between Pilibhit and South Kheri, a stretch of forest land of which 1,400 ha lies in Pilibhit Forest Division (about 5,000 ha is notified u/s of Indian Forest Act) unfortunately is under encroachment by Bengali refugees.

(d) The migration route between Kishanpur and Dudhwa comprises of forested patches of Lagdahan, Paraspur, Ghola-Gajraula etc. in the North Kheri



- | | | |
|-----|------------------------|-------|
| 1. | Dudhwa National Park | O |
| 2. | Shuklaphanta WLS | O |
| 3. | Bardia | O |
| 4. | Kishanpur | O |
| 5. | Tanakpur | O |
| 6. | Banbasa | O |
| 7. | Laggabagga | O |
| 8. | Kilpura | O |
| 9. | Kakrali Forest | O |
| 10. | Naghan Chim Forest | O |
| 11. | Pilibhit | O |
| 12. | Sharda River | O |
| 13. | Kheri | O |
| 14. | Puranagiri | O |
| 15. | Batanagarkhala | O |
| 16. | Nal Goth | O |
| 17. | Gonda Khal | O |
| 18. | Aambagh | O |
| 19. | Dwan | O |
| 20. | Chini | O |
| 21. | Ghalla | O |
| 22. | Kalonia | O |
| 23. | Dogari | O |
| 24. | International Boundary | ----- |
| 25. | Suheli River | O |

International Elephant Corridor

Forest Division. The cultivated areas to the North of Sharda river restrict free movement of the animals. However, old river courses called 'bhaghars' enable connectivity in the cultivated stretches. The international elephant corridor is shown in Fig. 10.

Parameters of Genetic Drift

The fragmentation of elephant habitats and general neglect of the corridors have led to a situation where elephant population is locked into small pockets resulting in the threat of genetic stagnation and inbreeding. This problem is to be addressed in the interest of long term survival strategy of the Indian elephant. This problem was studied in detail and on the basis of 1997 census, sex ratio and viable population in respect of different regions of habitat was computed (Table 3). It was deduced that sex ratio, viable population, minimum viable area and habitat integrity are the parameters determining genetic drift.

Elephant population and density - Regional variation

A survey was also conducted regarding the density of elephants in the study area. The data presented in Table 3 depicts the distribution of male, female and calf population within the various regions of the study area during May 1997. The maximum number of elephants was observed in Yamuna-Ganga region and an equal number of elephants was in Ganga - Khoh and Ramganga - Kosi regions. These areas are in the North of the study area from where elephants move towards eastern direction i.e. Gola-Sharda area. This gives an indication of elephant movement in between the Yamuna and

Table 3*Region-wise details of distribution and viable population of Elephant*

Region	Male	Female	Calf	Total population	Total area (ha)	Sex-Ratio	Viable population	Density per ha
Yamuna-Ganga	131 (44.67)	117 (39.00)	52 (17.33)	300	1,47,251.38	100:089	247	491
Ganga-Khoh	112 (25.34)	200 (45.25)	130 (29.41)	442	88,887.80	100:179	287	201
Khoh-Ramganga	46 (19.49)	132 (55.93)	58 (24.58)	236	77,061.90	100:287	136	327
Ramganga-Kosi	113 (18.40)	295 (48.05)	206 (33.55)	614	75,939.20	100:261	327	124
Kosi-Gaula	04 (57.14)	02 (28.57)	01 (14.29)	07	98,424.39	100:050	05	14,061
Gaula-Sharda	15 (21.43)	35 (50.00)	20 (28.29)	70	2,26,232.49	100:233	42	3,232
Dudhwa Nat. Park	03 (50.00)	02 (33.33)	01 (16.67)	06	88,373.90	100:067	05	14,729
Grand Total	424	783	468	1675	8,02,171.06	100:185	1100	33,164

Figures in parantheses are the percentage of total population in the respective region.

Sharda and confirms that the population is not completely locked off by large scale obstruction created by human beings.

The data of Table 3 was statistically analyzed and Null Hypothesis was tested using the Chi-Square test. The results are presented in Table 4.

As the calculated value 89.798 is much higher than the tabulated value, therefore, the difference between the observation and expected value is significant. Hence null hypothesis has to be accepted. There is no relation between the male, female and calf population of elephants. This also indicates that the population recorded during May 1997 is not the permanent population which is on move towards river Sharda

and the population are not permanently locked between the regions delineated in the study area.

On the basis of analysis of the entire data following comments can be made :

(a) *Sex Ratio* : The most important aspect of elephant's long term survival is the sex ratio. Since male elephants suffer a higher mortality than females from natural causes and poaching, the sex ratio of adults is usually unequal. At best it may be 1 male : 2 females and at worst it may go up to 1:20 or even more disparate as in parts of Southern India. The more unequal the sex ratio, the higher is the rate of genetic drift. The population locked in Khoh-Ramganga, Ramganga-Kosi and Gaula-

Table 4

Statistical analysis of population data

Items	Observed	Expected	(O-E)^2	
	O'	E'	O-E'	E
1	2	3	4	5
YG*M	131	76	55	39.920
YG*F	117	140	-23	3.851
YG*C	52	84	-32	12.080
GK*M	112	112	0	0.000
GK*F	200	207	-7	0.212
GK*C	130	123	7	0.343
KR*M	46	60	-14	3.160
KR*F	132	110	22	4.260
KR*C	58	66	-8	0.956
RK*M	113	155	-42	11.580

Contd...

1	2	3	4	5
RK*F	295	287	8	0.222
RK*C	206	172	34	6.917
KG*M	4	2	2	2.802
KG*C	1	2	-1	0.467
GS*M	15	18	-3	0.417
GS*F	35	33	2	0.159
GS*C	20	20	0	0.010
DNP*M	3	2	1	1.445
DNP*F	2	3	-1	0.231
DNP*C	1	2	-1	0.273
Total	1675	1675	0	89.798

Therefore the value of Chi-Square = 11.714
d.f. = (7-1) * (3-1) 6 x 2 = 12

For 12 degrees of freedom value of Chi-Square at 5% level of significance from Table 4 is = 21.026.

Sharda are sensitive to the problem if these corridors are not properly maintained.

(b) *Viable Population* : Since most Asian elephant population are small and isolated the goal should be to maintain an effective population size of at least 50 breeding individuals to counter inbreeding depression in the short term. A population

having 20 adult males and 40 males satisfies the criterion. This translates into a total population of 125-150 elephants. If the sex ratio is more unequal than 1:2 these figures will correspondingly increase. The population of Kosi-Gaula, Gaula-Sharda and Dudhwa National Park is less than the viable population and calls for immediate restoration of traditional tribal travel path.

SUMMARY

The North-Western Himalayan population of the Indian elephant, *Elephss maximus*, used to be distributed contiguously from the River Yamuna to the River Sharda in the past. This population was studied in the last decade of the twentieth century. The past migration patterns of elephants were compared with current movements in this region. The present day migration of elephants is localized and seems chiefly influenced by fodder and water requirements. The causes behind the fragmentation of elephant habitat mainly river valley projects and major construction works taken up after independence in the wake of development drive have been discussed in detail. The viability and ways means of restoring the possible corridors are discussed and a strategy for the long-term conservation of this population is suggested.

भारतीय हाथियों की उत्तर-पश्चिमी संख्या वाले प्राकृतावास के संरक्षण के लिए एक समरनीति
के.एन. सिंह

सारांश

भारतीय हाथी (*एलिफस मैक्जीमस*) की उत्तर-पश्चिमी हिमालय प्रदेश की संख्या विगत काल में यमुना नदी से लगाकर शारदा नदी तक सतत रूपेण फैली हुई थी। इन हाथियों का अध्ययन बीसवीं शताब्दी के अन्तिम दशक में किया गया था। हाथियों की पिछली प्रजनन सज्जाओं की तुलना उनके इस क्षेत्र में होने वाले वर्तमान गमनागमन के साथ की गई है। हाथियों का आज दिनों का प्रजनन कुछ स्थानों तक ही सीमित रह गया है और प्रतीत होता है कि यह प्रधानतः चोर और पानी की जरूरतों से ही प्रभावित है। हाथी प्राकृतावास का विखण्डन होने के पीछे प्रधानतः स्वतन्त्रता प्राप्त हो जाने के बाद विकास करने की दौड़ आरम्भ की गई नदी घाटी परियोजनाएं और बड़े-बड़े निर्माण कार्य ही कारण रहे हैं, जिनका विस्तार से इसमें अध्ययन किया गया है। संभावी हाथी गलियारों की सजीव क्षमता और उन्हें फिर से गतिमान बनाने के उपायों का विवेचन किया गया है, और हाथियों की संख्या दीर्घकाल तक कैसे संरक्षित बनी रहे, इसकी समरनीति भी सुझाई गई है।
