Chapter 5
Elephant Migration and Dispersal: A Biogeographic Process

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Abstract This chapter focuses on the biogeographical processes of elephant migration. The chapter is based on different dimensions of elephant migration in the study area. It starts by briefly reviewing the historical perspectives of elephant migration. Secondary information on the number of migrated elephants and the duration of stay in the destination habitat was collected from different forest beat, range and divisional forest offices and was analysed through statistical tools. Migration routes and their temporal shift have been identified through geographic information systems and were verified by ground information. When one analyses the nature and characteristics of elephant movement, some interesting facts come up. There is a strong relationship between crop calendar and migration and it can be seen that the movement is season-dependent. These facts were justified by correlating different variables and are represented through different cartograms. Movements of elephants within different patches were tracked and depicted in forest fragment maps. It may be useful to forecast the movement of elephants to avoid conflicts and agricultural loss. Another tendency is that migrated elephants turn into residential elephants, which becomes a major issue in the destination habitat as it raises the issue of human–elephant conflict as well as that of conflict between residential elephant and migrated elephant. This chapter addresses both of these issues.

Keywords Migration process • Trend of migration • Migration routes

5.1 Introduction

Human–animal conflict is a common phenomenon for animal species that migrate from their original habitat to another destination habitat. This kind of animal movement may be seasonal or annual. On the basis of the type of movement, the biogeographical processes of migration can be divided into non-recurrent directional movements and recurrent seasonal movements. Animals usually migrate from one place to another place that has more congenial environmental conditions, in search of new breeding grounds or food. The broad spectrum of migration includes movement behaviour of the respective animal species stressed by food uncertainty and the spatial heterogeneity of the resource base over a time scale, climate change and so on. Seasonal migration is found among birds, fishes and insects (Dingle and Drake 2007). Such animals are mainly '*r*' strategists with respect to their behaviour for survival and are capable of developing their colony through a higher rate of reproduction in a harsh, unproductive environment. For such species, a time span of one generation more or less equals the life span of their habitat. Because of the shorter span of their habitat, they manage to survive through migration to newer habitats and their population dynamics is characterised by migration and a population boom-and-burst cycle (high rate of reproduction).

The large and long-lived animals living in a habitat, whose life span is much longer than the time span of a generation, follow '*K*' strategy for their survival. Elephants are the '*K*'-strategists living in a less harsh, fairly constant and predictable

but competitive environment, and their population follows the carrying capacity of the habitat. They maintain a lower rate of birth and death. Hence, the migration of '*K*'-strategists is determined by the environment, nature of habitat, availability of food and ecological settings. In a fragmented landscape, their movement behaviour is more sensitive and they are found to leave their original habitat in search of a suitable habitat. Probably the elephant migration from Dalma to Panchet Forest occurs because of habitat disturbance in the Dalma region.

5.1.1 Habitat Requirements for Elephants

Another important theoretical consideration of our proposed work is the habitat requirements for the elephants. Elephant habitat selection depends on their forage behaviour. Elephants are wide-ranging animals requiring a large extent of continuous stretches of forests for food, shelter and water. The main habitat requirements are listed here:

- A herd of 100 elephants would require a minimum of about 650 km^2 of area.
- The home range size varies according to topography and types of vegetation.
- They spend about 70 % of their time feeding, which varies with seasons.
- Grasses, bamboo, paddy and any kind of vegetation are the main foods.
- Iron, copper, boron, calcium and sodium are the important necessary minerals; they have developed bark-feeding behaviour to obtain them.
- They consume 1.5 % of their body weight in 12 h of feeding.
- They require 100 L water at one time and 225 L of water in a day (Fig. 5.1).

We collected information regarding elephants' preference for habitat selection from the affected villages through a questionnaire survey. Three main factors chosen for habitat selection are food, shelter and source of water. The responses for these three factors indicate that food and undisturbed area are mostly favoured by migrated elephants.

5.2 Historical Perspective of Elephant Migration in the Study Area

In *Bengal District Gazetteers* in 1911, L. S. S. O'Malley recorded that a large number of wild animals including wild boar, spotted deer and porcupine were found to exist in the dense forest of Bankura district. But in southern West Bengal, elephants were abundant in the dense sal forest of Midnapore district and its adjoining areas in the early 1900s (O'Malley 1911a, b). When private forests were transferred to the forest department in 1955, few wild animals, including no resident herd of elephants, could be found anywhere in the forest. They remained rare until the 1980s because of forest degradation and poor areal coverage of coppice sal forests (Malhotra 1995; Palit 1991; Panda 1996).

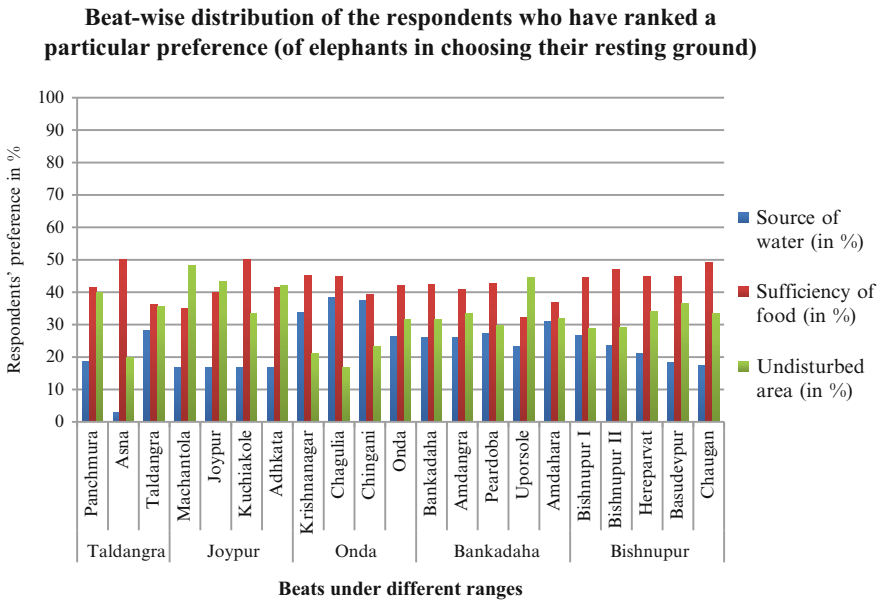


Fig. 5.1 Preferences for habitat selection

A few scattered individuals lived in the hilly region of Ajodhya Pahar and Bandwan range of Purulia district (situated along the western border of the study area). Thus, before the 1980s, there was no incidence of elephant migration in the southern West Bengal area except in the year 1976, when a herd of 42 elephants migrated from the Dalma area to Sindri of the Purulia district and stayed there for 20 days. They caused damage to paddy and killed two people (Shahi 1980).

As of the 1980s, elephant migration became a regular issue. In 1987, a herd of 50 elephants from southern Bihar moved to West Bengal after the wet season and stayed through the winter season (Sukumar 2003). Ironically, the elephants' decision was aided by the success of forestry projects in West Bengal (Datye and Bhagwat 1995) under which large patches of degraded forest were turned into regenerated forest. These forest patches provide corridors for movement and convenient shelter to elephants. In December 1987, the elephants left Dalma Wildlife Sanctuary and moved east by crossing Kangsabati River and entered Lalgarh range of West Medinipur district. Forest in these tracts was regenerated through successful implementation of the Joint Forest Management Programme. The forest patches in these tracts are surrounded by populated villages with paddy and ample water sources. Since 1988, the elephants have ventured into Bishnupur after crossing the Silabati River. As of 1995, the elephant herd had crossed the Dwarakeswar River and moved towards the northern forest division of Bankura district. They extended

their territory to Beliatore Forest of Bankura North Division as of 1999. During this time, another new herd entered the study area, crossed the Damodar River to the Burdwan district and returned. Today about 3–4 herds consisting of 15–70 elephants come each year in the Panchet Forest Division (PFD), and a group of elephants now stays throughout the year along with the residential elephants. They frequently move around the forest patches of Bankadaha, Bishnupur, Piardoba and Joypur during their stay in the Panchet Forest area.

5.3 Elephant Migration Trend: Volume and Duration of Stay

Data collected from the Forest Department show that the number of migrated elephants increases day by day. In 1997, a herd of 46 elephants migrated from Dalma Wildlife Sanctuary, but this number increased to 130 or 140 in 2011–2012. After entering the study area, the herd are segregated into smaller groups and roam within the forest patches, raiding crops, damaging mud houses and vegetables and creating serious problem that ultimately end with human–elephant conflict. In 1996, 44 elephants migrated in PFD. That number increased to 145 in 2012, including 110 elephants from Dalma and 35 from Purulia district. Forest department records depict a continuous increase in migrated elephants.

The diagram is self-explanatory. It clearly shows that there is a continuous increase in migrated elephants. The interesting fact is that initially only the Dalma herd invaded the southern West Bengal area, but a recent forest department report states that another herd is coming from Orissa through the Mayurjharna Elephant Reserve area. The physical appearance of this herd is different from that of the Dalma herd. These elephants are short in stature and their body colour is lighter. Their depredation is more harmful than that of the Dalma herd. According to forest department officials, this herd of elephants is more intelligent than the Dalma herd (Figs. 5.2 and 5.3).

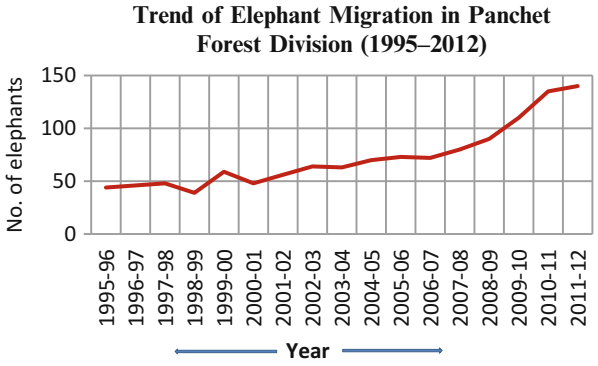


Fig 5.2 Trend of elephant migration in Panchet Forest Division in 1995–2012

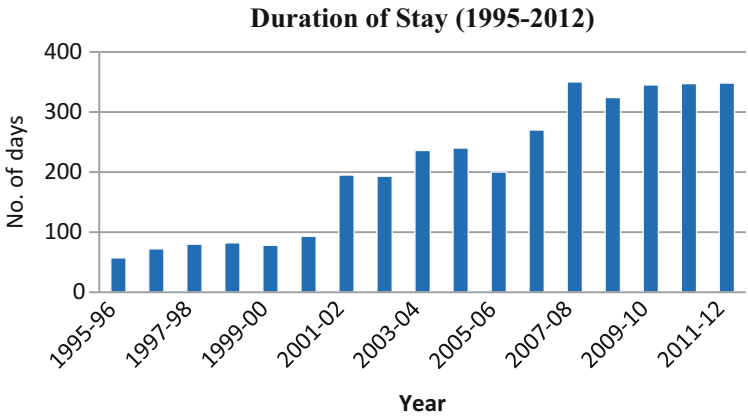


Fig. 5.3 Duration of stay at Panchet Forest Division in 1995–2012

Along with an increasing number of migrated elephants, the duration of stay in the study area has also increased. Initially, these elephants used to come just after the rainy season in late September and early October and return back to Dalma in January. But recently a change regarding the duration of stay was noticed (Kulandeival 2010). The information taken from the forest department reveals that 6–12 residential elephants roamed in the fragmented forest throughout the year 2010. Now one can see a trend of migratory elephant transforming into residential elephant. The number of elephants becoming residential is increasing, while the number of elephants that return back to their original habitat is noticeably decreasing.

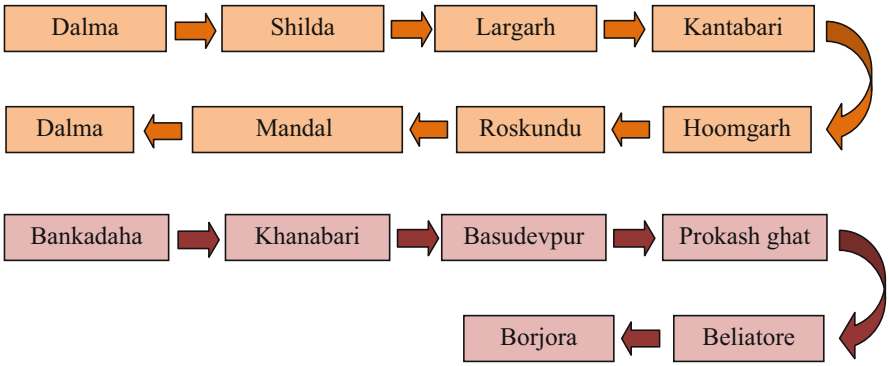
Plate 5.1 Solitary bulls raiding in agricultural field

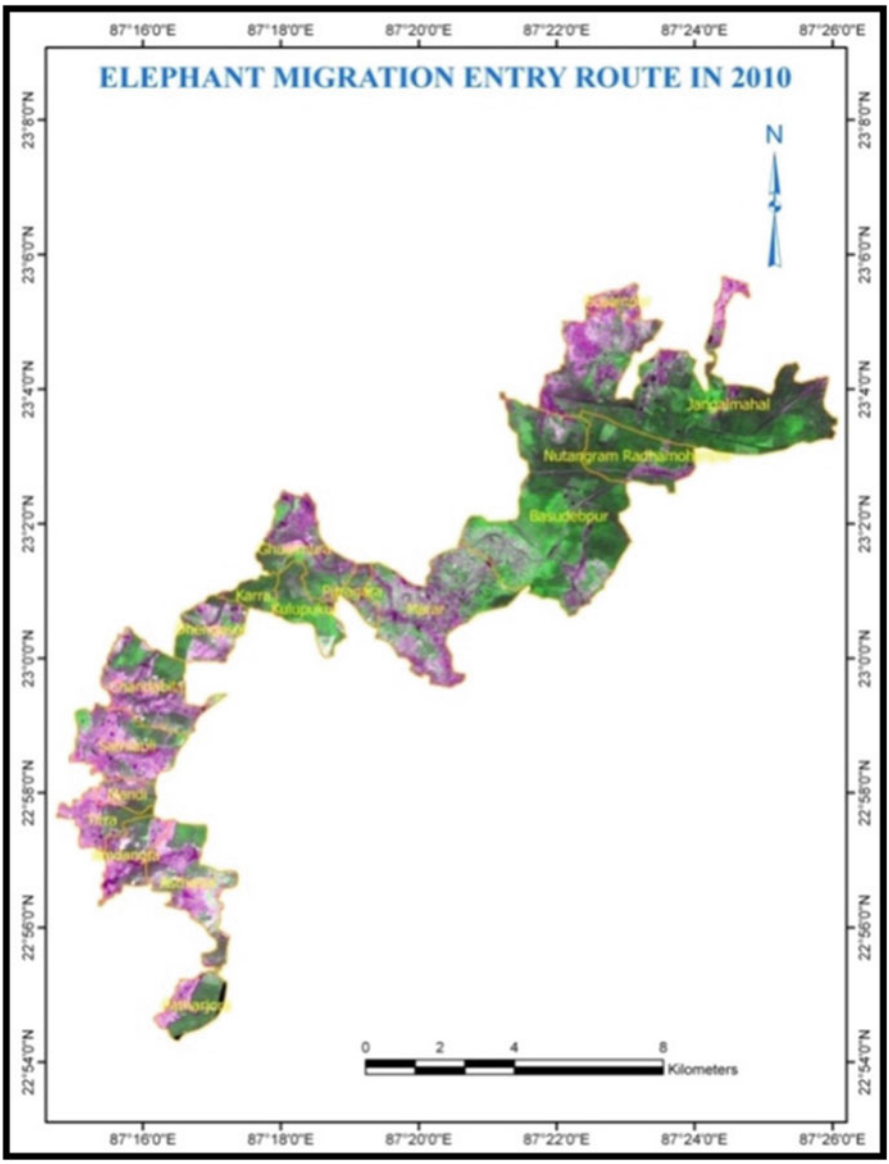
Plate 5.2 People throwing stone at elephant

5.4 Elephant Migration Routes and Their Temporal Shifts

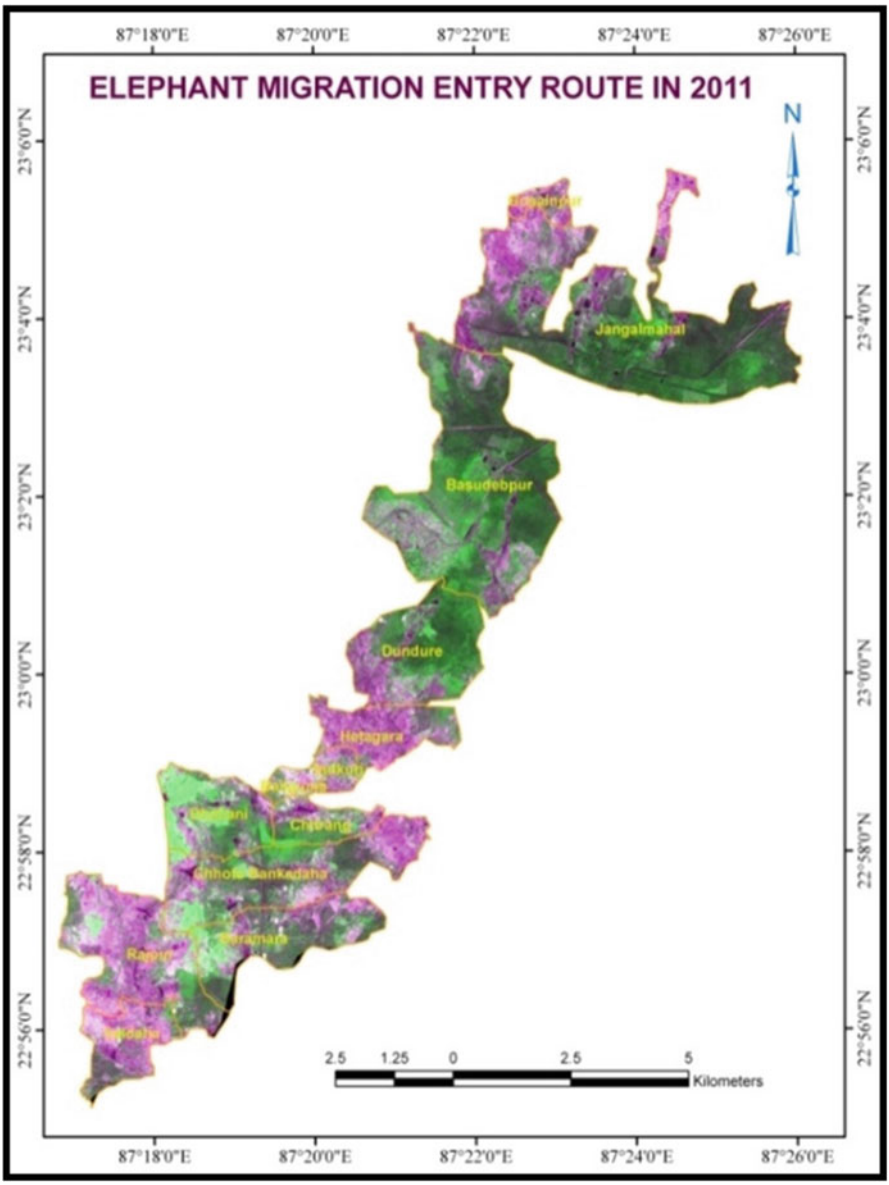
Elephants migrated from Dalma select the fragmented regenerated forest patches as their route or corridor. This corridor can be well identified on open source images. Initially, the herd used to come to Paschim Medinipur district from Dalma and return back to Dalma. But in 1987 they started penetrating different parts of Bankura district. Because of this situation, the government declared a new elephant reserve, Mayurjharna Elephant Reserve, in 2002 consisting of parts of Bankura, Purulia and Paschim Medinipur districts. Now, however, hardly any elephants stay at Mayurjharna. All of the Dalma elephants move to the study area and venture into new areas for food. They cross the Damodar River and enter Burdwan district.

After entering the study area, they bifurcate into different groups. Their entry route generally covers the areas of

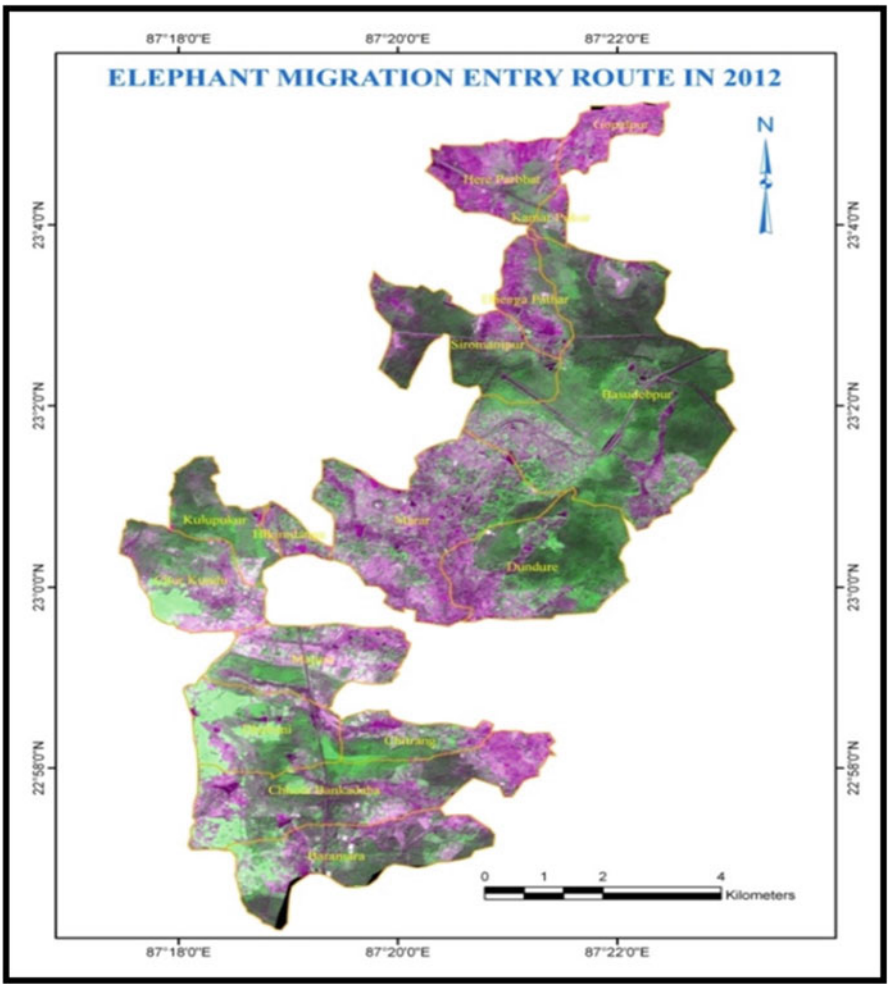




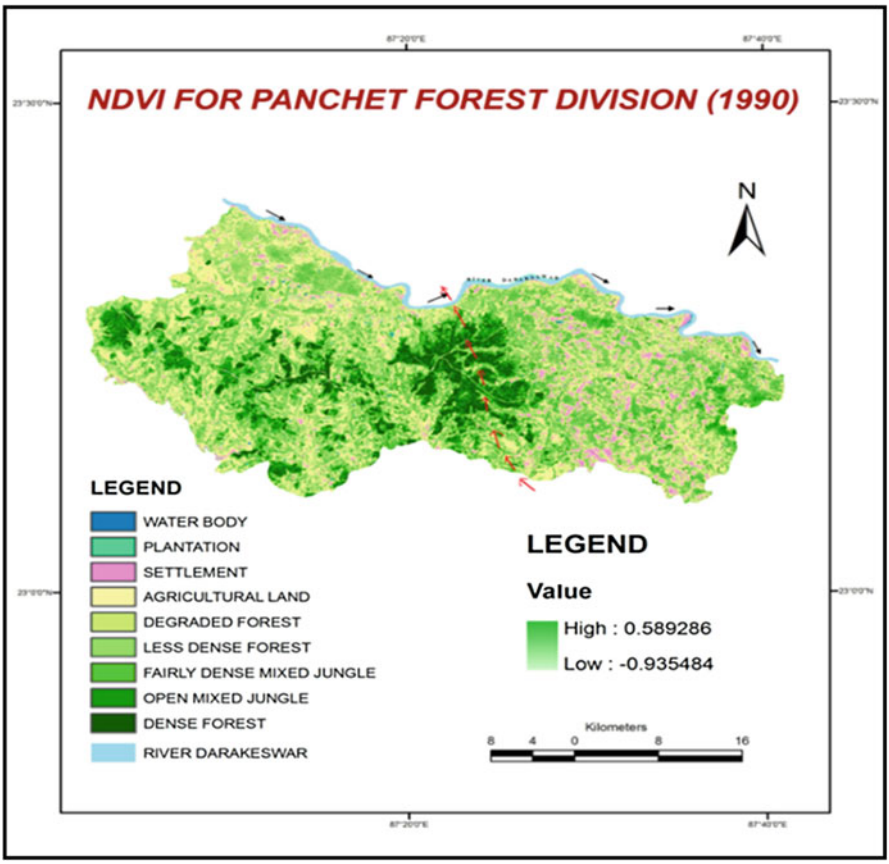
Map 5.1 Elephant migration entry route at Panchet Forest Division, 2010



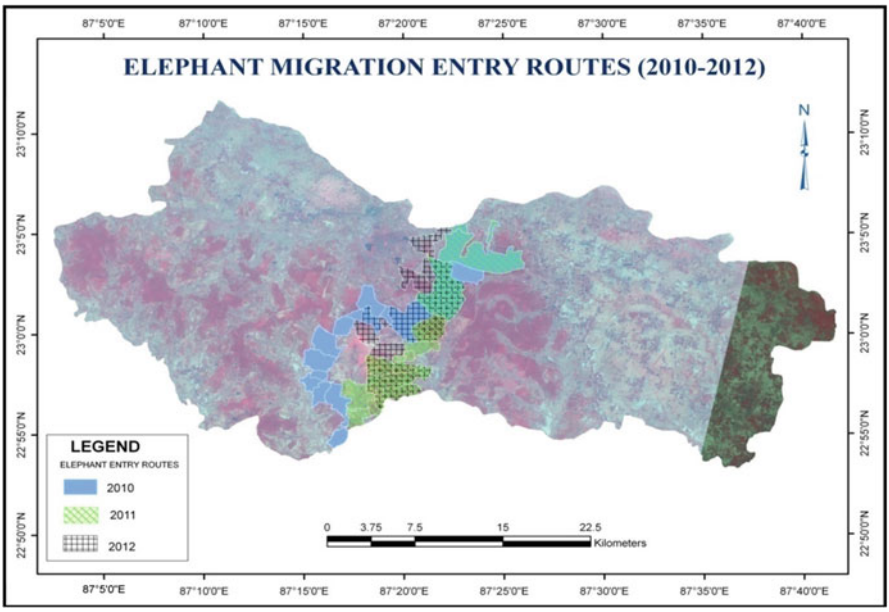
Map 5.2 Elephant migration entry route at Panchet Forest Division, 2011



Map 5.3 Elephant migration entry route at Panchet Forest Division, 2012



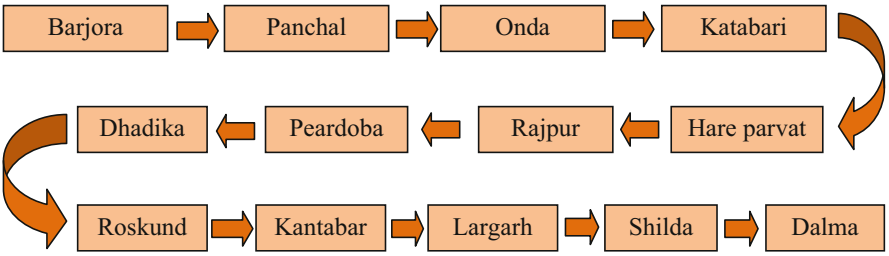
Map 5.4 Normalised differential vegetation index and entry route at Panchet Forest Division, 1990

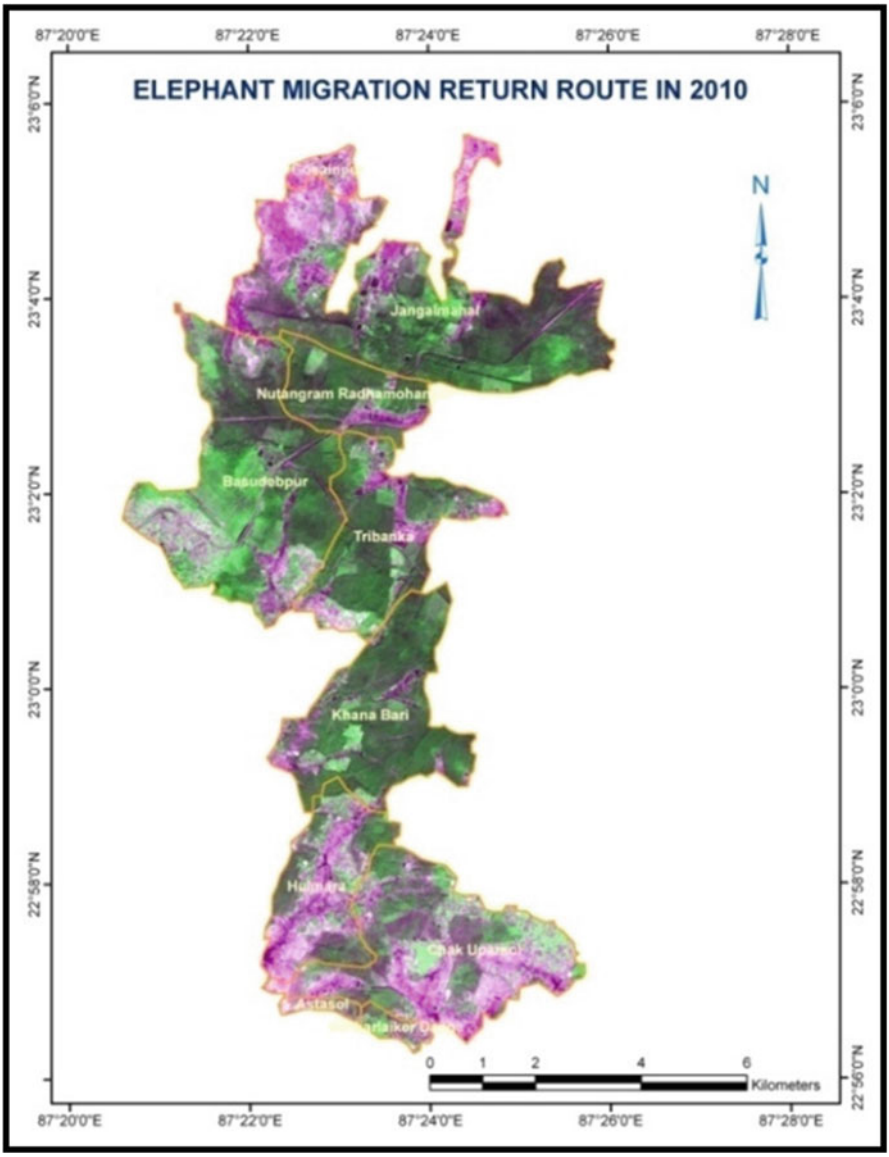


Map 5.5 Shifting entry route in the years 2010–2012

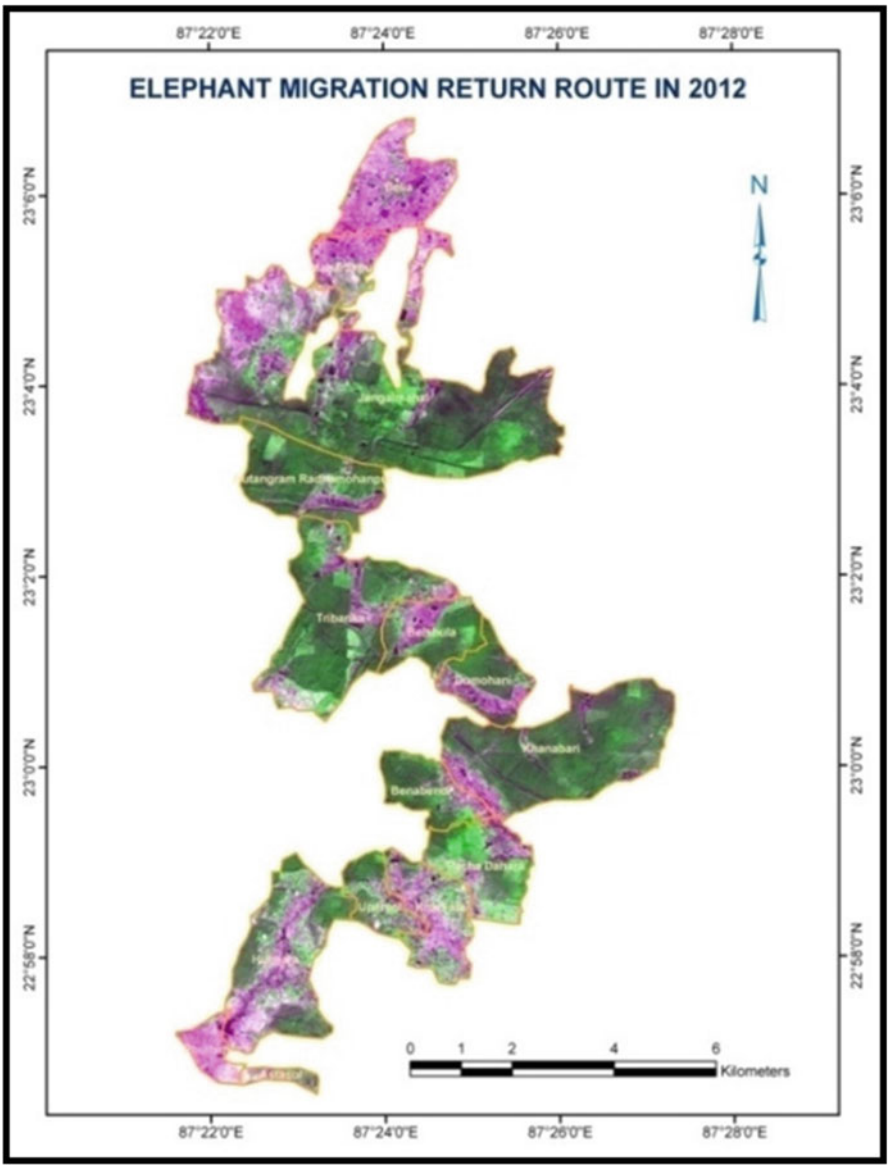
5.4.1 The Common Return Route

The temporal data on elephant migration routes have been taken from the divisional forest office and field survey. The data reveal that the migratory elephants change their routes very frequently. In the study area there has been a shift of routes to the east gradually over the years. The main reason behind this is that the land use in the eastern part is dominated by agriculture. From these crop fields they can easily access food. We have plotted the entry route on the normalised difference vegetation index (NDVI) map of PFD (Map 5.4). The NDVI value is physiologically related to the canopy chlorophyll content, which absorbs the photosynthetically active radiation. The index value shows sensitivity to the degree of canopy chlorophyll content and to the absorbed photosynthetically active radiation. Thus, when there is an increase in plant growth, the value increases, and vice versa. The moment of elephant is positively related to the NDVI value of the forest patch.

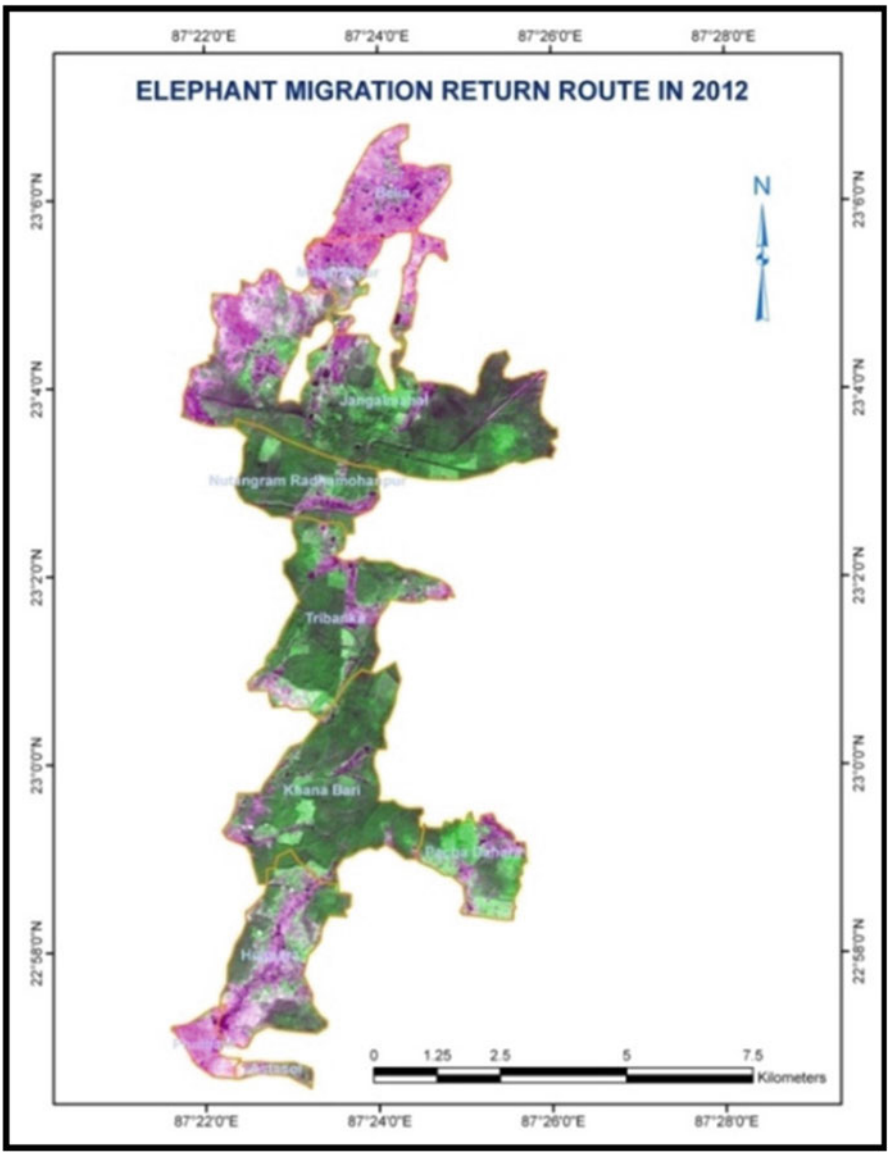




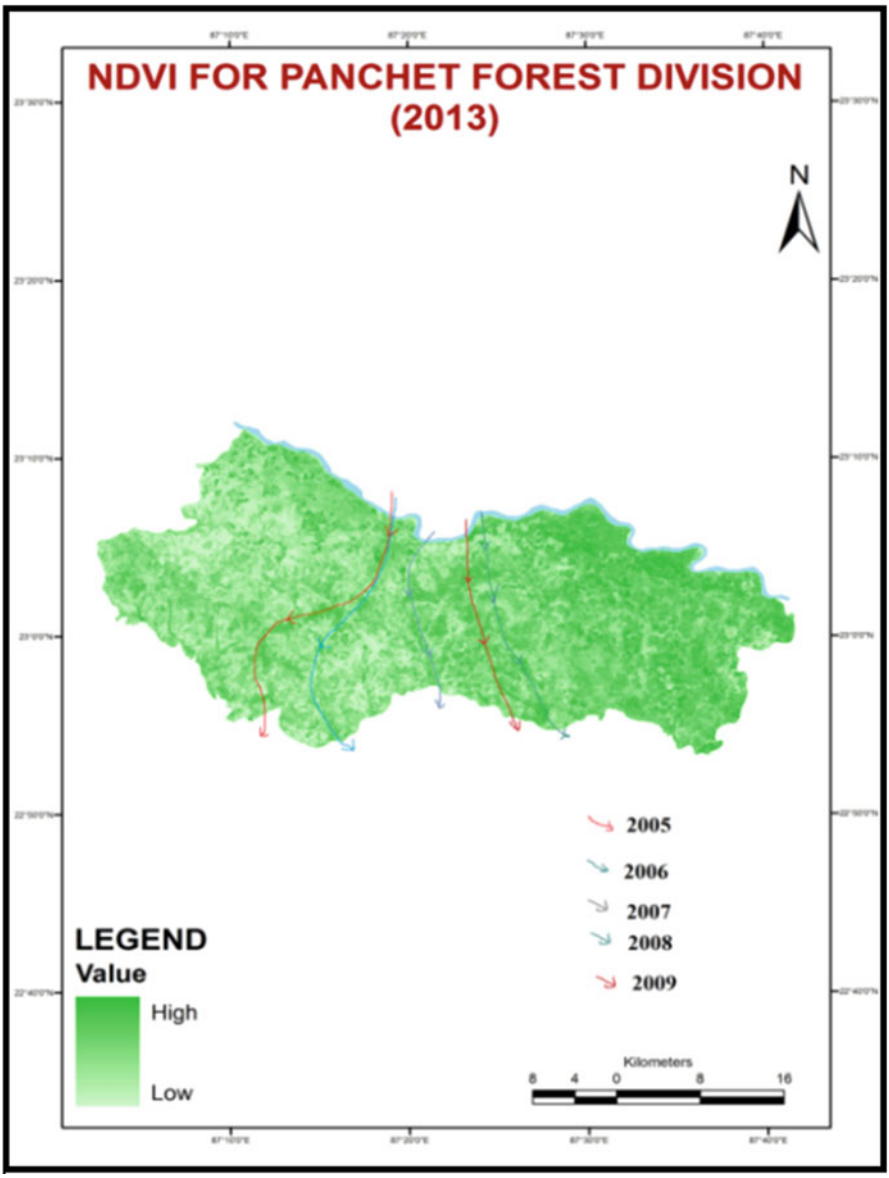
Map 5.6 Elephant migration return route from Panchet Forest Division to Dalma, 2010



Map 5.7 Elephant migration return route from Panchet Forest Division to Dalma, 2011

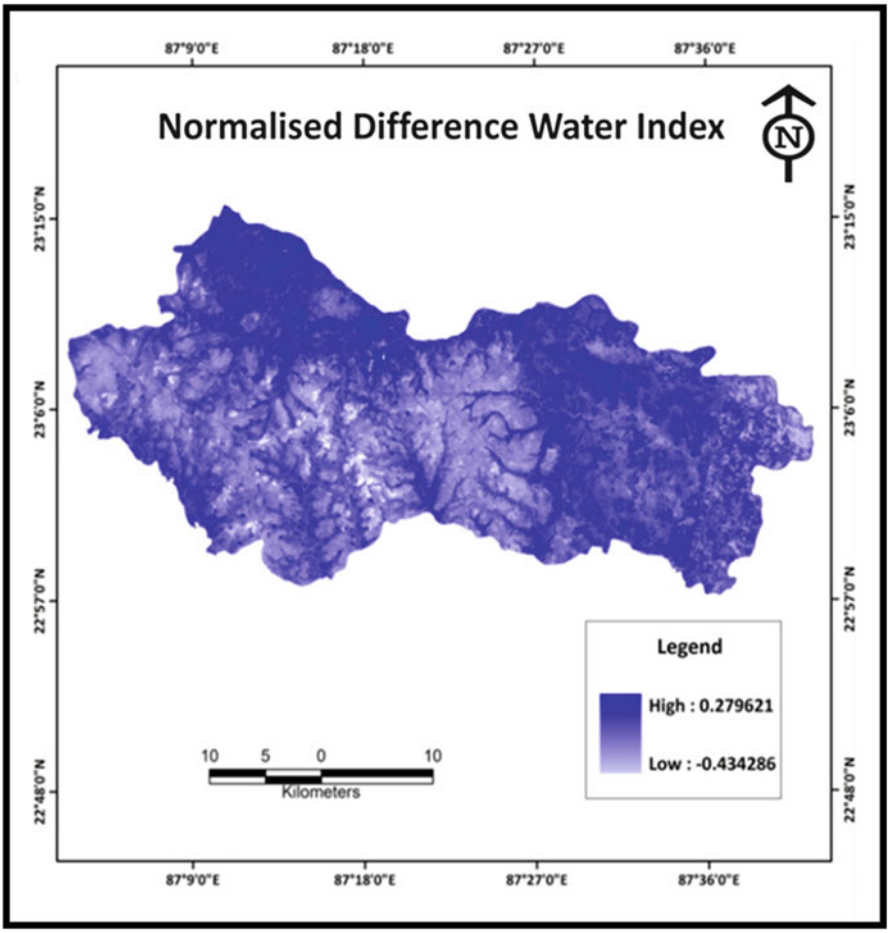


Map 5.8 Elephant migration return route from Panchet Forest Division to Dalma, 2012

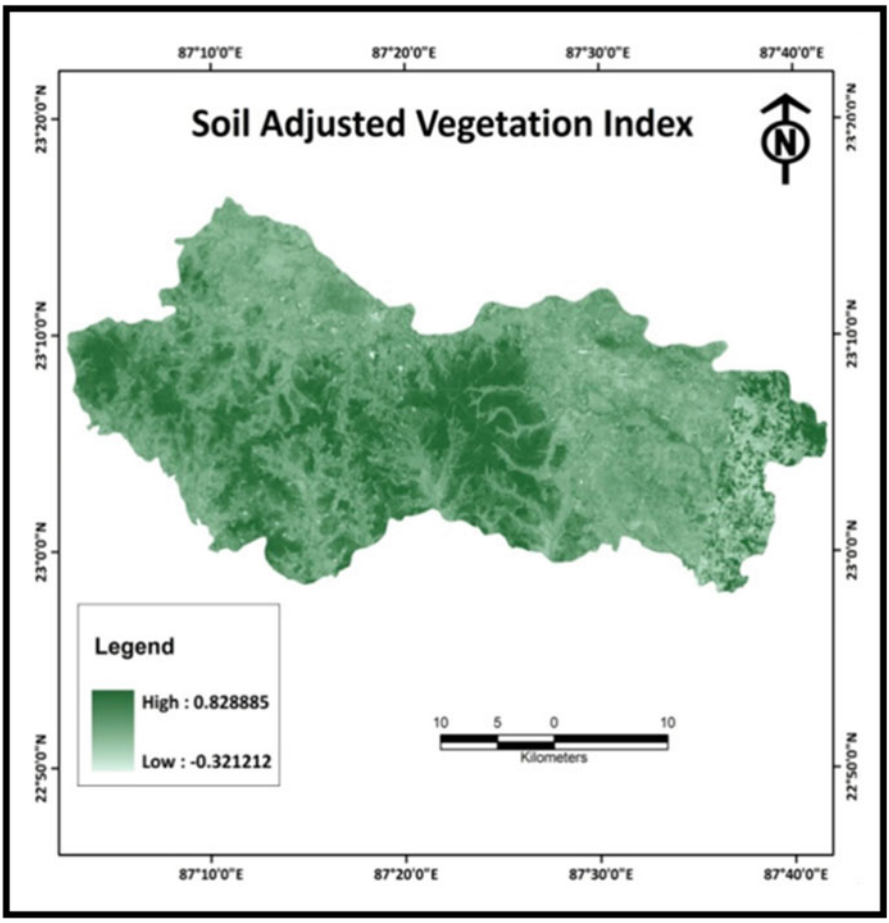


Map 5.9 Elephant migration return route in relation to the normalised difference vegetation index, 2005–2009

Though the entry route is more or less the same in different years, the change occurs in their return routes towards the east, towards the more fertile agricultural lands. It also matches the habitat quality of the region. The normalised difference water index (NDWI) represents the water-sensitive zones and the soil adjusted vegetation index (SAVI), which represents the soil background's influence on the canopy, also reveals the forest quality. Elephants usually follow these tracts for movement.



Map 5.10 Normalised difference water index for Panchet Forest Division, 2013

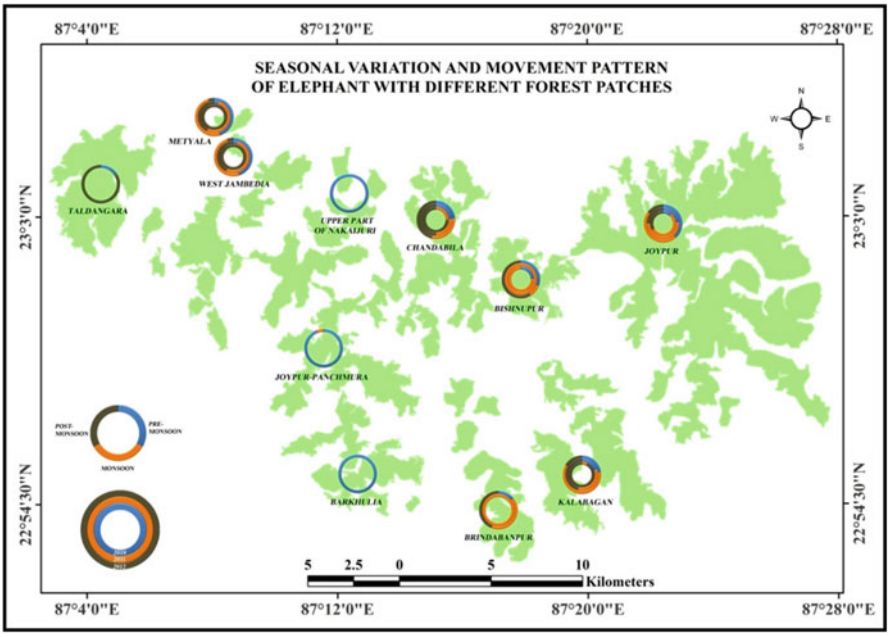


Map 5.11 Soil adjusted vegetation index for Panchet Forest Division, 2013

5.5 Seasonal Dependence on Migration Events

The animals migrate because of biological needs, scarcity of food and change in habitat quality. In our study, the last two factors are significant. Through analysing the information collected through field survey, we could detect a seasonal dependence in elephant migration. During the dry season there are very few elephants in different beats, and they are mainly the residential elephants. Just after the wet

season, the number drastically increases. For example, the number of elephants present in different seasons in 2008–2009 harvest year has been shown. It depicts the mass elephant concentration found from August to December, that is, during the harvesting season. Crops and vegetables in the field are easily accessible during this season. Crop raiding incidents are also frequent during this time. After December the elephants tend to return back to their original habitat, and so the number decreases, yet a large number of elephants still remain in the Panchet Forest area.



Map 5.12 Seasonal variation and migration patterns

5.6 Crop Calendar and Appearance of Elephants

The episode of migration exhibits a strong correlation with the crop calendar. As stated earlier, the elephants in the study area are found when paddy crops attain maturity. The appearance of elephants and the cropping pattern have been depicted in Fig. 5.4 and Table 5.1.

Elephant migration and its relationship to seasons and the crop calendar is depicted in the ergograph in Chapter 3 (Fig. 3.6). The climatic condition (rainfall and temperature) is shown along with the migration volume. The diagram shows that elephant migration is clearly linked to crop calendar and crop productions. The ergograph highlights the harvesting, growing and cutting of paddy, wheat, sugarcane, maize, Boro paddy, jute, potato and mustard seeds and vegetables. According to this cropping calendar, the number of elephants in the area also increases or decreases. The harvesting season starts in September–November and ends in January–February. The cutting of mature crops is done mainly in October–December. Raiding of crop fields becomes frequent during this phase. In May–August, sugarcane and jute are harvested. Hence, throughout the year elephants are getting food from alternative sources. Thus, they prefer to stay in newly invaded areas of PFD. Figure 3.6 also shows the relationship between crop calendar and the appearance of elephants.

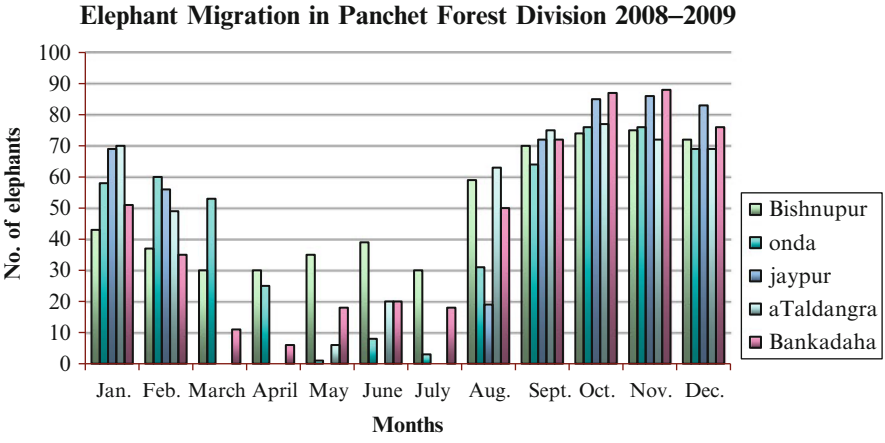


Fig. 5.4 Beat-wise elephant migration in Panchet Forest Division in 2008–2009

Table 5.1 Crop calendar and appearance of elephants

Crop type	Months	Elephant preference
Aman paddy (rice)	July–November	High
Potato	October–December	High
Pumpkin and other vegetables	November–February	High
Oil seeds	November–January	Low
Boro paddy (rice)	December–March	High

5.7 Conversion of Migrated Elephant to Residential Elephant

Originally during the migration to PFD, the number of elephants in a herd varied from 40 to 42. Later, when migration became a regular issue, the number increased. The duration of stay in the Panchet Forest also lengthened in consecutive years. Now a typical tendency is observed regarding the return of these migrated elephants. Each year some elephants stay back in Panchet and the adjoining forested areas of Bankura North, Bankura South and Paschim Medinipur Forest areas. The factors may be isolation of calf from the herd, human attack and isolation from the herd, frequent diversion of migration routes and so forth. But the easy availability of food from agricultural lands, provision for shelter in the forest patches, source of water and undisturbed environment are equally important factors. Thus, the number of residential elephants increased in the study area. As of the 2009–2010 harvest, there were 30 elephants in these areas while there were 3 or 4 in 1990. As a result, these elephants cause damage to crops, properties and human lives throughout the year. Previously the calf or old tusker who was isolated or rejected from the herd had to stay. But recently the sub-adult male and female elephants have become residential. This conversion of migrated to residential elephant has raised conflict between residential and migrated elephants. The villager's opinion is that "when a Dalma herd enters into a residential elephant's territory, the residential elephants starts to move away from those areas and creates much damage". The residential elephants become more violent and dangerous to the villagers (Kulandeival 2010). It is observed that a single bull and tuskers are more dangerous than the herd (Fig. 5.5).

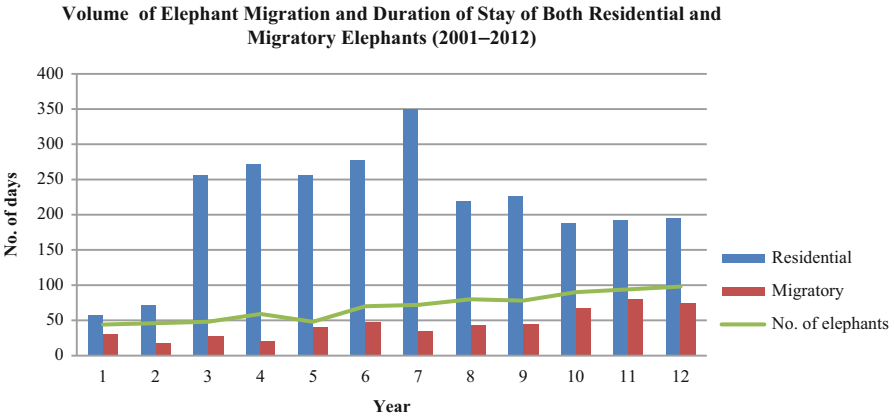


Fig. 5.5 Volumes of migration and duration of stay of residential and migratory elephants, 2001–2012