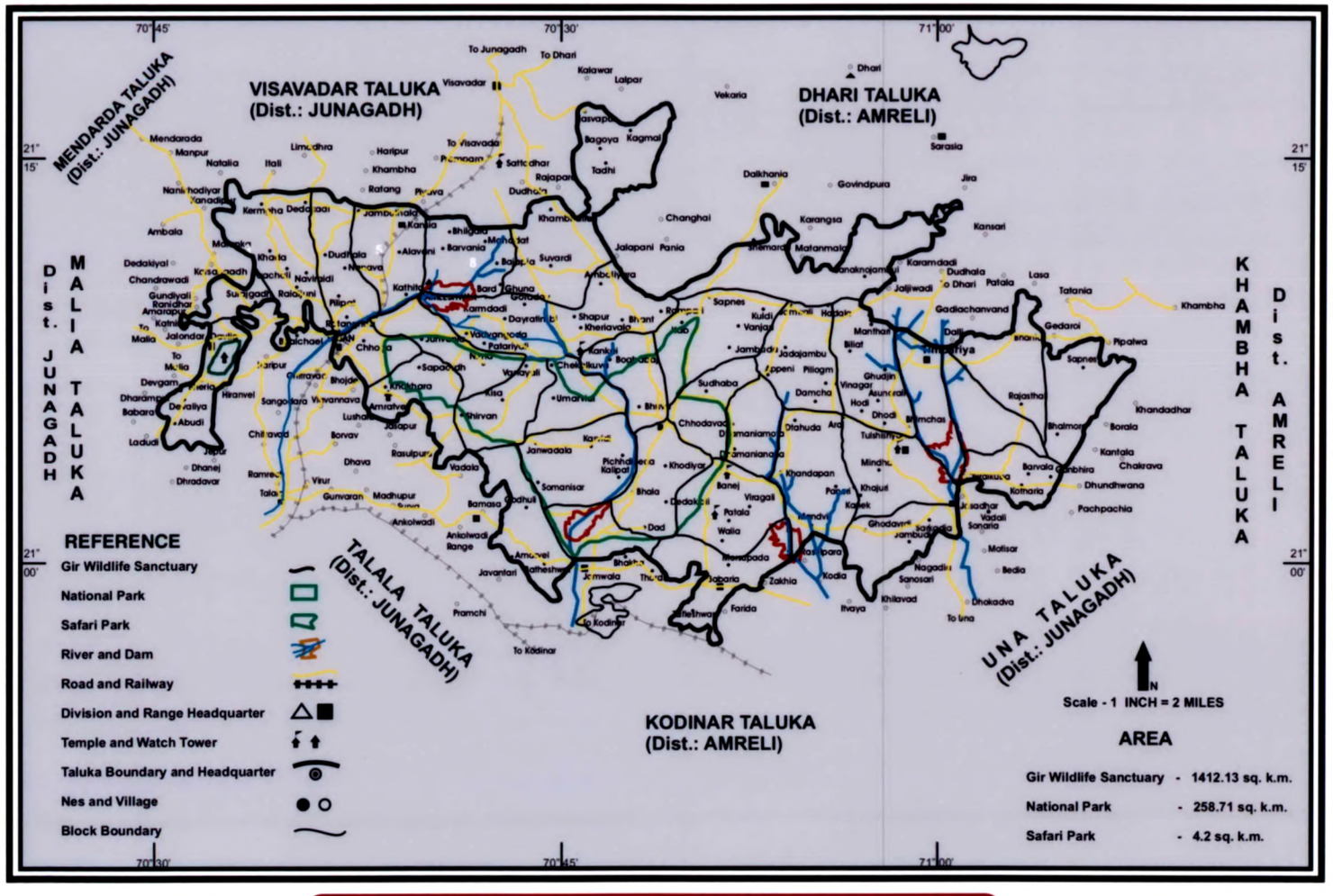
CHAPTER 4
METHODOLOGY



MAP OF GIR NATIONAL PARK AND SANCTUARY

METHODOLOGY

1. **Inventory of all the major plant taxa in Gir National Park and Sanctuary:**

The quality of vegetation in any ecosystem is one of the best indicators of the environmental conditions there. Plants being the primary producers are one of the important factors that determine the nature of all other life forms in the area. We have selected 36 points on the basis of varied vegetation types and zones of the forest (Map-2). The GNPS has been divided into three parts; Gir viz. National Park, **(Zone nos. 7,9,11,12,13,17 to 22 and 26),** Gir Sanctuary West **(Zone nos. 1 to 6, 8, 10, 14 to 16, 24 and 25)** and Gir Sanctuary East **(Zone nos. 27 to 36)**. The plant species including lower forms were collected to generate the list. In Gir National Park and Sanctuary the field trips were regularly conducted in each month for seven to eight days. Every month the whole forest area was surveyed for the representative sample for the inventory.

2. **Herbaria preparation:**

Herbarium helps in the identification and detailed study of the specimen. A herbarium is a storehouse of preserved plant materials. The method adopted for herbarium preparation is as follows.

* Plants were collected in plastic bags and / or vasculum.
* The collected specimens were individually pressed between blotting papers or newspapers. This helps to remove the moisture content and to retain the morphological features.
* A small branch with flowers and/or fruits were collected in case of trees, shrubs and tall herbs.
* For small herbs and grasses the entire plant with flowers and/or fruits including the underground portion were collected.
* Uniform pressure was applied through field press to develop moisture-free good specimens.
* The blotting papers were changed regularly once in a day to avoid fungal or insect attack. A weak solution of Mercuric Chloride (H_gCl_2; 0. 1% in ethanol) was sprayed on the specimens before being subjected to pressing (Jain and Rao, 1977).
* The drying process takes 1 - 2 weeks depending upon the specimen and season.
* The well-pressed specimens were mounted on the herbarium sheets using an adhesive (Fevicol) and stitching with thread. Respective details like the

botanical name, local name, number, morphology and remarks were mentioned on each herbarium sheet.

* A reference number was assigned to each specimen using tag.
* A care was taken to collect a quality plant material (healthy) for herbarium preparation.

Field Notes

The following details were recorded in the field notebook with respective reference number:

* Date and time of collection of the plant material.
* Locality, the name of the place and the approximate distance and direction with reference to a familiar place.
* Habitat like marsh, aquatic, grassland etc.
* Habit in form of herb, shrub, tree, grass or climber.
* Local name and common English name if possible.
* Systematic recording of these details were of great help in correct identification and documentation of the species.
* Phenological characteristics were also recorded. The data on different morphological characteristics including shape of tree bark characteristics, latex etc were also noted.
* All the species were classified according to Bentham and Hooker's system of classification using published reference flora.
* The herbarium specimens prepared during the study have been deposited in the Botany Department, The Maharaja Sayajirao University of Baroda, Vadodara. A separate set in duplicate was also deposited in the forest department (Wildlife Division, Sasan – Gir) for further reference.
* The laboratory work mainly comprised of the preparation of herbarium specimens and correct identification of collected species. The life forms were identified using morphological features with the help of published flora, Flora of Presidency of Bombay-Vol-I to III (Cook, 1901-1908), Flora of Gujarat state (Shah, 1978), Flora of Saurashtra (Santapau, 1962; Bole and Pathak, 1988), Flora of Nalgonda District, Andhra Pradesh (Rao, 2001), Flora of Madhya Pradesh (Mudgal et al,1997) and Flora of Maharashtra State (Sharma et al,1996, Singh et al, 2000).

MAJOR LOCALITIES OF GIR NATIONAL PARK AND SANCTUARY

3. **Photographic documentation:**

For documentation, photographs were also taken for plant specimens and general vegetation type. The photography was accomplished with the help of photographic camera - Canon AE with necessary lenses.

4. **Ecological Sampling through quadrates:**

For community studies, quantitative estimation of community structure and composition is necessary. This needs precise sampling units in form of quadrates. Therefore field trips to Gir forest were arranged regularly for seven to eight days during monthly surveys. Quadrates of predetermined size were marked out and all the species occurring within the area were listed. In a mixed community with a number of layers strata of vegetation, the quadrate size differed for the life forms. At ground level small quadrates were laid but for shrubs and trees larger size of quadrates were taken. Each stratum was separately sampled and such superimposed quadrates of different size/were (nested quadrates). Quadrates in the sampled area were laid at random pattern in the entire range of vegetation. The shapes of the quadrates were usually a square as the term denotes. However, the size of the quadrates varied with the type of vegetation. For small plants like grasses and herbs with great diversity, quadrates of 1 X 1 m^2 were taken while for the shrubs and tree species quadrates size of 20 X 20m^2 were chosen. In each and every monthly survey we have sampled total 360 quadrates in each month for trees and shrubs (8 months during winter and summer). In the monsoon period we have sampled 400 quadrates for study (4 months during monsoon). The total sampled quadrates covered about 18 % of the entire area under Gir National Park and Sanctuary.

5. **Ecological data of major plant forms like hubs, shrubs, climbers, grasses and trees:**

The compiled ecological data provide the baseline information for conservation and sustainable management of forest ecosystem. We have surveyed and studied the entire GNPS during November 1999 to November 2003

This is essential for the degree of dispersion or frequency of different species. Numerical counts of each individuals species were recorded for their abundance and density using quadrates.

Frequency (F): This refers to the degree of dispersion of individual species in an area and is usually expressed in terms of percentage occurrence. It can be defined as the chance or probability of an individual of a given species to be

present in a randomly placed quadrates. Sampling at several places at random and they recording each species that occured in each quadrate. For instance if a species occured in five quadrates among a total of 20 quadrates studied, then its frequency is 25%, that means

$$\text{Frequency (F)} = \frac{\text{Number of quadrates in which a}}{\text{Total number of quadrates sampled}} \times 100$$

A species most abundantly spread all over the area will have chance of occurring in all the samplied quadrates and, therefore, its frequency will be 100%. A poorly spread species. (even with large number of individuals in one corner) would be low. Thus a higher frequency value shows a greater uniformity of its dispersion. For frequency, simply the presence or absence of a species in the quadrates studied was recorded.

Abundance (A): This is the total number of individual of different species in a community per unit area (depending on the type of species unit area varies) Quadrates were laid random at several places and the number of individuals of each species was summed up for all the quadrates.

$$\text{Abundance (A)} = \frac{\text{Total number of individuals of a species in all quadrates}}{\text{Total number of quadrates in which the species occurred}}$$

Density (D): Density is also an expression of the numerical strength of a species. It is the total number of individuals of each species divided by the total number of quadrates studied.

$$\text{Density (D)} = \frac{\text{Total number of individuals of a species in all quadrates}}{\text{Total number of quadrates sampled}}$$

6. Species diversity:

Diversity means variety and variability. Species diversity therefore refers to the variation that exists among the different living forms. With the growing concern on extinction of various species at a very rapid pace, identification of different species of plants and their conservation is of primary importance. Species diversity indicates the extent of biodiversity in the ecosystem and helps to study the impact of factors like livestock grazing and other human interference on the regeneration of different species. It also identifies the species, which needs concerted efforts for its conservation. The two major component of species diversity are species richness and species abundance.

Species diversity can be calculated using species diversity and richness software developed by Henderson and Seaby (2001). The generated plant inventory and respective ecological data was used for analysis to note species diversity in different zones of GNPS.

Species richness (SR): Species richness is simply the number of species found in the community. Species richness is calculated as follows (Menhinick, 1964).

Species richness (SR) = $\frac{S}{\sqrt{N}}$

Where, S = Number of species in a community

N = Number of individuals of all species in a community

Diversity index: Diversity is often represented in the form of indices. Diversity indices attempt to incorporate both richness and abundance into a single numerical value. These are therefore referred to as heterogeneity indices. A given value of diversity index can result from different combinations of species richness and abundance evenness. However, it would be difficult to separate the relative importance of species richness and evenness from the given value. Species diversity is calculated by following formulas.

a. Shannon Wiever function (H)

Shannon Wiever index of diversity can be calculated as(SW)

$$\mathbf{H} = \sum_{i=1}^{S} (Pi)(\log_2 Pi)$$

Where,ni = Number of species.

N = Total number of species.

Pi = ni/ N

S = Number of species

The value of Shannon Wiever index varies from 0 to 1. A value of 0 indicates the presence of only one species; while that of 1 means that all species are equally represented. This index assumes that individuals are randomly sampled from an indefinitely large population. The index also assumes that all species are represented in the sample. It is moderately sensitive to sample size and gives more weightage on richness, ie 'if there are rare species recorded, the index tends to give a higher value. The value obtained from a

sample is of no significance. The index becomes useful only when two or more sites are compared.

b. Simpson Index (D)

Simpson species diversity index (Simpson, 1949) can be calculated as

$$\mathbf{DS} = 1 - \sum_{i=1}^{k}\left[\frac{ni(ni-1)}{N(N-1)}\right]$$

Where, DS = the diversity index

ni = the number of individuals belonging to a species,

i = 1 to k

K = is the total number of species

N = is the total number of individuals of all species

The value of Simpson's index varies from 0 to 1. A value of 0 indicates the presence of only one species; while that of 1 means that all species are equally represented.

Simpson's index denotes the most abundant species in the sample and is less sensitive to species richness. It is moderately sensitive to sample size.

iii. Species diversity (SD)

Species diversity is calculated in the form

SD = I - $\sum$ (pi)^2

Where,Pi = ni/N

ni = number of species

N = total number of species

The low value is indicative of low diversity

iv. Margalef D

Margalef (D) index can be calculated as

$$\mathbf{D} = \frac{(S-1)}{In\ N}$$

Where, S = species number

N = the total number of individuals in the sample

v. Species evenness (J)

Species evenness (Equitability) refers to the number of individuals of each species present in the total population. For example, in a habitat composed of say 25 species, if 90% of the individuals belong to a single species and the

remaining 10% are distributed among the 24 other species. Evenness or abundance would be considered low, on the other hand, if each of the 25 species accounted for 10% of the total number of individuals, evenness would be considered maximum. The species evenness indicates measure of species diversity and identifies the dominant and rare species in the ecosystem. In turn this denotes species that need to be conserved.

Species evenness (J) can calculated through index (Magurran, 1988) -

$$\mathbf{J} = \frac{D}{\log S}$$

Where, S = Total number of species in a community,

D = Shannon- Wiever index

vi. Berger – Parker Dominance Index

Berger – Parker Dominance Index is simple, both mathematically and conceptually,

$$\mathbf{d} = \frac{N_{max}}{N_T}$$

Where, N_T = the proportion of the total catch

N_{max} = dominant species

vii. McIntosh diversity measure

McIntosh (1967) suggested the Dominance index:

$$\mathbf{D} = \frac{N - U}{N - \sqrt{N}}$$

Where, N = is the total number of individuals in the sample

U = is calculated as:

$$\mathbf{U} = \sqrt{\sum ni^2}$$

Where n_i = is the number of individuals belonging to the i^{th} species.

viii. Brillouin index (H)

Brillouin index can be calculated as,

$$\mathbf{H} = \ln N - \sum_{i=1}^{s} \frac{\ln n_i}{N}$$

Where N = is the total number of individuals in the sample,

n_i = is the number of individuals belonging to the i^{th} species

s = the species number

This information measure should be used in favour of the Shannon index when the species differ in their capture rates. This index describes a known population, there is no room for uncertainty while using this index. It places more emphasis on species richness and is moderately sensitive to sample size. However, calculating the Brillouin Index can be time consuming and complex and can give misleading answers due to its dependence on sample size.

ix. Fisher's Alpha (s)

$$S = \alpha(1 + N/\alpha)$$

Where,S = is number of species in a sample

N = is the number of individuals

α = the index of diversity

The procedure for fitting the model is to calculate the number of species expected in each abundance class and compare that with the number of species actually observed using a goodness of fitness. This index's sensitivity to sample size is low and gives more importance to richness.

x. Q. statistic

This infrequently used diversity measure was proposed by Kempton (1979). It measures the interquartile slope of the cumulative abundance curve and is estimated by :

$$Q = \tfrac{1}{2}n_{R1} + \sum_{R2+1} n_r + \tfrac{1}{2}n_{R2} \,/\, \log(R2/R1)$$

Where, n_R = the total number of species with abundance R;

S = the total number of species in the sample;

R1 and R2 are the 25% and 75% quartiles of the cumulative species curve.

n_{R1} = the number of individuals in the class where R1 falls

n_{R2} = the number of individuals in the class where R2 falls

This index has been used little probably because of the difficulties of computation.

xi. Diversity Ordering

Different diversity indices may differ in the ranking they give to communities (Hurlbert, 1971; Tothmeresz, 1995). An example from Tothmeresz (1995) illustrates the point. Consider three artificial communities with the following

sets of species abundances for each of which diversity has been calculated using both Shannon – Wiener (H) and Simpson's (D):

Community A : H, D

Community B : H, D

Community C : H, D

If H(B) > H(A), it could be argued that B is the most diverse, however, as D(A)>D(B) the opposite conclusion could also be entertained. Communities such as A and B which cannot be ordered are termed non – comparable. Such inconsistencies are an inevitable result of summarizing both relative abundance and species number using a single number (Patil and Taillie 1979). Diversity profiles offer a solution to this problem by identifying those communities that are consistent in their relative diversity.

7. Importance Value Index:

The importance value index (IVI) is a statistical quantity, which gives an overall picture of the importance of the species in the vegetative community. It considers the relative values of density, frequency and basal area of every species in a study area. It thus incorporates three important parameters, which are measures of diversity and productivity of every species. IVI was calculated for major tree forms of GNPS.

IVI = Relative density + Relative frequency + Relative basal area.

Relative density (RD) is the proportional representation of a species in a sample.

$$\mathbf{RD = \frac{Density\ of\ the\ species}{Total\ density\ of\ all\ species} X\ 100}$$

Relative frequency (RF) is the proportion of frequency of a species in the sampled area.

$$\mathbf{RF = \frac{Frequency\ of\ occurrence\ of\ the\ species}{Total\ frequency\ of\ all\ the\ species} X\ 100}$$

Relative basal area (RBA) is the proportion of basal area of a species in the total area.

$$\mathbf{RBA = \frac{Sum\ of\ basal\ area\ of\ all\ individuals\ of\ a\ species\ in\ the\ sample}{Total\ basal\ area\ of\ all\ the\ species\ in\ the\ sample} X\ 100}$$

RBA is the area occupied by the base of a species. It is considered as a good indicator of the size, volume or weight of a species. The GBH or DBH measures are used to calculate the basal area of free species.

Girth at Breast Height of Tree is the girth (circumference) of a tree at a height of 1.37m from the ground (Standard breast height). The GBH is an important estimate of the standing biomass of a tree. The diameter (DBH) of the tree at this height can also be measured.

Height of Tree provides information on the vegetation, growth rate and length of the bole (main stem, trunk). It may be another important measure to estimate the standing biomass of the trees.

Canopy Cover:

This refers to the extent of ground area covered by the spread of tree branches and leaves. This is one of the parameters needed to understand the vegetation profile.

* It helps to identify the shade tolerant plants.
* It is important to make vegetation manipulations like pruning or planting.
* It helps to determine the optimal vegetation pattern for the ecosystem.

For this, a square mirror, which is divided in 36 blocks of 1x1inch, was taken. While standing below the canopy the reflection of side branches of the tree in mirror are marked. Avoid main trunk and bigger main branches. The numbers of total blocks are counted in which branches are seen. Repeat the exercise form all four sides of tree. Take the average to calculate the canopy cover of that tree (Shailaja and Sudha, 1997).

8. Regeneration status of rare and endangered plant taxa:

Regeneration survey of plants specially trees and shrubs is essential to know the health and trend of the forest. This also provides relevant information, which can be used for evolving appropriate management strategies. In traditional forestry to understand the habitat of any protected area, it is necessary to know the composition of forests and its development trend.

Random samplings were undertaken in the study area. Specially in the areas that are under heavy anthropogenic pressure and affects the vegetation. The data was collected only for rare and endangered plants in GNPS. The quadrates were laid near the selected neses in the both west and east side of the GNPS.