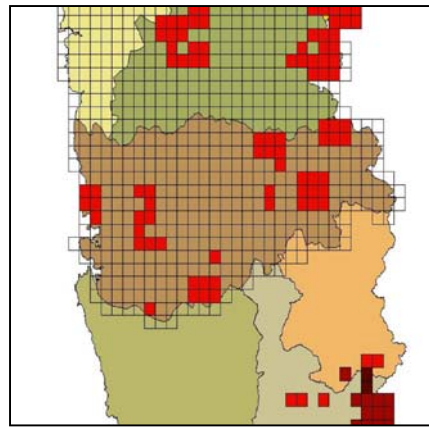


Prioritising areas for Forest Conservation in the Konkan region of the Western Ghats hotspot (India) – a pilot study



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Applied Environmental Research Foundation (AERF)



British Ecological Society



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www.aerfindia.org

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Sameer Punde

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Executive Summary

Identifying priorities has become an integral part of conservation planning. A range of approaches in identifying priorities has been reviewed here – from species based approaches to landscape level planning. However, this research focuses on the use of two widely accepted prioritisation schemes – the Important Plant Area (IPA) programme and the High Conservation Value Forests (HCVF) network. The objective was to use these schemes in identifying priority areas for forest conservation at a local level. Conservation planning at a finer spatial scale is more relevant to conservation agencies and managers who often operate at the level of the management unit. Therefore agencies such as the Applied Environmental Research Foundation (AERF) - a local non-government organisation engaged in community-based conservation and restoration of forests in the northern Western Ghats of India will certainly benefit from local level prioritisation studies such as this one. This pilot project has resulted in the identification of 17 priority areas in 6 administrative blocks within 2 districts of the Konkan region. This region forms an important part of the Western Ghats biodiversity hotspot of India. These 17 sites broadly fulfil three IPA (A, B, C) and four HCVF (1,2,3,6) criteria. In the absence of valid secondary data, gaps in data relating to threat status of species and habitat types, the research was based on rigorous field surveys and local knowledge. A simple analysis in GIS was used and an innovative rating system for assessing habitat quality was incorporated into the analysis. The outputs of this study were a set of maps depicting areas of conservation importance. As a result of the pilot study, the research provides practical recommendations for a more comprehensive study covering the entire Western Ghats and paves the way for a systematic conservation plan for the northern section of the Western Ghats hotspot.

1.0 Background and rationale

Setting priorities is an integral part of conservation. Sutherland (2000) emphasises the need to prioritise in the wake of escalating conservation problems and the lack of adequate time and money to tackle them all. Conservation biologists therefore set priorities to focus efforts to conserve species, ecosystems and even landscapes at scales ranging from regional to global levels.

A number of approaches for setting priorities have been developed and used by various agencies worldwide, however the IUCN red listing is probably the most widely used and accepted approach for prioritising species at the global level (see www.redlist.org). In recent years, a shift in the conservation paradigm has been observed from a species specific approach to spatial approaches incorporating habitats, ecosystems and landscapes and therefore new priorities are being set in identifying areas and habitats important for conservation and biodiversity. One of the most successful approaches has been the Birdlife International Important Bird Area (IBA) programme. Encompassing the IUCN red listing approach, the IBA programme goes beyond a species approach towards a spatial approach to include areas with significant populations and habitats important to birds. Over 7500 IBAs have been identified throughout the globe. Following on from the success of the IBA programme, Plantlife International has launched the Important Plant Areas (IPA) programme using an approach similar to the IBA although the focus here is on plants. Be it birds or plants, prioritising areas for conservation has so far been undertaken using specific taxa, groups or habitats. Apart from IBAs and IPAs, Key Butterfly Areas (KBA), Important Fungi Areas (IFA) as well as important areas for groups of useful species such as Medicinal Plants or Timber species has also been identified. Even schemes to identify areas such as critical wetlands or undisturbed forests are also being developed. The High Conservation Value Forests (HCVF) scheme originally developed by the Forest Stewardship Council (FSC) is one such scheme relevant to this study. Each prioritisation scheme lends itself towards achieving a set of conservation goals. The Important Plant Area (IPA) programme for example contributes to target 5 of the Global Strategy for Plant Conservation (GPSC), which aims to protect 50% of the most important areas of plant diversity by 2010. As a prerequisite in meeting these targets, it is essential to first identify areas important for plant conservation, which could then lead to a strategy for conservation, management and sustainable use. Encompassing all these spatial prioritisation schemes, Conservation International (CI)

has recently proposed to identify Key Biodiversity Areas (KBA), which is an essential step towards landscape-level planning.

Based on a review of some existing prioritisation schemes mentioned above, the author presented a paper at the Annual Conference of the Indian Association of Angiosperm Taxonomists (IAAT) at Pune, India in 2006. A basic comparison of some of the various schemes, criteria and categories were discussed at the conference. However, the objective of the author's paper was to discuss existing prioritisation schemes with relevance to identifying areas for forest conservation at a regional or even at the local scale. As a result of this discussion, two schemes were identified which were then used in a pilot process. At this stage, priority areas were identified at the local or sub-regional scale incorporating districts or blocks – administrative boundaries within a state. For the purpose of this study, the Ratnagiri and Sindhudurg districts were selected which form part of the Konkan-Sahyadri corridor in the northern region of the Western Ghats hotspot. The two schemes selected for the study were - the Important Plant Area (IPA) programme and the High Conservation Value Forest (HCVF) network. All the areas identified as a result of this study fit one or more of the following criteria.

Table 1: Criteria and categories of the IPA and HCVF schemes
Criteria compared and used in this study have been shaded in grey

IPA	HCVF
Criterion A: Threatened species	HCV 1 Globally, regionally or nationally significant concentrations of biodiversity values
A(i) Site contains globally threatened species	HCV1.1 Protected Areas
A(ii) Site contains regionally threatened species	HCV1.2 Threatened and endangered species
A(iii) Site contain national endemic species	HCV1.3 Endemic species
A(iv) Site contains near endemic/restricted range species	HCV1.4 Critical temporal use
B: Botanical Richness Site contains high number of	HCV2 Globally, regionally or nationally significant large

species within a range of defined habitat or vegetation type	landscape level forests
C (threatened habitat or vegetation type)	HCV3. Forest areas that are in or contain rare, threatened or endangered ecosystems
	HCV4. Forest areas that provide basic services of nature in critical situation
	HCV5. Forest areas fundamental to meeting basic needs of local communities
	HCV6. Forest areas critical to local communities' traditional cultural identity

The objective of this study was to test, compare and use these categories at the district level. Broadly all three criteria of the IPA were used and combined with some of the relevant criteria of the HCVF (see shaded rows in Table 1). The combination of these two schemes has been referred to as “*Important Forest Areas*” (IFA), a term used for the purpose of this report. However, the challenge of the project was to apply the schemes at the local level, details of which have been discussed further on in this report.

1.1 Using global approaches locally - searching for hotspots within a hotspot

The conservation prioritisation schemes mentioned above provide a set of well-defined guidelines for identifying priority areas at the global, national and regional scale. The outputs of these programmes provide an important decision making tool at these scales often useful for policy makers, decision makers, managers as well as national and international conservation and development agencies. However, more often than not, conservation activities and management implementation are undertaken at the local level or at the level of the management unit and therefore refining of priorities set at the regional level is required.

Harris et al. (2005) emphasise the need to narrow down spatial priority setting at the site level feasible enough for managers to implement conservation targets. It was therefore conceptualised as a part of this project to use spatial priority setting at a local scale useful enough for agencies and managers operating at the finer spatial scale. The

proposed outputs of the project were primarily maps. This project was undertaken for the Applied Environmental Research Foundation (AERF), a non-government organisation operating in the Konkan region of the Western Ghats biodiversity hotspot of India for over a decade. The Foundation and its partners including a consortium of local NGOs, botanists, experts, community groups, range forest managers as well as stakeholders concerned with the conservation of forests in the Konkan region will benefit from this project. As a result of this project, the Foundation will be able to further target its activities in areas that require urgent action. Following on from this pilot study, the AERF will carry out a more extensive prioritisation study for the entire Konkan region or the northern Western Ghats in the coming year.

The current research is a result of the prioritisation study at its pilot stage. A comprehensive prioritisation study for the Konkan region is planned by the AERF that will incorporate major aspects of biodiversity in the region. In the next two years the Foundation plans on developing a network of experts and managers in the region in order to develop a comprehensive conservation plan for the entire Konkan region. At this pilot stage, the focus for the study was forests, since the Foundation's current focus is on forests and their conservation. The primary objective of the pilot project was:

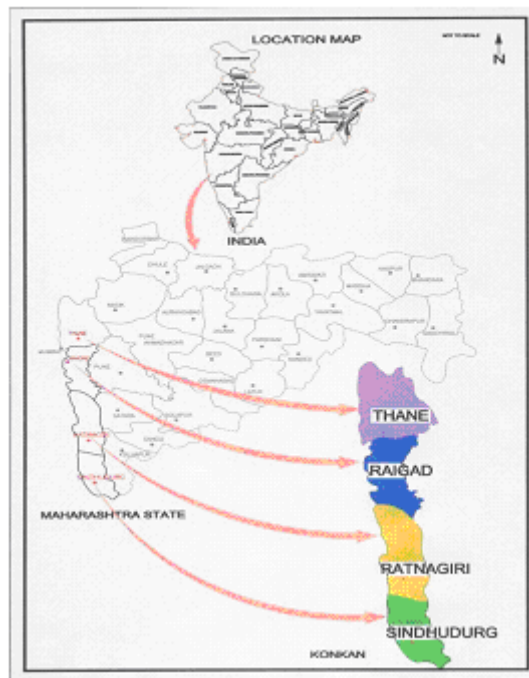
- To test and compare two international conservation prioritisation schemes – the Important Plant Area (IPA) programme and the High Conservation Value Forest (HCVF) network, and to apply these schemes in a pilot processes to identify priority areas for forest conservation at a local scale – two districts within the northern Western Ghats hotspot.

The purpose of this study was to test two prioritisation schemes and their applicability in identifying priority forest areas on a local scale. Although this was a pilot process, the output of this study will prove to be a viable input for planning conservation activities for agencies such as the AERF. The AERF has been engaged in forest conservation in the Konkan region for over a decade. It is therefore fair to provide the reader with a brief introduction of the region and its conservation importance.

1.2 The Study area – a landscape profile of the Konkan region

A comprehensive profile of the Konkan region and its biodiversity is beyond the scope of the current study. However, this section not only provides a brief introduction to the region but has also been a useful exercise in identifying IPA criteria C sites and HCVF2 & 3. Since a habitat or vegetation classification system was a prerequisite for identifying sites of the said categories, the various vegetation types of the region have been depicted here and an attempt has been made to devise a habitat classification system for the Konkan region.

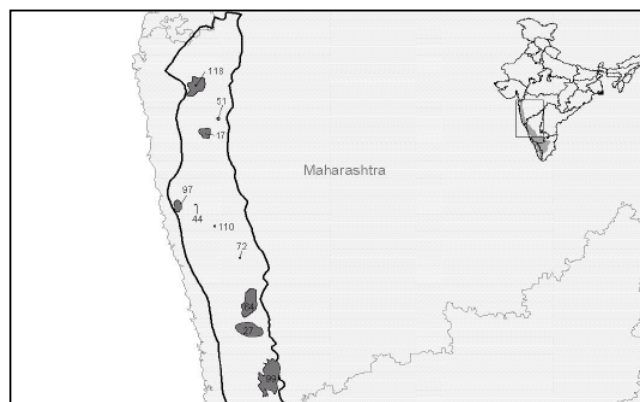
Fig 1: Map of the Konkan region



The Western Ghats is a globally recognised biodiversity hotspot (see www.conservation.org). Locally known as the Sahyadri, the Western Ghats is one of the 34 global biodiversity hotspots and one of the two within the Indian sub-continent. This hotspot is unique due to its topography and climate. The Western Ghats are a continuous mountain range that runs parallel to the entire western coast of peninsular India. Every year as the monsoon (rainy season) sets in from the west, the region between the mountains and the coast receive some of the highest rainfall within the sub-continent. It is due to this unique geography and climate that this region supports an immense amount of biological diversity. The entire Western Ghats has been known to

support a variety of forest types from Evergreen to dry deciduous and scrub forests. The Ghats are a home to many species of conservation importance such as the Tiger (*Panthera tigris*), Asian Elephant (*Elephas maximus*), Leopard (*Panthera pardus*) and the Indian Gaur (*Bos gaurus*). Over 2000 endemic plants have been recorded from the region many of which are used by local communities in traditional medicinal practices. A prioritisation study for the entire Western Ghats has been recently undertaken along with a detailed ecosystem profile (Bawa et al 2007, Das 2005). However, these studies were undertaken at the scale of the entire hotspot and a number of aspects of regional biodiversity were incorporated. It was evident from the ecosystem profile that the northern Western Ghats has undergone severe deforestation and degradation. In turn, conservation research and efforts have fallen short in the north. The study has been able to identify a few priority sites and the presence of the Sahyadri-Konkan corridor – probably the only ecological corridor present in the north. However, large gaps in the protected area network are evident and the threats to the Sahyadri-Konkan corridor are obvious. The following map sourced from the Western Ghats Ecosystem Profile (Bawa et al 2007) depicts the boundary of the hotspot in the north (black boundary line) and number of protected areas (shaded areas) and priority biodiversity areas (dots) within the hotspot.

Fig2: Map of Priority Conservation Areas in the Northern Western Ghats
(source: *Ecosystem Profile of the Western Ghats, Bawa et al 2007*)



This map shows the presence of protected areas (shaded polygons) in the north as well as in the south. However, there remains a stark gap in the middle of the hotspot. Priority areas have been identified here (see dots) however protected areas are absent. This

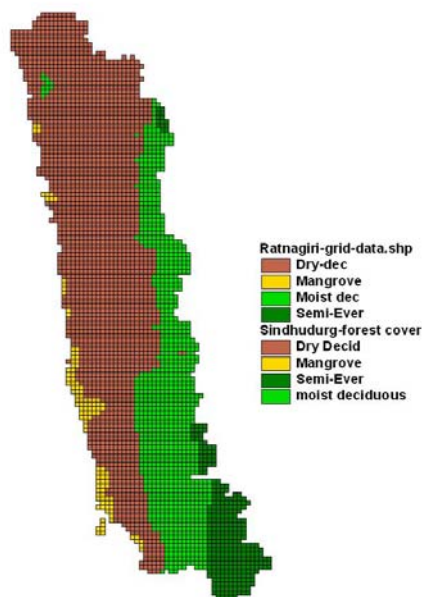
currently un-protected area primarily falls in the Konkan region of the hotspot, where the current research concentrates.

The Konkan region is bounded by the Arabian Sea on the west and the mountain range of the Western Ghats towards the east. This narrow strip of land lies between the coast and the mountain range with a width of between 30-50kms has been divided into 6 Ecological Zones, 4 vegetation types and 3 major forest types using the widely accepted yet outdated forest classification system devised by Champion and Seth (1968). A thematic map depicting forest types of the region has been shown here, prepared on the basis of secondary literature from Mishra and Singh (2001), Singh and Kartikeyan (2000), and Kulkarni (1988).

Kulkarni (1988) has categorised the vegetation of the region into 4 broad types. However, he claims that plant communities in the region are not sharply defined and it is difficult to pin-point dominant species within communities. Even so, Kulkarni's work has been able to define some of the vegetation types of the region and the dominant or abundant species within them. For example, Dry Deciduous Forests of the region, which remains the dominant cover here, shows a dominance of species of the genus *Terminalia*.

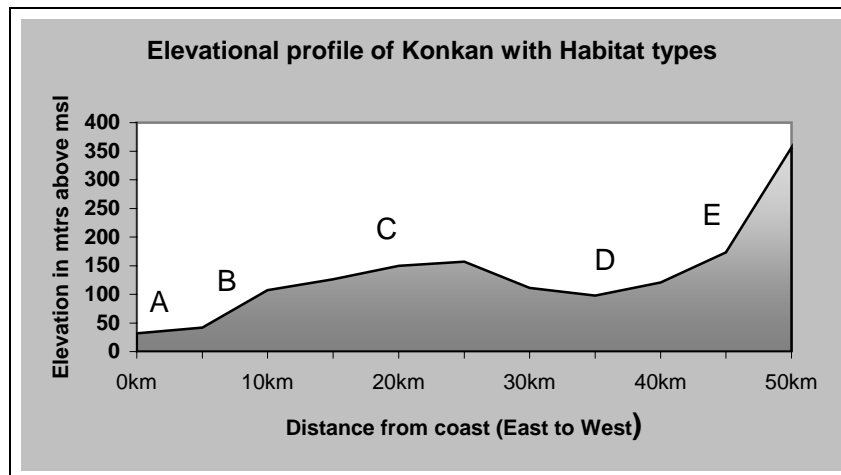
Fig 3: Forest Types of Konkan

Major Forest Types in the Konkan region



This forest map has been an important input in defining IPA criteria C sites and HCVF2 & 3. However, both schemes lay emphasis on defining the habitat and ecosystem types of the region. So far, an attempt to classify the habitat or ecosystem types has not been conducted for the region. At this stage of the project, only the classification of forest types was used. However, it was felt that a habitat classification system needs to be devised for the region, which will certainly help in undertaking a more comprehensive prioritisation study for the region. At this stage, habitat types were classified according to the East-West elevation profile of the region. Rare and unique habitats of the region that may be of conservation significance have been depicted here along the elevation gradient – from A (coast) to E (mountain range).

Fig 4: Elevation Profile of the Konkan region



Although this was a preliminary attempt, it could potentially lead towards the development of a habitat classification system for the region along the guidelines of the EUNIS system. Some habitats that may be of conservation significance in the region have been shown on the profile graph. Each habitat type has been assigned a letter from A to E. Brief descriptions of each habitat type is given in the following table.

Table 2: Some identified threatened vegetation types of the Konkan region

Habitat types	Description of habitats of Conservation Significance
A: Coastal zone: Mangrove, Estuary, Mudflats, Sandy and Rocky Beaches.	<ol style="list-style-type: none"> 1. Sandy Beaches and estuarine habitats with dense or medium dense stands of <i>Calophyllum inophyllum</i>. 2. Uncut Mangroves with medium to high density with Type 1 or 2-population structure.
B: Coastal elevation zone: scrub, riparian vegetation, grassland or rocky outcrops	<ol style="list-style-type: none"> 1. Steep slopes facing seaward, thick vegetation if undisturbed may hold significant populations of some globally red-listed species such as <i>Saraca asoca</i>, <i>Callophyllum Inophyllum</i> and rare evergreen tree species such as <i>Hydnocarpus pentandra</i>. However very few undisturbed patches remain (only 3 such sites found during pilot stage) 2. Undisturbed riparian forests patches or groves with medium to high density and Type1/2 population
C) Low elevation Plateau	<p>Low elevation plateau or locally known as “sada” interesting vegetation characters, stunted growth, very poor soil profile, geologically significant, rocky outcrops, often inundated with water during monsoon which supports a high diversity of herbaceous vegetation.</p> <ol style="list-style-type: none"> 1. Undisturbed and/or minimally grazed “sada” rocky outcrops with a minimum species richness of 4 herb species/sq.m
D) Low elevation Ghat base: Riparian Forest, scrub habitats	<ol style="list-style-type: none"> 1. Waterlogged, unpolluted swampy habitats, river or streamside dense stands of <i>Pandanas spp.</i> 2. Dense or medium dense stands of large, old growth riparian tree species including <i>Terminalia arjuna</i>, <i>Pongamia pinnata</i> occasionally interspersed with <i>Mangifera indica</i> and/or <i>Lagerstroemia microcarpa</i>.
E) Ghat base	<ol style="list-style-type: none"> 1. Undisturbed, old growth groves or forest patches with significant populations of <i>Antiaris toxicaria</i>, <i>Sageraea laurifolia</i> and/or <i>Tetrameles nudiflora</i>.

The conservation significance of these habitats was decided upon based on the observed area of the habitat and perceived threats to the habitats according to threat categories defined by the IPA programme (Anderson 2002). The presence of unique or rare species within these habitats was also considered. This was an attempt to classify some of the important habitats of the region as encountered during the field survey. This

list should not be considered exclusive or complete and is just an initiative towards developing a threatened habitat classification system for the region.

To recap, the objectives of this pilot project were to use the IPA and HVCF schemes to identify priority sites for forest conservation in two districts of the Konkan region. To achieve these objectives the following activities were undertaken.

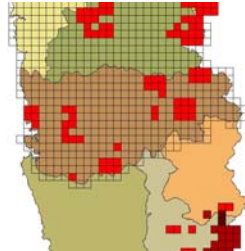
2.0 Methods and Activities:

To achieve the project objectives outlined above, the project team carried out a two-stage sampling and data collection process. During the initial stages of the project, experts from the Important Plant Area (IPA) Programme suggested on undertaking an expert consultation workshop similar to Conservation Assessment and Management Planning (CAMP) workshops for IUCN listing. Such a workshop allows for an open dialogue and a common platform for all experts, botanists in this case, who then suggest areas that may fulfil IPA criteria and categories. As a result of this workshop, a list of potential IPAs may be compiled which then the team could further assess through fieldwork and data collection to confirm IPA status. Given the limitations of this project at its pilot stage, a full-fledged IPA workshop could not be arranged. Instead, the team compiled a list of experts, which were consulted individually. In addition to this, local people were consulted at great lengths given the fact that it is local people that truly understand the landscape and its elements within the Western Ghats. At every location visited during the fieldwork process, village experts, indigenous knowledge holders, farmers and tribals were all interviewed using an informal, semi-structured interview schedule. Experiences and results of such a technique have been discussed in further detail in the final section of this report.

Although experts and local people provided a lot of information in terms of areas that potentially could be IPAs, the team only assessed such sites during the second stage of fieldwork. During the first stage, a systematic grid based sampling strategy was employed whereby the entire study site – the district of Ratnagiri was divided into 5km x 5km grids. The first grid was randomly selected on the eastern most side of the study area, after which every alternate grid towards its west was selected. So, the selected grids formed a line running from west to east. A similar line of grids was formed approximately 30kms south of this grid. In total 8 (5kmx5km) grids were selected, however this was later thought to be too small a sample size and therefore additional grids were added 30kms north and south to selected grids. Upto 12 grids were selected

for the first round of fieldwork. During the analysis, however, the data was represented in 2kmx2km grids. A representation of the sampled sites has been shown here.

Fig 5: A representation of the distribution of sampled grids in the study area



During the first phase of fieldwork, each grid was visited, local experts were consulted and aerial images on Google Earth[®] were referred to. Based on this information, areas within the grids where high forest cover was present were then visited. (as per local informants and aerial images). At each sampled location, the team undertook a survey using systematically laid 25m x 25m quadrats recording all tree species, tree girth, canopy cover, vegetation height as well as regeneration on the forest floor.

Based on this systematic sampling technique, a total of 27 sites were assessed. In the second round of fieldwork, the team undertook a more purposive sampling technique. Following observations undertaken during the first round, it was found that intact forests were to be found in sacred groves and contiguous patches along the base of the Western Ghats. The remaining 16 locations were then selected for assessment based on secondary literature on sacred groves of the region (Deshmukh 1998) and information provided by local experts and communities. During the second round, more importance was given to local knowledge and expert opinion in the selection of sites for further assessment. Using this method an additional 16 sites were assessed. A different data collection procedure was also used in this case. A rapid assessment based on a plot less sampling technique called the Point Centre Quarter (PCQ) was used. Although a different sampling procedure was employed measurement of forest parameters were essentially the same.

Since this was a pilot study the purpose of which was to decide and test an appropriate sampling and data collection strategy for the said objectives, the use of two different sampling strategies and methods were adequately tested. This allowed a comparison of

the two strategies and effectiveness of the data each strategy provided. This has allowed for the selection of an appropriate sampling strategy and data collection procedure planned for the comprehensive survey in the coming year.

3.0 Analysis

The exercise of using two sampling and data collection strategies proved fruitful in terms of testing and developing a methodology for a more extensive survey. But on the other hand, the two strategies provided different forms of similar data and therefore a comprehensive analysis using statistical techniques was out of the question. Even so, there was enough data to identify priority areas and therefore it was conceptualised that the data be incorporated into a simple rating system, which could then be translated into thematic maps. An overlay of these maps along with red-list distribution data and forest types from secondary sources will provide an appropriate representation of the potential IPAs or HCVFs in the region.

Primary and secondary data was translated into maps and incorporated into a logical overlay in a Geographic Information System (GIS). A logical overlay employs the use of Boolean operators to analyse the spatial coincidence of input data layers (Johnston 1998). For example, IF “species richness = high” AND “forest type= moist deciduous” THEN “criteria B sites” for that forest type. Such rule-based models were developed and used to identify priority sites that fit IPA or HCVF categories. Similar rules were used to identify sites fitting other IPA and HCVF sites such as:

Table 3: The Rule based System

IF	AND	THEN
<i>“Red-list species = present”</i>	<i>“Forest Intactness Rating=High”</i>	<i>“Site = IPA Criteria A” OR “Site = HCVF1”</i>
<i>“Species richness = high”</i>	<i>“Forest type= x ”</i>	<i>“Site = IPA criteria B” OR “Site = HCVF2”</i>
<i>“Forest type = x”</i>	<i>“Forest cover= dense or moderately dense”</i>	<i>“Site = IPA criteria C” OR “Site = HCVF3”</i>

3.1 Data sets used for the Logical Overlay

To perform the logical overlay in GIS, the following data sets were used. Each data set included both primary and secondary data sources which were then converted into grid (2kmx2km) maps.

3.1.1 Presence of red-listed species

Both the IPA and the HCVF schemes give emphasis to areas where significant populations of globally, regionally threatened or national endemic species are found. The IPA programme calls these criteria A sites whereas the HCVF network categorises them as HCVF1 (sub criteria 1.2, 1.3). Sub-categories have also been defined depending on the threat status of the species. However, for the benefit of this study, two sources of data were used. Distribution maps of all globally red-listed, regionally listed as well as endemics were prepared and overlaid into one map. Distribution of national endemics and regionally threatened species were sourced from Mishra and Singh (2001). On the other hand, primary data collected during the field surveys depicting areas where contagious or patchy populations of red-listed tree species were also included in the analysis. As a result, a map depicting presence of rare, threatened and endemic species was prepared.

3.1.2 Tree Species Richness

The second category in the IPA as well as the HCVF scheme is focused on identifying important habitat or vegetation types. Whilst the IPA lays more of an emphasis on identifying areas with high plant diversity, the HCVF highlights the need to consider the ecosystem and landscape scale. Species richness is a well-accepted criterion however; the IPA site selection manual (Anderson 2002) clarifies the need to select the richest areas within a given habitat type or bio-geographical zone for best representation of all habitat types within a given area. Considering the study at hand, forests form the major habitat type within the Konkan region. Therefore, maps delineating the major forest types of the region were incorporated into the analysis. Based on Singh and Kartikeyan (2001) and Kulkarni (1988), maps were prepared depicting forest types in the Ratnagiri and Sindhudurg districts. Field data collected by the team in the 255 grids were then overlaid on the map of forest types. Forests being the major ecosystem in the region, the number of woody, canopy-forming trees within the surveyed forests was considered to calculate species richness of that forest. The entire Konkan region is broadly composed

of 3 bio-geographical zones (see section 1.3) and therefore each zone was equally sampled during the survey process. As a result, the map overlay of forest types and sampled richness within each zone depicts areas of highest richness for each forest type, which then fulfils criteria B of the IPA scheme. To refer to the map outputs please refer to the results section.

3.1.3 Forest Cover

Criteria C of the IPA scheme identifies threatened habitat types. Category HCVF2 and 3 lay emphasis on large forests and threatened ecosystems. Combining these schemes and their respective categories, the current research was able to identify areas with contiguous forests for each forest type in the region. A logical overlay of maps depicting forest types and forest cover was undertaken. Maps of forest cover were procured from the Forest Survey of India (2003). The logical overlay for forest cover and type highlighted critical sites where intact forests of each type were present. At the regional level, this was a useful exercise to identify threatened forest types.

When the logical overlays of these maps were undertaken for IPA A, B and C sites, it was found that there remained a lacuna in the resultant maps. To define criteria A or HCVF 1 sites, an estimate of populations of red-list species was required and the percentage of site population with reference to total populations of the species. On the other hand, the logical overlay of forest cover and forest types to identify criteria C sites showed areas restricted to just the eastern part of the district. It was therefore conceptualised to add a component of “forest health” or “habitat quality” into the analysis that could provide an appropriate representation of priority areas in the region. In order to prepare the additional data layer, primary data was used. Each parameter was simply categorised and used in a scoring system devised for the analysis. Total scores were added up for every surveyed grid and represented on the maps. This scoring system was aptly named the Forest “Intactness” Rating (FIR).

3.2 The Forest “Intactness” Rating (FIR)

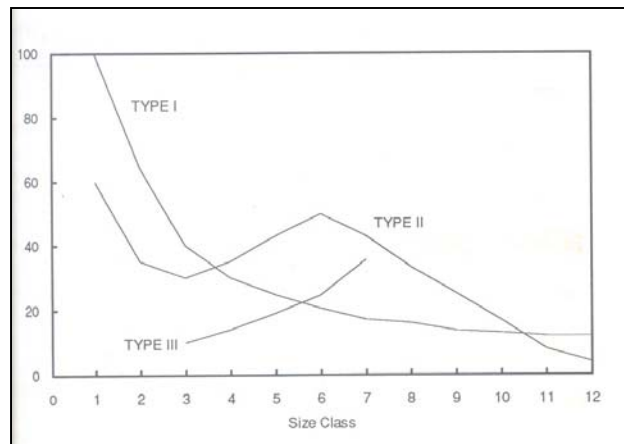
At the end of the fieldwork process, two sets of similar data were collected. Since two different sampling strategies were used during the data collection process, a simple scoring system was devised which could incorporate both data sets and then could be translated into a map-based format. All primary data was categorised into 3 classes.

Each class was then allocated a grade between 0-3. Since this was primarily an exercise to identify and map locations within the study site that fulfil IPA and/or HCVF criteria, the following data sources were used and incorporated into the FIR.

3.2.1 Forest Population Structure (Type 1-3)

Peters (1994) highlights the need to understand the population structure or recruitment history of a forest species, which reflects the survival of a species within a forest. In turn this understanding helps in gauging the health of a population of a species within a forest. Peters further provides three basic commonly found population structures in a forest and explains the health or sustainability of a population for a given structure. Based on a size-class distribution of tree girth, broadly 3 types of structures have been defined.

Fig 6: Population Structures
(source Peters 1994)

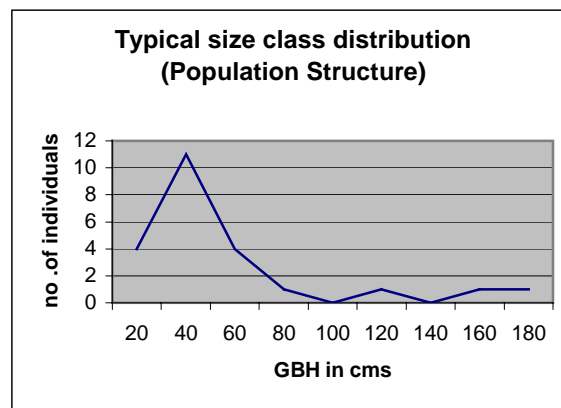


According to Peters, a Type I tree population represents the ideal, self-maintaining population characterised by high regeneration and a stable and equally distributed adult population. The Type II structure with its irregular “peaks” and “valleys” represents a population that may have undergone or is currently experiencing disturbance due to which irregular seedling establishment is observed. Such a trend is common in a secondary forest. Finally the third structure (Type III) represents a population with a severely limited seedling establishment that may be due to severe anthropogenic disturbance.

During the course of this project, measurements of girth at breast height (GBH) were taken for dominant tree species within a surveyed forest. This data was used to prepare

size class distributions for each surveyed location. The size class distributions were then compared to the three types of population structures described. Scores from 1-3 were allocated to each depending on observed population structure of dominant tree species. Interestingly, none of the forest structures found during this study relate to Type I. This may be due to severe anthropogenic pressure on the forests of this region. Therefore only 2 scores were allocated. A typical forest structure of the region has been shown here.

Fig 7: A typical size-class distribution of tree species in the study area



3.2.2 Species and Regeneration Guilds (1-3):

Poiani et. al (2001) compares the use of two strategies for the selection of priority areas - the use of the umbrella-species concept and the selection of areas with the largest area of natural vegetation. Both approaches have been used as a part of this study. Similar to the umbrella species approach, species and regeneration guilds were defined for the area under study. During the surveys, dominance of tree species was recorded based on the DAFOR scale. Species guilds were defined for each grid based on the three highest encountered species for that grid. This data was cumulated for the entire region to define 6 broad guilds of dominant tree species for forests within the region. However, these were later simplified into 3 categories based on successional stages – secondary and late secondary forests and primary forests. In addition to this, percent cover of regenerating species on the forest floor were also recorded using Bran-Blanquet Intervals. These were also compiled in a similar procedure to the Species Guilds. Scores were allocated to each based on Early Pioneer, Late Secondary and

Primary species according to characters defined by Peters (1994). The major Species and Regeneration guilds of the region have been briefly compiled in the following table.

Table 4: Species and Regeneration Guilds defined in the study area

Guild	Dominant Tree Species	Regenerating Species
Primary (one or more of the following combinations of species)	<i>Mangifera indica</i> & <i>Syzygium cumini</i> and/or <i>Lagerstroemia microcarpa</i> .	Forest floor dominated by <i>Terminalia bellirica</i> , <i>Careya arborea</i> , <i>Caryota urens</i> & <i>Zanthoxylum rhesta</i> occasionally with <i>Syzygium cumini</i> & <i>Dillenia pentagyna</i>
	<i>Terminalia bellirica</i> & <i>Mangifera indica</i> with <i>Garcinia indica</i>	
	<i>Terminalia bellirica</i> & <i>Syzygium cumini</i> occasionally with <i>Mammea suriga</i> and/or <i>Ixora brachiata</i>	
	Riparian vegetation dominated by <i>Terminalia arjuna</i> , <i>Pongamia pinnata</i> and <i>Lagerstroemia microcarpa</i> .	
Late Secondary	<i>Lagerstroemia microcarpa</i> , <i>Terminalia crenulata</i> , <i>Bombax malabarica</i> , <i>Mangifera indica</i>	<i>Leea indica</i> , <i>Bombax malabarica</i> , <i>Macaranga peltata</i> , <i>Holarrhena antidysentrica</i> , <i>Vangueria spinosa</i>
Secondary	Dominated by <i>Terminalia crenulata</i> , <i>Terminalia paniculata</i> and <i>Bridelia retusa</i>	<i>Carissa carandas</i> , <i>Calycopteris floribunda</i> , <i>Bridelia retusa</i> , <i>Lantana camera</i>

3.2.3 Forest strata and Canopy cover (1-4)

Many studies on forest birds, insects and mammals such as by Kalko and Handley (2001) and Osborn et al. (1999) to name a few, reveal the importance of structural complexity and diversity of forests that in turn provide a range of niches for arboreal fauna. Vertical stratification of forests has therefore been given importance in assessing the health of forests (see www.sfmindicators.org). As a part of this study tree heights were recorded using a clinometer at random sampling points within grids. Similar to the size class distribution, height classes were also calculated to indicate the various canopy layers within a forest habitat. In general, there were up to 4 canopy layers. Accordingly, a scoring for this category was organised. Percentage canopy cover was also similarly incorporated into the analysis.

To summarise, the following scores and categories were used for the FIR system.

Table 5: The FIR system

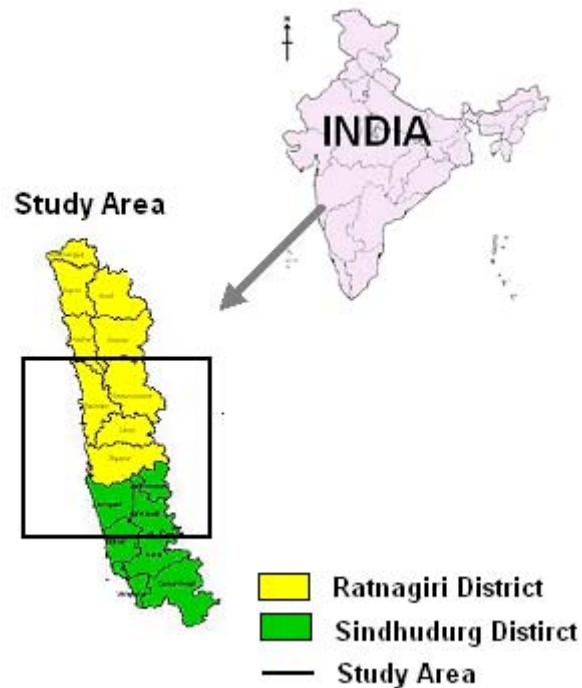
Criteria	Rating		
	1	2	3
Average no. of (richness) of canopy forming trees per 0.5 acre of forest area	<5 species/plot	6-10 species/plot	>10 species/plot
Population structure of dominant trees – Type 1, 2, 3)	Type 3	Type 2	Type 1
Canopy layers (height classes)	1-2	3	4
Canopy cover (%)	20-35	50-60	75 and above
Species and Regeneration guild	Secondary	Late Secondary	Primary

All scores for each surveyed grid were added up and represented into a FIR map shown in the results section of this report. The FIR map was also used in the overlay for identifying criteria A and C sites shown here.

4.0 Results & Discussion

The outputs of this study were primarily maps. These maps define areas that are of conservation priority and which fulfil criteria and categories of the IPA and HCVF schemes. Since this was a pilot project, only a limited area was covered within the Konkan region – mostly the southern Ratnagiri and northern Sindhudurg district. A total of 6 administrative blocks were surveyed viz. Sangameshwar, Ratnagiri, Lanja, Rajapur in the Ratnagiri district and Kankavli and Malvan blocks in the Sindhudurg district. The following map generally depicts the study area.

Fig 7: The Study Area



As a result of the rule-based analysis undertaken in GIS, the following outputs were prepared. Areas that meet each of the 3 categories have been shown individually. The final map depicts all the priority sites (see Fig 14)

4.1 Areas with significant population of threatened species

Both the IPA and HCVF schemes have lay emphasis to threatened species in the IUCN red-lists. Criteria A or HCVF1 sites should have significant populations of red-listed species. These may be globally or regionally threatened plants as well as endemic and restricted range species. This aspect of the study proved to be difficult. During the initial stages of literature review and comparison of prioritisation schemes based on which a paper has been presented (see section 1.0), it was found that although the entire Western Ghats houses upto 20% of the sub-continent's plant diversity, less than 4% of the species on the IUCN red-list are found in the Konkan region of the Western Ghats hotspot. Moreover, most of these species are in the low risk categories – VU & LR (Punde, 2007). This maybe due to the fact that high-risk, red listed species are totally lost in the region or the lack of an assessment of species within the region that fulfil red-

list criteria. In any case, a stark gap still remains in the knowledge of the conservation status of plant species in the region. There have been red-list assessments undertaken for the Maharashtra state (Mishra & Singh 2001) however there are no national or even regional estimates of populations of these species and therefore it was difficult to decide whether populations of threatened species encountered in the field were of global or regional significance. Therefore, for the purpose of this study, distribution of global, regional red-list species was compiled from secondary literature and integrated with field records of populations encountered during the survey exercise. To add a component of “significance” to the populations encountered, data relating to population structure and habitat quality was incorporated into the analysis (see section 3.2.1). As a result of this analysis, areas fulfilling the first criteria were depicted on a district level map (see Fig 8). Although the areas depicted on the maps broadly fulfil the first category of the IPA and HCVF schemes, they do not necessarily meet their sub-categories and criteria. Even so, this has proved to a useful exercise to represent occurrence and “health” of populations of red-list species in the region.

4.2 Areas with high species diversity

Criteria B sites relates to areas with highest species richness for a particular vegetation type. Number of canopy forming tree species was recorded for every grid location as a surrogate of species richness in the area. The survey was equally represented within the 3 ecological zones of the region. To identify the locations fulfilling criteria B, records of highest richness for every forest type were represented. The resultant map shows that dry deciduous forests with the highest species richness are concentrated in the north of the region whereas only a few pockets of semi-evergreen forests remain in the south (see Fig 9). Only two vagrant patches of species rich mangroves remain in the study area whereas moist deciduous forests fulfilling criteria B are equally represented in the north as well as the south. This particular category of priority areas is of relevance to agencies directly involved in forest management. Alternatively, the identified sites could potentially be reference sites for forest restoration in the region.

4.3 Threatened habitats or vegetation types

The third category proved to be the most difficult to identify. In the absence of a well-defined habitat or vegetation classification system for the region, threatened habitats could not be appropriately defined. However, a general forest classification system

developed and used for the entire sub-continent was used (Champion and Seth 1968). This broad scale classification was useful for this project at its pilot stage. An attempt to classifying the various habitats of the region has also been attempted here; however it was not incorporated into the actual analysis (see section 1.3). Initially, it was conceptualised that the forest types with the most density or cover will fulfil this criteria. To do so, maps of forest types were overlaid on forest cover images provided by the Forest Survey of India (2003). Forest cover was categorised into four – dense, moderately dense, open forest and scrub. The classified images for the region revealed the absence of dense forests and therefore only 3 classes were used for the analysis. The overlay however, revealed the confinement of moderately dense forests only in one ecological zone of the region (see class E in Fig 3). Thereby all vegetation types were not appropriately represented in the map (see Fig 10). In such a situation, the overlay of forest cover was replaced by the map depicting FIR scores for each sampled grid. Since, all ecological zones and forest types of the region were equally represented for the calculation of FIR, the map seemed appropriate for the analysis and identification of criteria C sites. For the sake of comparison, both overlays used in the analysis have been shown here (see Fig 10 &11).

4.4 The Forest “Intactness” Rating

To represent the “health” or “quality” of forest habitat in the region, a scoring system was devised as a part of this project (see analysis). Scores for each grid were represented into a map and used for the analysis. Since, this map was used as a basis for further analysis – such as for identifying Criteria A and C, the FIR map has also been included as one of the results (see Fig 12). In general, it is an appropriate representation of undisturbed forests in the region. Scores for the FIR range between 1 to15.

4.5 Important “Forest” Areas (All IPA & HCVF sites)

Integrating the first 3 criteria of both schemes (IPA & HCVF), all identified sites were finally integrated into a single district level map. A representation of all the sites fulfilling every criterion considered here has been shown on this map (see Fig 14). Since this final map is an overlay of all previous maps, this output will be considered as the primary output for conservation planning for the Konkan region. Details of the locations of all sites shown in the final maps have been given here.

Table 6: Locations of priority areas shown in Fig 14

Criteria	Name of villages near or within site
A	Ujgaon, Tamhane, Ghansori, Varvade
B	Shivane, Dewood, Wagheri, Zarye, Chivani, Ingalwadi
C	Khorninko, Prabhanvalli, Devde
A, C	Tamhane, Talawde
B, C	Nate, Ambalgaon, Kumbhavde, Yavteshwar, Mahan, Revandi
A, B, C	Upale, Punas, Gothane, Kundi

4.6 Sacred Groves as High Conservation Value Forests (HCVF 6)

All 3 criteria of the IPA as well as the first three criteria of the HCVF were fulfilled in the areas identified here. However, the remaining criteria of the HCVF required an understanding of landscape level features and ecosystem services provided by the area. This was beyond the scope of this study. However, the HCVF network imparts priority to forests, which are of importance to local communities in terms of their livelihoods or cultural identity. Cultural identify and significance of forests is of great relevance to some forest patches of the Konkan region.

Almost every village in the Konkan region has a sacred grove. These forest patches range between a few acres to hundreds of hectares. These forests are traditionally protected by local communities. Such communities impart religious importance to these forests and often, even the removal of leaf litter from these forest groves is considered a sin. In the absence of a developed protected area network in the region, these forest patches are of conservation significance and are often the only remnant patches of climax vegetation. It was evident that these areas fulfil criteria 6 of the HCVF network and therefore undisturbed sacred groves above 2 ha were located on an aerial map using a GPS. A comprehensive study and documentation of sacred groves of the region is currently underway at the AERF but during the course of this project the team were able to identify potential HCVF 6 sites in two administrative blocks of the Sindhudurg district. Fig 13 depicts the work that is currently being undertaking in documenting sacred groves of conservation significance in the region.

4.7 Results of the pilot study

The present document is a report of a pilot study, the results and experiences of which will pave a way for a comprehensive prioritisation study for the entire northern Western Ghats. The objective of the pilot study was to test two prioritisation schemes as well as test and try two sampling and data collection strategies for identifying priority areas. As a result, it was found that both schemes are quite similar in terms of their criteria. All three criteria of the IPA scheme match with the some sub-categories of the first 3 criteria of the HCVF and therefore all 6 criteria of the two schemes were combined to produce the final map of priority areas (see Fig 14).

In terms of the sampling strategies used, it was found that although a systematic sampling strategy was unbiased and appropriate in mapping various vegetation types and to identify threatened habitats of the region, it was a time consuming exercise and a few areas could be covered in the given time. On the other hand, the purposive selection of areas, was effective and efficient however all vegetation types and bio-geographical zones of the region could not be equally represented. Therefore, both sampling strategies had their advantages and disadvantages and selection of an appropriate strategy will be based upon the time and resources at hand.

Both, plot based as well as plot-less methods were used for the assessments and again the issue of time and money was the factor in deciding which methods were deemed appropriate. Interestingly, since a rating system was used for the analysis and for the preparation of maps, even the limited data that the rapid, plot-less method provided was good enough for the analysis and for the map-based outputs. In turn, due to time saved at each site, more number of sites could then be visited and assessed for the given time period of the project. These observations have been useful in deciding an appropriate strategy and methods for the comprehensive prioritisation and conservation planning study for the Konkan region.

Fig 8: Map of identified IPA A & HCVF 1 sites (Result 1)

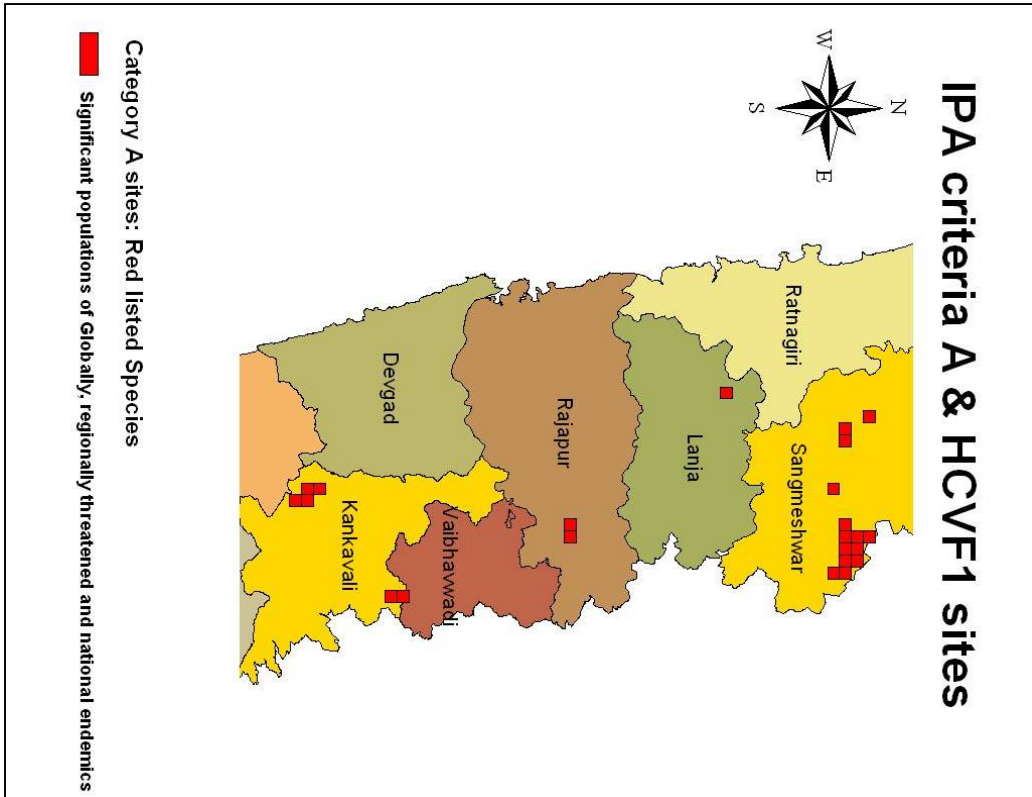


Fig 9: Map of IPA B & HCVF2 sites in the study area (Result 2)

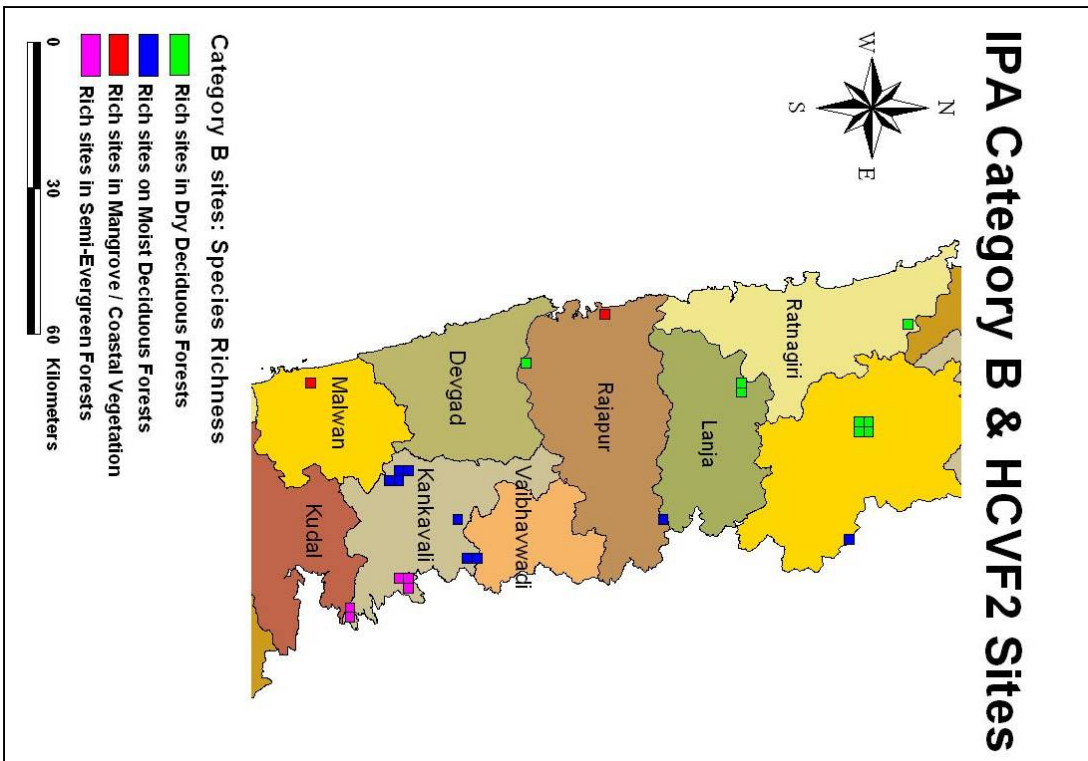


Fig 10: Overlay of Forest cover and Type

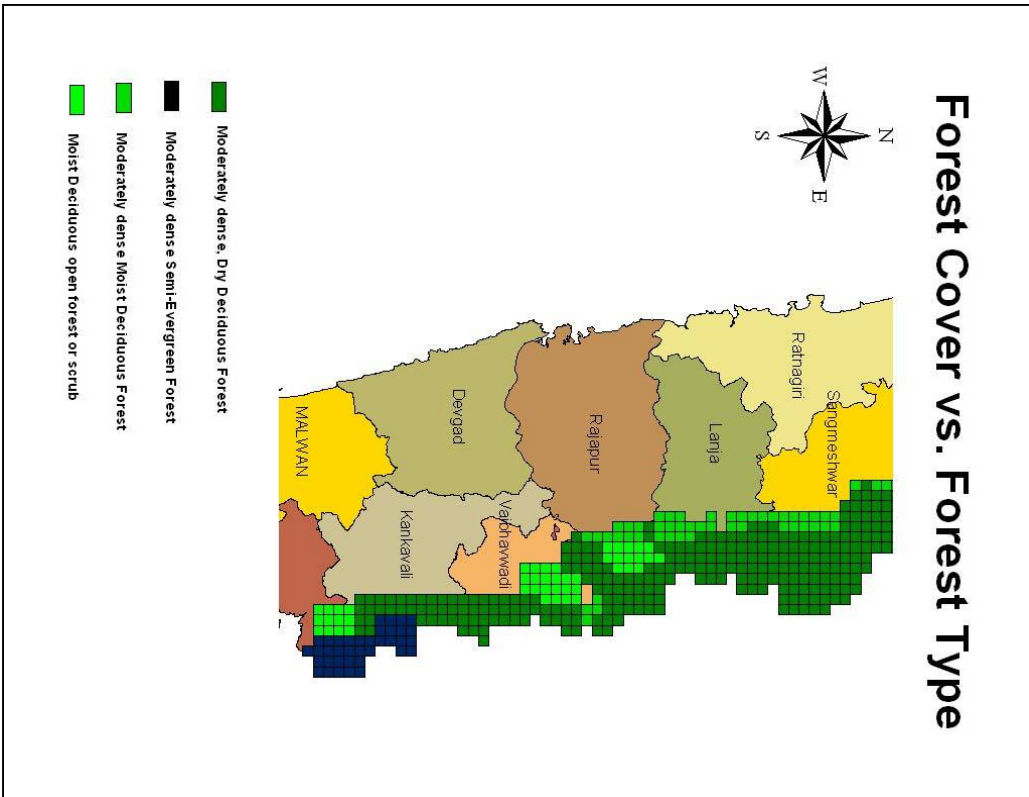


Fig 11: Criteria C & HCVF3 sites in the study area (Result 3)

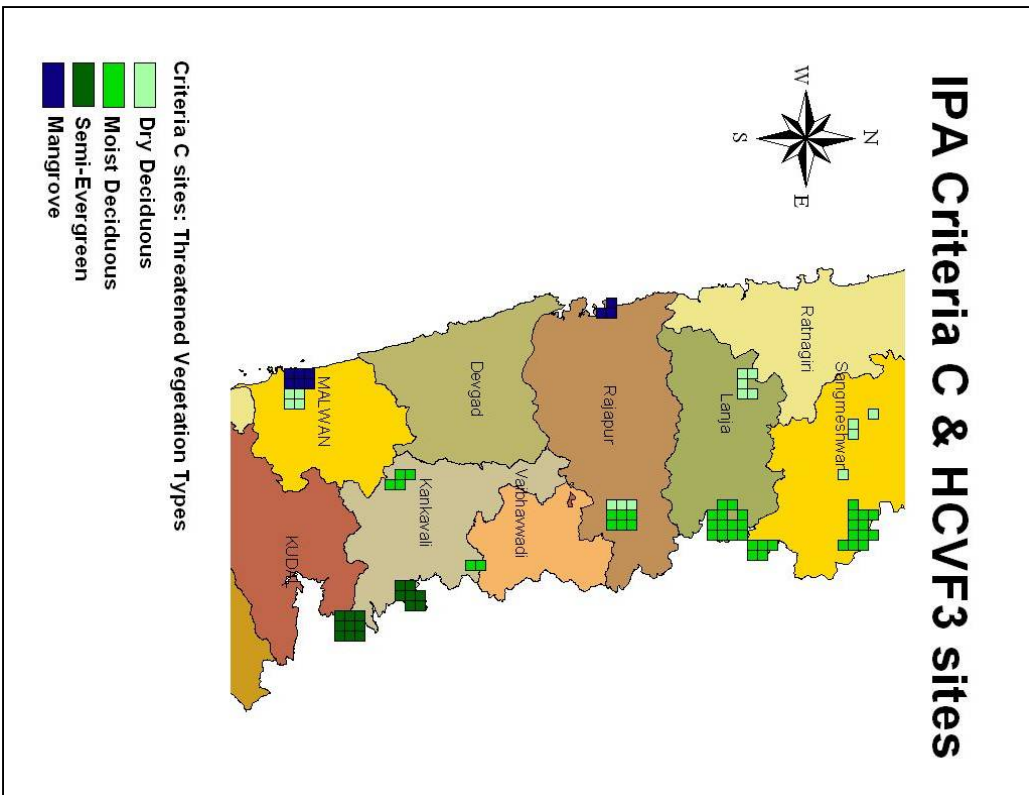


Fig 12: Map showing FIR values in the study area

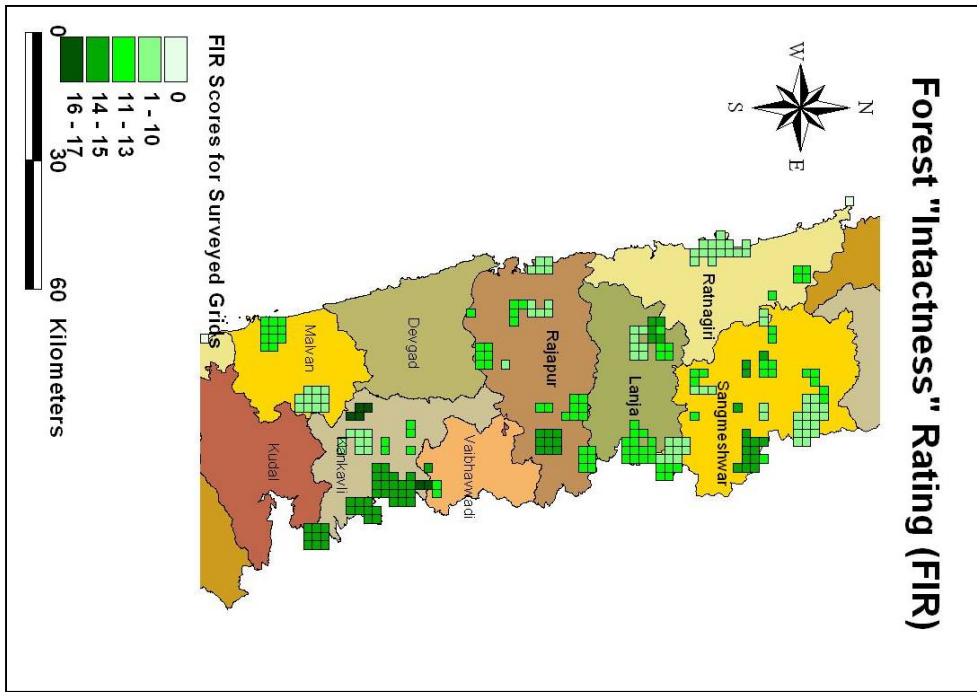
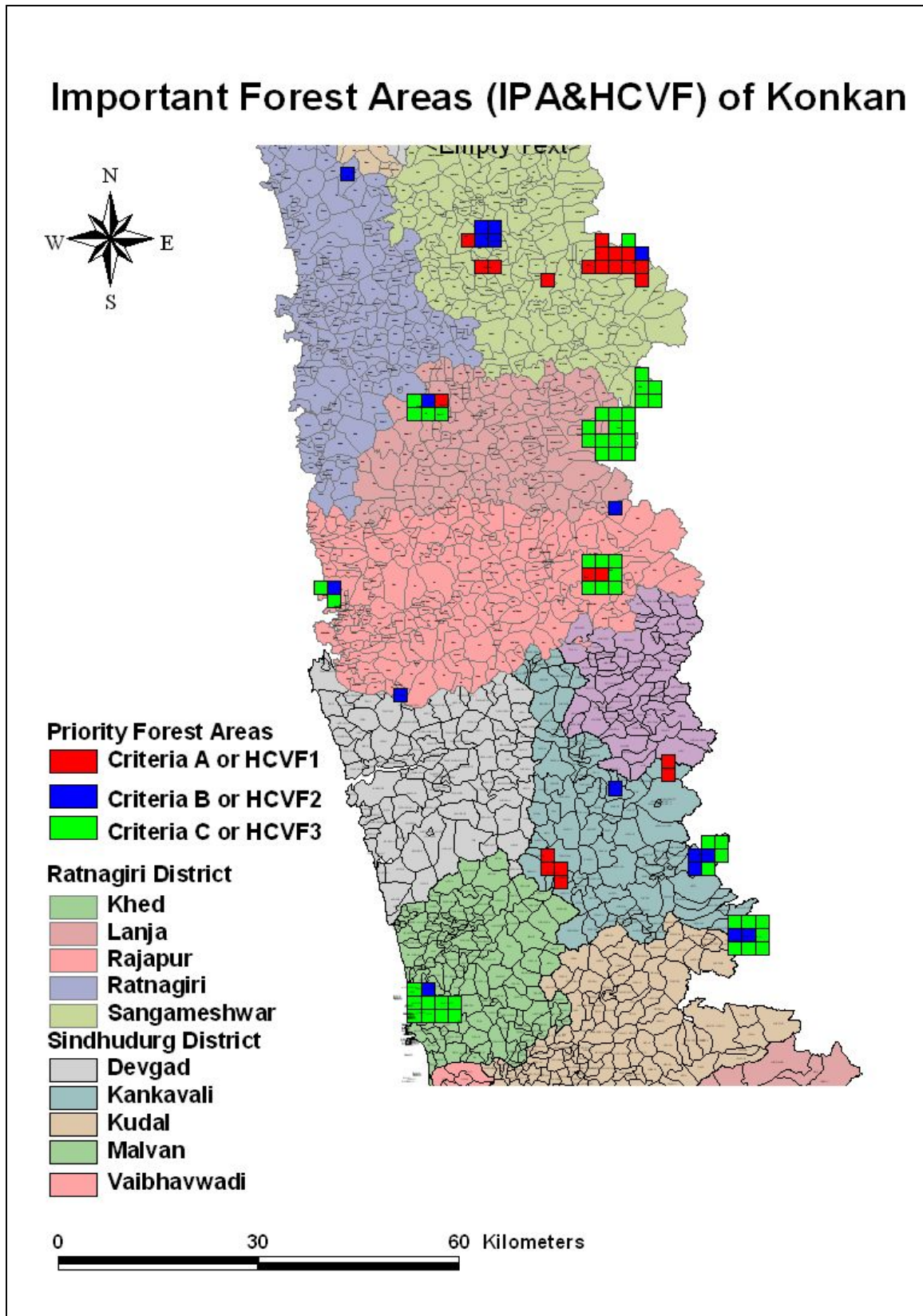


Fig 13: Aerial image showing presence of sacred groves in Sindhudurg district – potential HCVF 6 sites



Fig 14: Map of all identified priority areas (Final Result)



5.0 Conclusion

To conclude, the last section of this document will touch upon the relevance of the results, implications for conservation, challenges and drawbacks of the project and finally applicability and future directions of the task in hand.

The project set out to use two prioritisation schemes at a level relevant to conservation agencies, NGOs and managers. Although this was a pilot project it turned out to be a rigorous mapping exercise, which the previous section of the report has revealed. This research has been able to identify priority areas for forest conservation using 3 criteria from two internationally accepted prioritisation schemes. This gives local conservation agencies such as the Applied Environmental Research Foundation (AERF) a direction to focus its action oriented work and in turn receive international acceptance for its efforts. Based on the results and experiences the following recommendations can be made:

- An assessment of threatened species in the northern Western Ghats needs to be undertaken. Threat status of many plant species within the region remains unknown and significance of local populations needs to be checked.
- A habitat classification system or a revised vegetation classification system needs to be developed for the region, which severely hampered efforts in identifying, threatened habitats.
- This study has proved the applicability of international prioritisation schemes in identifying areas on a local scale.
- The pilot study has certainly paved a way for a comprehensive prioritisation study for the entire region. The use of an unbiased sampling strategy is recommended however local knowledge is crucial in identifying areas and should be appropriately used. Additionally, a rapid assessment type of a data collection strategy is generally adequate in a prioritisation study such as this; however for developing a classification system for vegetation and habitats a more systematic and in-depth data collection process will be required.
- Lastly, the region under study has experienced extensive deforestation and degradation. Therefore, undisturbed patches of native vegetation are rare and confined to small forest patches and groves. Traditionally protected forest areas such as sacred groves as well as community and private forests are significant conservation areas. An appropriate conservation strategy needs to be developed for the same.

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