The Ecological Status of the

TROPICAL DRY EVERGREEN FOREST

Held Within the Sacred Temple Groves of the Coromandel Coastal Belt

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The Ecological Status of the Tropical Dry Evergreen Forest Held Within the Sacred Temple Groves of the Coromandel Coastal Belt

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Abstract

The Tropical Dry Evergreen Forest (TDEF), is a narrow coastal belt of forest in South India, which hosts over 1000 flora species.
It is estimated that only 0.2% of this range now exists as a TDEF ecosystem, making it a rare forest type. The last remnants of the TDEF mainly exist in sacred groves that are found around temples. These shrines situated outside villages, have a religious cultural belief system surrounding the deity, which means historically pockets of forest around the temple were protected and held sacred. These groves vary in size, sometimes less than a hectare but others up to 10 hectares.
This article explores the present ecological status of the sacred groves within the designated TDEF zone, to create an understanding of the security of the biodiversity held within these remnants and hence the TDEF.

Introduction

1.0 *The Tropical Dry Evergreen Forest (TDEF)*

Within the coastal region of south-eastern peninsular India there is a vegetation type defined as Tropical Dry Evergreen Forest – TDEF (Champion and Seth 1968 [1]). It has a narrow range, approximately 500 km long running north to south, and with a width no wider than 50km, see figure 1 below. This range experiences both of India's Monsoon systems, the summer South West in the summer and the North East in the winter. The annual rainfall for the zone varies between 1000 to 1500mm, with the majority experienced at the latter part of the year (Meher-Homji 1974 [2]). This zone is also affected by dew for up to 2 months after the North East monsoon, which all taken into consideration leads to this zone having a limited dry season. The predominant evergreen vegetation of this TDEF zone gives way to more deciduous flora as one moves inland out of the zone.

Figure 1 – The geographical extent of the TDEF

1.1 *What is the TDEF?*

The TDEF, like most tropical forests, contains large amounts of species and biodiversity, it is estimated that up to 1000 different plant species make this forest type their home with over 300 of these being woody. The forest type has adapted to being in a cyclonic region, with a relatively low canopy of 8 to 10 metres with the occasional emergent tree. The canopy of evergreen trees with its evergreen shrub understory is rich with inter-linked lianas, and the forest floor is a rich layer of biomass that is effectively recycled by plant feeder roots in the top 1 cm of soil. The TDEF, like classical tropical forests, holds its nutrient wealth in the canopy, thus once cut the soil becomes impoverished and quickly leached by the region's intense monsoon rains.

Figure 2 – A Derris ovalifolia liana growing into the canopy of a remnant TDEF grove.

A forest type is not only the flora, the plants that are present within the ecosystem, but also the fauna, the mammals, birds, reptiles and insects that survive and thrive in this habitat. In the past leopards and elephant herds would have roamed these regions, perhaps even tigers, but today the TDEF is home to smaller mammals, the mongoose, porcupine, Indian civet cat, jungle cat, and many more including the fruit bat which is an important vector for spreading seeds of the forest. The TDEF is not only home to a large population of reptiles and a myriad of bird species that gain protection from the dense habitat the TDEF offers, but it also gives place for the insects, some of which are pollinators, to help the ecosystem thrive.

1.2 *The status of the TDEF*

In 1992 it was estimated that only 5% of the TDEF zone was under forest cover (*Meher-Homji 1992 [3]*). In 2002 this estimate was revised to only 4% (*Wikramanayake et al 2002 [4]*), but in both estimations, it was understood that most of this forest cover was disturbed. As a result of extensive field studies carried out between 1999 and 2004 by the Auroville botanical team, a reasonable assessment was made, that from this 4 % of forest, 5% could be assessed as a pristine remnant of the TDEF, with the other 95% to be highly disturbed and categorised as degraded scrub. Therefore, it would be fair to state that only 0.2% of this range now exists as a TDEF ecosystem, and consequently making it a very rare forest type in India, if not the rarest due to its anyway limited range. The circumstances which have left this forest system in a fragile state are many, but mainly the high concentration of human population in this coastal belt and the impact that has on the environment. There are many other factors like the presence of an active port in Puducherry and in the mid 1800's it has also been documented that in an area close to Cuddalore, within the TDEF zone, one of India's largest steel mills was active and being fueled by wood and charcoal (Raman A. 2017 [5]).

1.3 *The Sacred Temple Groves*

During the study in the early 90's, the Auroville botanical team located, visited, and assessed 85 sites dispersed within the designated zone, these consisted of reserve forests, hillocks, temple groves, tank bunds, and a few miscellaneous sites. It was ascertained that governmental reserve forests and hillocks were generally secondary growth vegetation,

with species present that could reestablish after the disturbance. Historically these forests had predominately been managed as woodlots for fuel wood and paper pulp. The last remnants of the TDEF, which indicate a primary forest, existed in the sacred groves that were found around temples, generally of the deity Ayyaner but not exclusively. These shrines were situated outside villages, and the religious cultural belief system that the god enjoyed hunting and being in the forest at night meant that pockets of forest around the temple were kept, protected and held sacred.

Figure 3 – The entrance to a sacred temple grove.

These groves vary in size, sometimes less than hectare but others up to 10 hectares, during our studies in the late 90's to mid-2000's up to 65 sacred groves were researched and analysed. Each grove was surveyed, recording the species present and their abundance, providing more data about the profile of the original forest. The plant data was recorded at the Auroville Herbarium and cross checked with the French Institute in Pondicherry and the Rapinat Herbarium in Trichy, Tamil Nadu. Phenological information for each plant was recorded to allow for timely further study and seed collection. From the sites studied, a total of 1130 species of angiosperms were recorded.

It should be noted that each of the sacred grove were islands amongst ever increasing cultivated, local dwellings or built-upon land. This highlights not only the fragility of these existing areas but also their inability to expand.

2.0 *Understanding the present ecological status of the Sacred Temple Groves*

Due to the fact that these sacred groves contain the last remnants and thus potentially the last evidence of the TDEF ecology, they hold the key to any conservation effort. Thus, it is considered to be highly important to study and understand the ecological dynamics and status of these sacred groves presently, as they are the benchmark for any conservation effort or project.

Drawing from information gathered during the studies in the late 90's to the mid-2000's carried out by the Auroville botanical team, and information gained from extensive rapid assessment field visits of the 58 sacred groves in 2021 and 2022 this study began. This was executed as part of a larger TDEF conservation project implemented through the Auroville Botanical Gardens and funded by a Ramco Cement CSR project.

Methodology

A multi-pronged methodology was designed to gain the required insight into groves and to allow this assessment to be carried out. This approach included:

- Comprehensive field visits to all sites.
- Geo referencing present sacred groves, including boundaries, temple infrastructure and waterbodies.
- Analysis of canopy cover using historical and present Google Earth images.
- Quantitative and qualitative data analysis.
- Biodiversity distribution analysis.

The study area was defined as 58 sacred groves within the Chengalpattu, Cuddalore and Villupuram districts, and corresponded to the study carried out by the Auroville botanical team two decades prior. See *figure 4*, for the map of the groves to be studied:

Figure 4

For each of the chosen locations, the following protocol for the rapid assessment was followed:

1. During the field visits, notes on the ecology were made; description of state of canopy and understory, noteworthy species and subsequent regeneration, notes of large specimens, temple development, observations of frequency of temple visits, etc.
2. The GPS technician, with an “under canopy” handheld GPS unit, collated and geo-referenced the boundary and key elements of the grove, e.g. temple infrastructure, water bodies, species of interest, etc.
3. The botanists, armed with the groves previous species lists, scanned the groves for the presence of key species and noted their presence, and if any new species to the grove were observed, these would then be added. It has to be noted that these rapid assessments did not include full formalised vegetation surveys.
4. Specimen trees were located, geo-referenced and measured (as this element was part of another study, the results were not incorporated in this report but are available in Annex 1, “*The Heritage Specimens of the Sacred Groves*”.)
5. From the collected GPS data, the total surface area of each sacred grove was calculated and tabulated.
6. From the GPS data studied, the present canopy cover was calculated for each grove (e.g. minus open spaces, temple infrastructure, water bodies etc.).
7. Historical Google Earth images were studied, two images as far as possible apart timewise, depending on their visual quality, were chosen for each grove. For both images, polygons of the canopy were created and surface area of canopy were quantified. Both satellite images, with the evolving canopy were saved as photographs for future reference.
8. From the data, the present and past canopy cover was calculated as a percentage of the total grove area for each grove. This then allowed for the present percentage loss or gain of canopy for each grove to calculated.
9. From the field notes, categories of descriptions of canopy cover and understory were made and tabulated to create comparable qualitative information for each grove. This was felt important as, for if an ecological assessment was to be made, the quality of the canopy and understory needed to be understood.
10. As these assessments did not include full botanical surveys, it was decided that a list of the main 40 evergreen/brevi-evergreen trees and woody shrubs would be used as a sample set to understand their presence, spatial distribution and the biodiversity of each grove. The list was determined and during the site visits the presence of these species was checked.

Results

1. Sacred grove size analysis

The first step in the process was to understand the present area of the sacred groves in the zone. From the GIS information gathered, a map for each grove was created, see *figure 5* for a sample sheet:

Figure 5 – Map of Konjikuppam sacred grove

Once all the grove sizes were understood a table was created listing the grove name and size, see *figure 6* below:

Sacred Grove name	Size - Hectare	Sacred Grove name	Size - Hectare
Athiyanallur1	0.048	Purnankuppam	0.78
Nathamedu	0.11	Pannakuppam	0.79
Manapattu	0.18	Kasipallayam	0.81
Sedarapattu	0.19	Silikeripallayam	0.86
Puthupallayam	0.2	Mugaiyur	1.26
Gannachavadi	0.21	Periyamudaliarchavadi	1.26
Irumbai	0.22	Tiruchitrambalam	1.26
Karasur	0.28	Periyakumatti	1.32
Athiyanallur2	0.29	Thondamanatham	1.6
Nagari	0.32	Thirumannikuzhi	1.66
Kadagampet	0.36	Pudur	1.71
Ramanathapuram	0.38	Melvadakuthu	1.99
Vandikuppam	0.4	Cinnakumatti 2	2.14
Venangapettu	0.46	Kulanthaikuppam	2.7
Talaikanikuppam	0.49	Alamarathukuppam	2.75
Kumulam	0.5	Kodivinayagar	3.12
Vellazhakuppam	0.5	Velleripattu	3.12
Arasadikuppam	0.53	Suriyanpet	3.36
Kottakarai	0.53	Sendirakkillai	3.5
Mangalam	0.57	Ramapuram	3.79
T Murthikuppam	0.63	Konjikuppam	3.99
T Puthupallayam	0.63	Muthanai	4.5
Cinnakumatti 1	0.65	Krishnavaram	4.56
Kunathammankovil	0.65	Paalvathunnam	4.93
Kizhpettai	0.67	Urani	5.13
Odiayampet	0.67	Ommiper	5.6
Varakkalpattu	0.7	S Pudur	8.81
Akasampet	0.72	Puthupet	10.2
Kumaramangalam	0.77	Kothattai	19

Figure 6 – Table of sacred groves area - Hectares

From this data, the total area that the 58 groves represent could be calculated, the result being 120 hectares in total.

To make the analysis clearer, the groves' sizes were grouped and the quantity of groves per group was calculated, see *figure 7* below:

Figure 7 – Table of sacred grove sizes in groups- Hectares

Sacred Grove Size	Number
Up to 0.5 hectare	17
Between 0.5 to 1.0 hectare	16
Between 1 to 2 hectare	8
Between 2 to 4 hectare	9
Between 4 to 6 hectare	5
Between 6 to 10 hectare	1
Between 10 to 20 hectare	2

From this table it can be deduced that more than 50% of the 58 groves are less than 1 hectare in size

The following bar chart, *figure 8* below, breaks down the figures to visually understand the size and distribution of the groves:

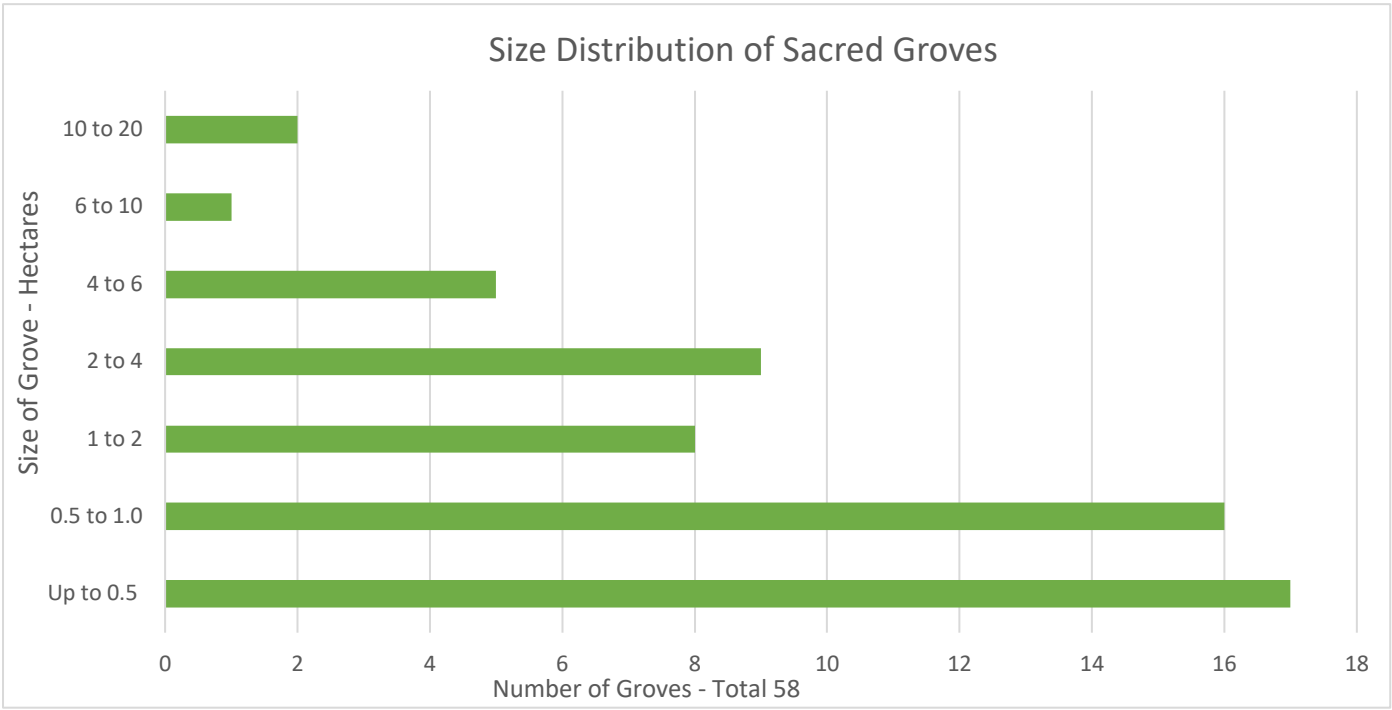


Figure 8 – Bar chart of size distribution of sacred groves.

The next step was to understand the correlation between these grove size groups and their respective percentage of the total area the 120 hectares that these groves represent. For example, 33 groves out of the 58 total, which is 58%, are under one hectare in size, but it can be seen that this proportion of small groves only represent 13% of the surface area of the total 120 hectares the 58 groves cover. On the other side of the spectrum, only 3 groves out of the total, which is 5%, are between 6 and 20 hectares, but it can be seen that this proportion of the large groves represent 32% of the surface area of the total 120 hectares the 58 groves cover. This is illustrated in the following pie-chart in *figure 9:*

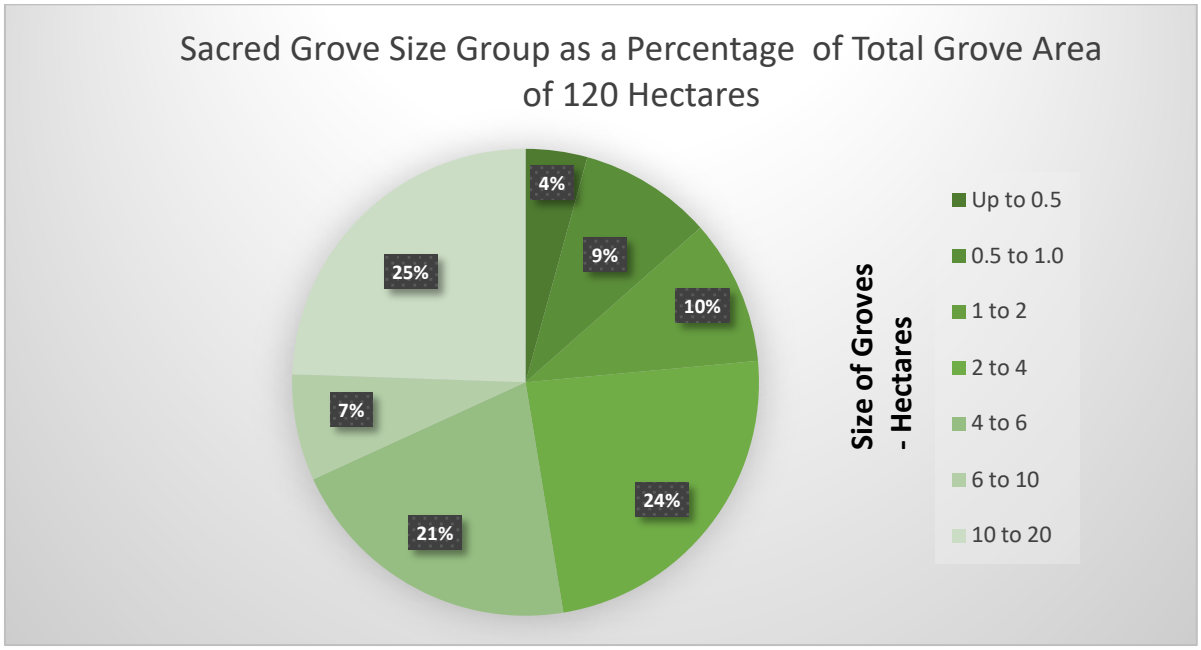


Figure 9 – Pie chart of grove sizes as a percentage of the total grove area.

The analysis of size showed clearly that the largest percentage of groves were small, with 58% of the groves being under 1 hectare, whereas the largest groves between 6 and 20 hectares only represented 5% of the groves. This indicates that the largest percentage of groves are prone to impact due to their small size, as for example a temple extension or small clearing will represent a higher proportion of a grove that is small. Whereas the same development or clearing on a larger grove would have less overall ecological impact.

Taking into consideration the overall surface area of the groves, it can be concluded that 41 groves below 2 hectares, which is 71% of the total number of groves, only represents 28 hectares, which is 23% of the total 120 hectares. Whereas, 17 groves between 2 and 20 hectares, which is 29% of the total number of groves, represents 92 hectares, which is 77% of the total 120 hectares.

It could be seen that this has a two-way effect on the vulnerability of the ecology. On the one hand it is advantageous on an ecological level to have small groves spread out over the zone, as though they are more vulnerable to impact, there is a chance that these groves, if well protected, can become biodiversity banks for the areas that they are situated. Along with the help of vectors, they could become points of dispersal for natural regeneration of the species into the region. On the other hand, the largest 8 groves, correspond to 64 hectares, which is 53% of the total 120 hectares the groves represent, therefore if these groves are ecologically impacted, it would drastically affect the overall coverage of the sacred groves and hence impact the surface area of the last remnants. This can be seen with the Puthupet sacred grove which in the last 20-year period lost 9% of its canopy, which in this case amounts to 0.79 hectares. This loss in itself is larger than the size of more than half of the groves.

2. Sacred grove canopy analysis

The next step in the process was to understand for each sacred grove what was the actual canopy cover it offered, e.g. the total area of the grove minus the open spaces, temple infrastructure, water bodies, etc. This work was implemented by combining the GIS information which was collected during the site visits with the Google Earth imagery, past and present. For each grove a historical image, of maximum time span away from the present, but of analytical quality, was chosen and a polygon of the vegetation canopy was superimposed on the image. The size of the polygon, and hence the canopy, was calculated and recorded in hectares. This was repeated for a similar analytical quality image as close to the present date as possible. Please see below *figure 10* for a sample of these images, and appendix 1 for the full set of images, past and present, for each of the groves.

Figure 10 – Sample images of Mugiayur sacred grove canopy, 03/2009 and 02/2022.

Once all the images were created and canopy polygons added, the data of canopy surface area was tabulated. Please see below *figures 11 and 12*, for the full data of grove size, historical canopy cover, present canopy cover and reduction or gain in canopy cover as a percentage:

Figure 11 – Table 1 of grove sizes compared to canopy cover.

Name of Grove	Total area of grove	Historical canopy area	Date of Historical data	Present canopy area	Date of present data	Loss or gain of canopy - percentage
Athiyanallur1	0.048	0.046	Oct-10	0.029	Apr-21	-37
Nathamedu	0.11	0.05	06-Oct	0.04	Feb-22	-20
Manapattu	0.18	0.17	06-Oct	0.17	Feb-22	0
Sedarapattu	0.19	0.19	Mar-10	0.19	Sep-21	0
Puthupallayam	0.2	0.19	Jun-06	0.19	Sep-21	0
Gannachavadi	0.21	0.19	Mar-11	0.1	Sep-21	-47
Irumbai	0.22	0	Jan-00	0	Feb-22	-100
Karasur	0.28	0.28	Mar-10	0.26	Sep-21	-7
Athiyanallur2	0.29	0.27	Mar-11	0.27	Apr-21	0
Nagari	0.32	0.31	Mar-10	0.28	Sep-21	-10
Kadagampet	0.36	0.36	Jun-11	0.36	Sep-21	0
Ramanathapuram	0.38	0.31	Feb-10	0.36	Feb-22	16
Vandikuppam	0.4	0.36	Aug-06	0.36	Sep-21	0
Venangapettu	0.46	0.31	Oct-10	0.34	Sep-21	10
Talaikanikuppam	0.49	0.32	May-12	0.3	Sep-21	-6
Kumulam	0.5	0.49	Mar-10	0.42	Sep-21	-14
Vellazhakuppam	0.5	0.27	May-11	0.2	Feb-22	-26
Arasadikuppam	0.53	0.47	Mar-10	0.37	Sep-21	-21
Kottakarai	0.53	0.38	Jun-11	0.41	Sep-21	8
Mangalam	0.57	0.55	Sep-05	0.21	Sep-21	-62
T Murthikuppam	0.63	0.56	Jun-10	0.54	Sep-21	-4
T Puthupallayam	0.63	0.56	Jul-10	0.54	Sep-21	-4
Cinnakumatti 1	0.65	0.38	Oct-10	0.38	Apr-21	0
Kunathammankovil	0.65	0.46	Sep-12	0.45	Feb-22	-2
Kizhpettai	0.67	0.51	Jan-05	0.41	Jan-22	-20
Odiayampet	0.67	0.56	Jul-11	0.56	Feb-22	0
Varakkalpattu	0.7	0.57	May-11	0.49	Sep-21	-14
Akasampet	0.72	0.39	Mar-10	0.46	Feb-22	18

Name of Grove	Total area of grove	Historical canopy area	Date of Historical data	Present canopy area	Date of present data	Loss or gain of canopy - percentage
Kumaramangalam	0.77	0.77	Jun-10	0.77	Feb-22	0
Purnankuppam	0.78	0.78	Mar-10	0.78	Sep-21	0
Pannakuppam	0.79	0.6	Jan-05	0.57	Feb-22	-5
Kasipallayam	0.81	0.35	Mar-12	0.29	Feb-22	-17
Silikeripallayam	0.86	0		0		-100
Mugaiyur	1.26	0.74	Mar-09	0.49	Feb-22	-34
Periyamudaliarchavadi	1.26	0.92	Jan-05	0.42	Sep-21	-54
Tiruchitrambalam	1.26	0.68	Nov-12	0.42	Feb-22	-38
Periyakumatti	1.32	1.12	Mar-11	0.98	Feb-22	-13
Thondamanatham	1.6	1.1	Mar-11	1.18	Mar-22	7
Thirumannikuzhi	1.66	1.62	Jun-10	1.63	Sep-21	1
Pudur	1.71	1.67	Mar-11	1.63	Sep-21	-2
Melvadakuthu	1.99	1.57	Mar-11	1.59	Feb-22	1
Cinnakumatti 2	2.14	2	Oct-10	2	May-21	0
Kulanthaikuppam	2.7	2.6	Jul-10	2.5	Apr-21	-4
Alamarathukuppam	2.75	1.82	Mar-10	1.72	Feb-22	-5
Velleripattu	3.12	2.61	Apr-02	2.51	Mar-21	-4
Kodivinayagar	3.12	1.85	Sep-12	1.88	Sep-21	2
Suriyanpet	3.36	3.33	Mar-11	3.31	Sep-21	-1
Sendirakkillai	3.5	3.47	Oct-10	3.47	Jul-20	0
Ramapuram	3.79	2.23	Mar-11	2.58	Feb-22	16
Konjikuppam	3.99	2.62	Mar-11	2.26	Mar-11	-14
Muthanai	4.5	3.83	Mar-11	3.84	Apr-21	0
Krishnavaram	4.56	2.93	Jun-10	2.29	Feb-22	-22
Paalvathunnam	4.93	2.37	Oct-10	2.1	Apr-21	-11
Urani	5.13	4.16	Oct-10	3.98	Jan-22	-4
Ommiper	5.6	2.53	Mar-05	2.91	Sep-21	15
S Pudur	8.81	5.8	Mar-11	5.78	Mar-22	0
Puthupet	10.2	8.98	Jan-02	8.19	Jan-22	-9
Kothattai	19	6.9	Mar-11	6.9	Apr-22	0

Figure 12 – Table 2 of grove sizes compared to canopy cover.

From the data collected and calculated, the following charts were prepared to show the breakdown of total canopy cover compared to the total area the groves represent, both historically and presently, see *figures 13 and 14* below:

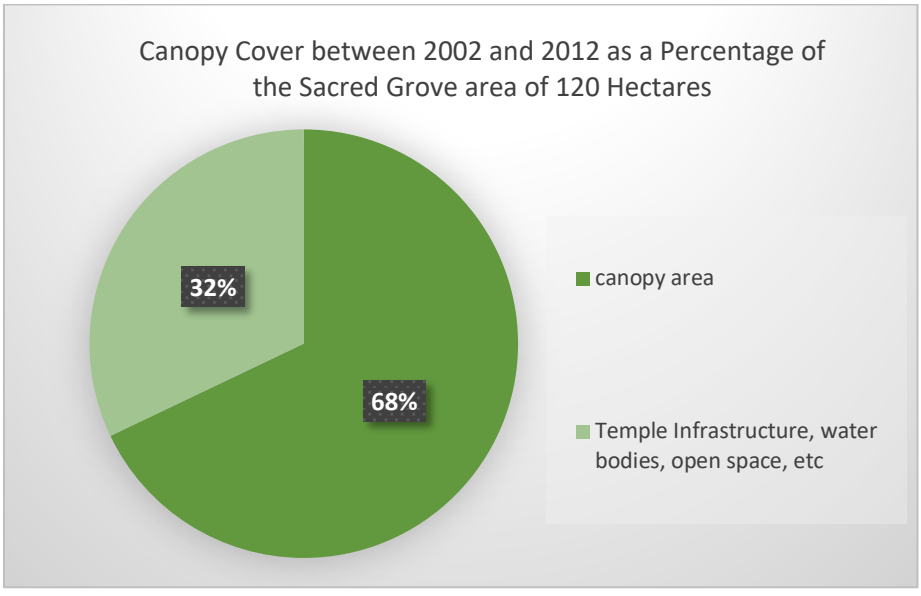


Figure 13 – Pie chart to show canopy cover percentage between 2002 and 2012

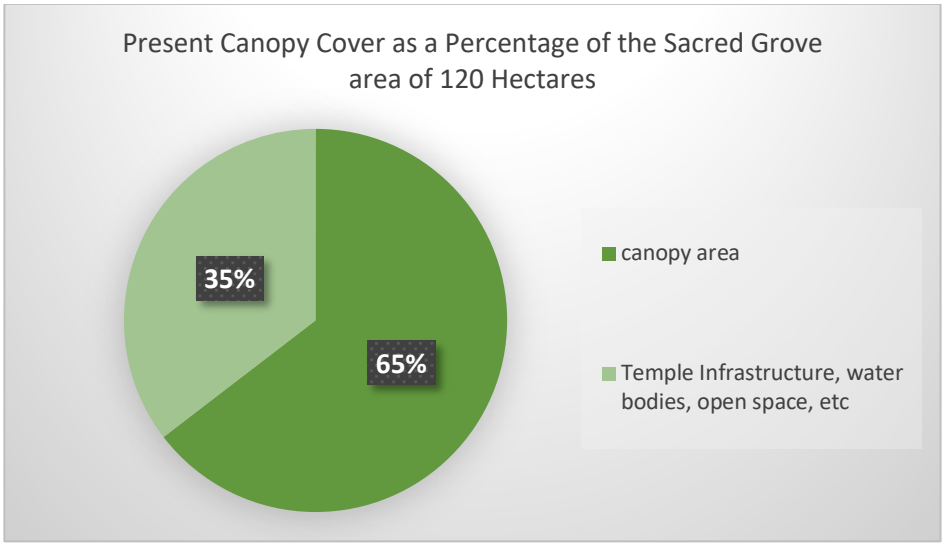


Figure 14 –Pie chart to show present canopy cover percentage.

The next step was to understand how each groves canopy cover has been affected within the last 10 to 20 years. The following bar chart illustrates how the 58 grove's canopies have changed, as a percentage loss, no change or percentage gain, see *figure 15* below:

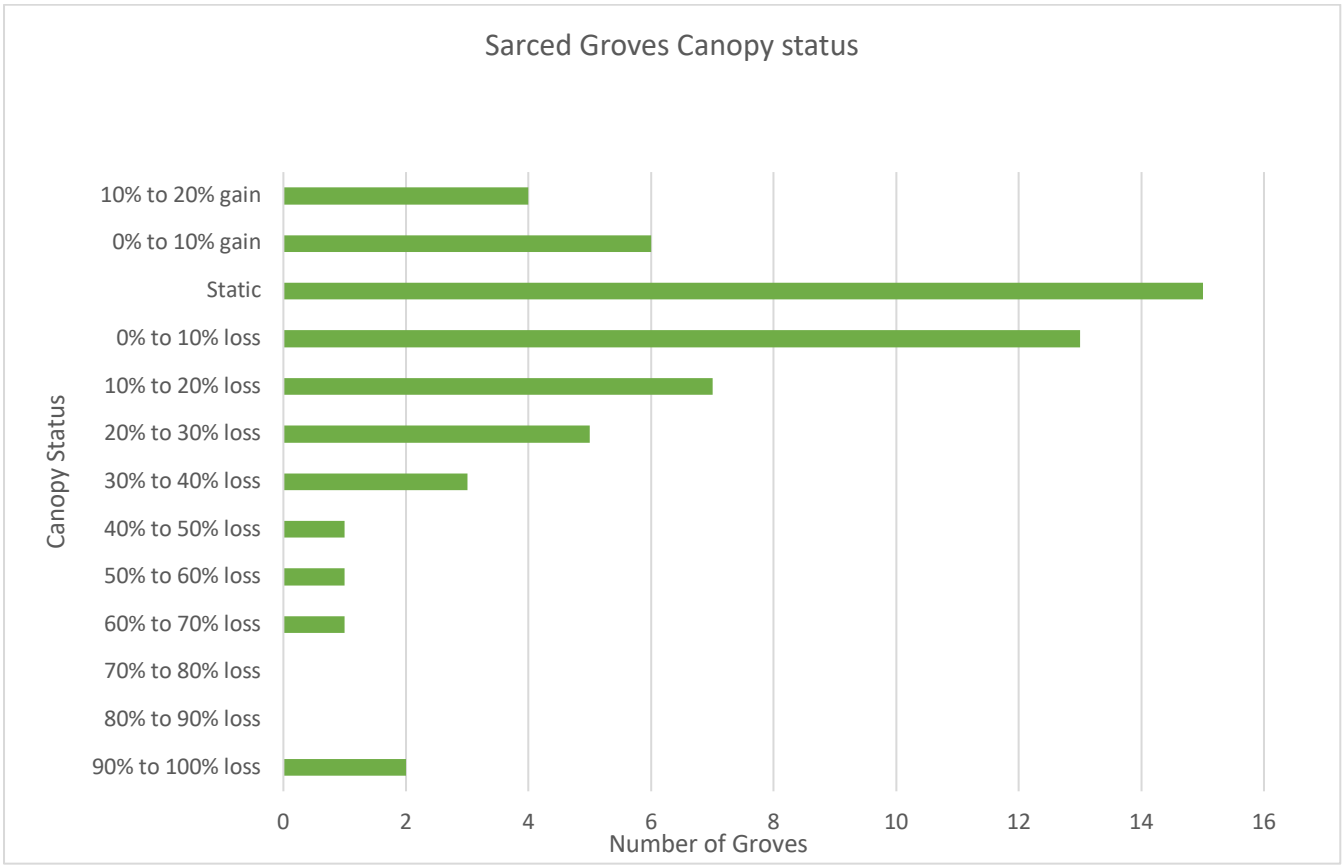


Figure 15 – Sacred groves canopy status from between 2002 to 2012 and the present.

To further illustrate this from the point of view of a number of groves as a group and as a percentage loss, no change or percentage gain, see the pie chart in *figure 16* below:

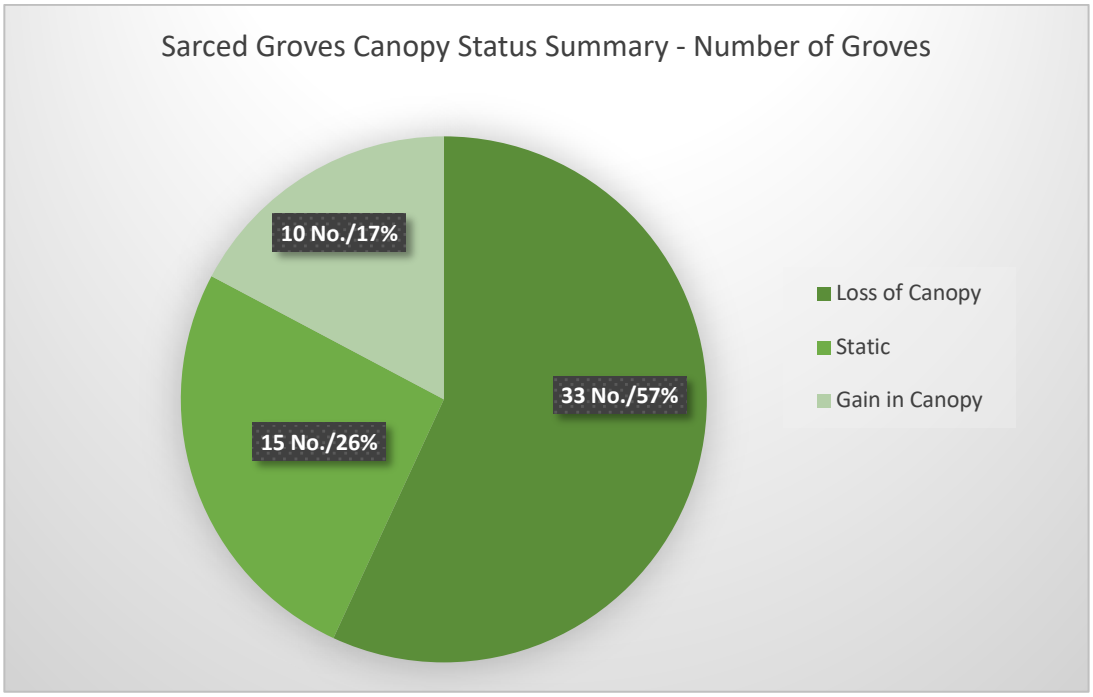


Figure 16 –Pie chart to summarise present canopy status.

As the above illustrates the percentage of canopy loss and gain, the next step was to quantify this as actual hectares. The chart below, *figure 17*, illustrates the actual hectares lost or gained for each grove:

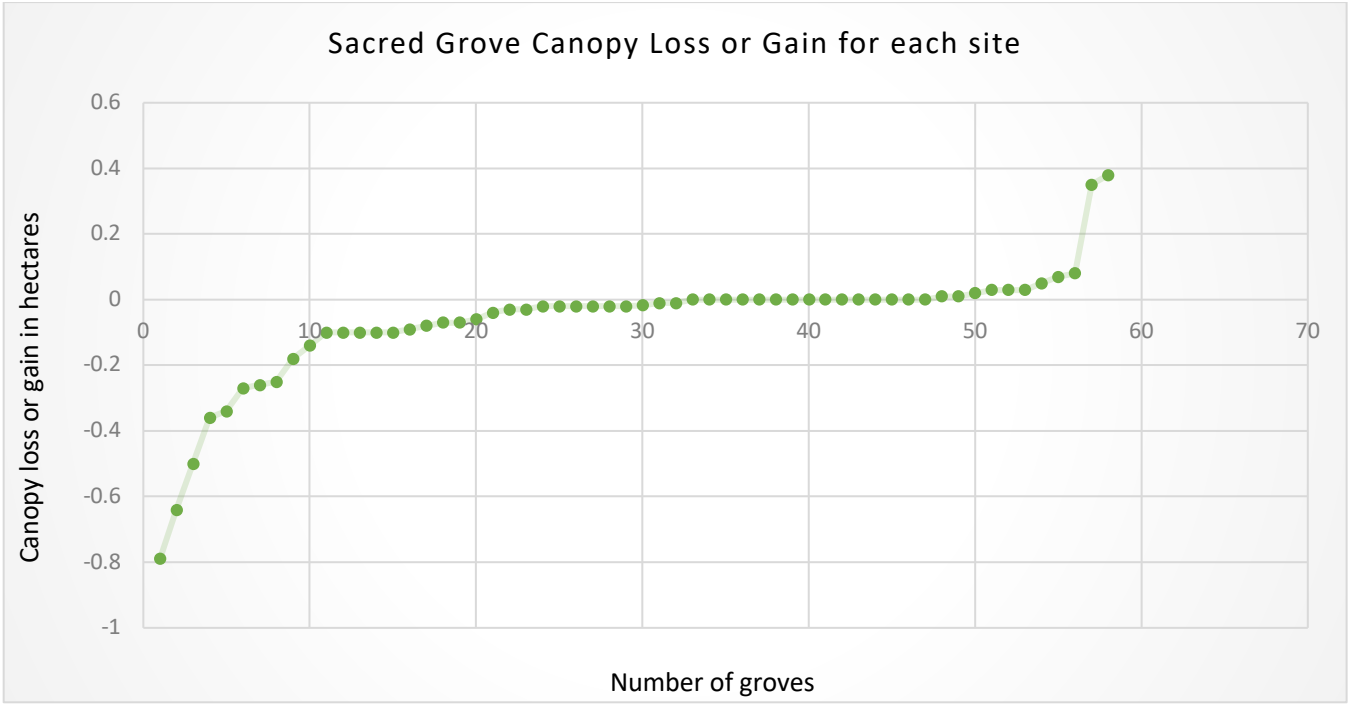


Figure 17 – Sacred groves canopy loss or gain for each site in hectares

Combining the percentage with the actual canopy change area, a summary was made in the table below, *figure 18* :

Figure 18

Canopy Status	Number of Groves	Area in Hectares	Percentage of full Canopy
Loss	33	5.92	7.6 %
Static	15	0	0
Gain	10	1.05	1.4 %

By looking in detail at the canopy cover of each grove it can be assessed that presently the 58 sacred groves represent 120 hectares, but only 78 hectares have vegetative cover, which is 65% of the total.

This can be compared to the historical data that was assessed between 2002 and 2012, which was 82 hectares of vegetative cover, which is 68% of the total. Therefore, it can be seen that between the historical period and the present there has been a loss of 4 hectares canopy, this amounts to a 5% loss in the canopy.

Looking further into the distribution it can be concluded that more half the groves, 58 %, suffered canopy loss, whereas about a quarter, 24%, were in a static state showing no loss or gain and finally 17% showed a gain in the canopy. There was no pattern observed whether the loss or gain correlated with grove size, and was therefore seen as a random attribute.

3. Sacred grove ecological qualitative data analysis

Now that there is an understanding of the size of each grove, how that relates to canopy cover and subsequent loss or gain of canopy, the next stage was to understand the qualitative elements of the overall quality of the ecology e.g. canopy area/understorey for each of the 58 groves.

It first should be stated that none of the sacred groves could be classified as a forest, as their function dictates that a religious/cultural activity happens on the site. What could be said is that a sacred grove will contain patches of remnant vegetation that would historically have been part of the original TDEF of the area. It is clear from the site visits that some groves have patches of remnant forest in them, which have survived the rigors of time. It is also observed from these site visits that a large percentage of the vegetation patches of these groves have suffered a certain level of disturbance. Therefore, during the site visits to the groves, an effort was made to study the status/make-up of the canopy area and quality/presence of its understory. It would be fair to say these two elements indicate the ecological status of the vegetative area, e.g., is it a patch of remnant TDEF forest, is it a stand of TDEF trees, is it degraded etc. In order to analyse this qualitative data, standard categories had to be created. Though this is a limiting factor, as it is restricting to put an element so abstract in a box, the observations were made by many team members to gain accuracy.

The following categories were decided upon, and were applied to all of the groves:

A. TDEF canopy with understory – *An area with mainly TDEF evergreen canopy trees, with lianas a long with an understory.*
B. TDEF canopy with partial understory - *An area with mainly TDEF evergreen canopy trees, with some lianas and an understory partially disturbed or cleared.*
C. TDEF canopy with no understory - *An area with mainly TDEF evergreen canopy trees, but with a highly disturbed or cleared understory.*
D. Mixed canopy with understory – *An area with TDEF trees mixed with common/opportune species e.g. Neem, Banyan, country mango, tamarind etc, with an understory.*
E. Mixed canopy with partial understory - *An area with TDEF trees mixed with common/opportune species e.g. Neem, Banyan, country mango, tamarind etc, with a disturbed/partly cleared understory.*
F. Mixed canopy with no understory - *An area with TDEF trees mixed with common/opportune species e.g. Neem, Banyan, country mango, tamarind etc, with a highly disturbed/cleared understory.*
G. Low disturbed canopy with understory – *An area with low vegetation, sometimes with palmyra clumps and thorny/non thorn climbers and an undisturbed understory.*

H. Low disturbed canopy with partial understory - *An area with low vegetation, sometimes with palmyra clumps and thorny/non thorn climbers and a partially disturbed/cleared understory.*
I. Low disturbed canopy with no understory - *An area with low vegetation, sometimes with palmyra clumps and thorny/non thorn climbers and a heavily disturbed/cleared understory*
J. No canopy/Fruit tree canopy – *An area where the canopy has been removed and/or grove developed as fruit tree orchard. Therefore, of no botanical interest for this study.*
K. Info presently unavailable – *Newly found grove where border and canopy analysis could be done but are awaiting a more in-depth vegetation study.*

The next step based on the field site visit notes, was for each of the 58 groves to be placed into one of the above categories to allow the analysis to take place. This segregation of the groves proved quite difficult, taking the banyan tree as an example, as it was present in nearly all groves, if it was integrated amongst the canopy, and allowed to grow undisturbed amongst the evergreen TDEF and emergent species, then it would be included in the TDEF canopy category. If it was managed and maintained as a stand-alone sacred tree then it would be in the mixed canopy category. Though these nuances could put into question this idea/accuracy of categorisation, the fact that this process is more to acquire an indicator of the present status of the ecology, it was considered a valid process to explore.

Other difficulties that were experienced in this categorisation process, was that some groves had areas of different ecological states, and thus fitted in many categories. Generally the most dominant category was chosen as the classification, but this observation was then taken into consideration during analysis.

The following bar chart below in *figure 19*, highlights the initial findings:

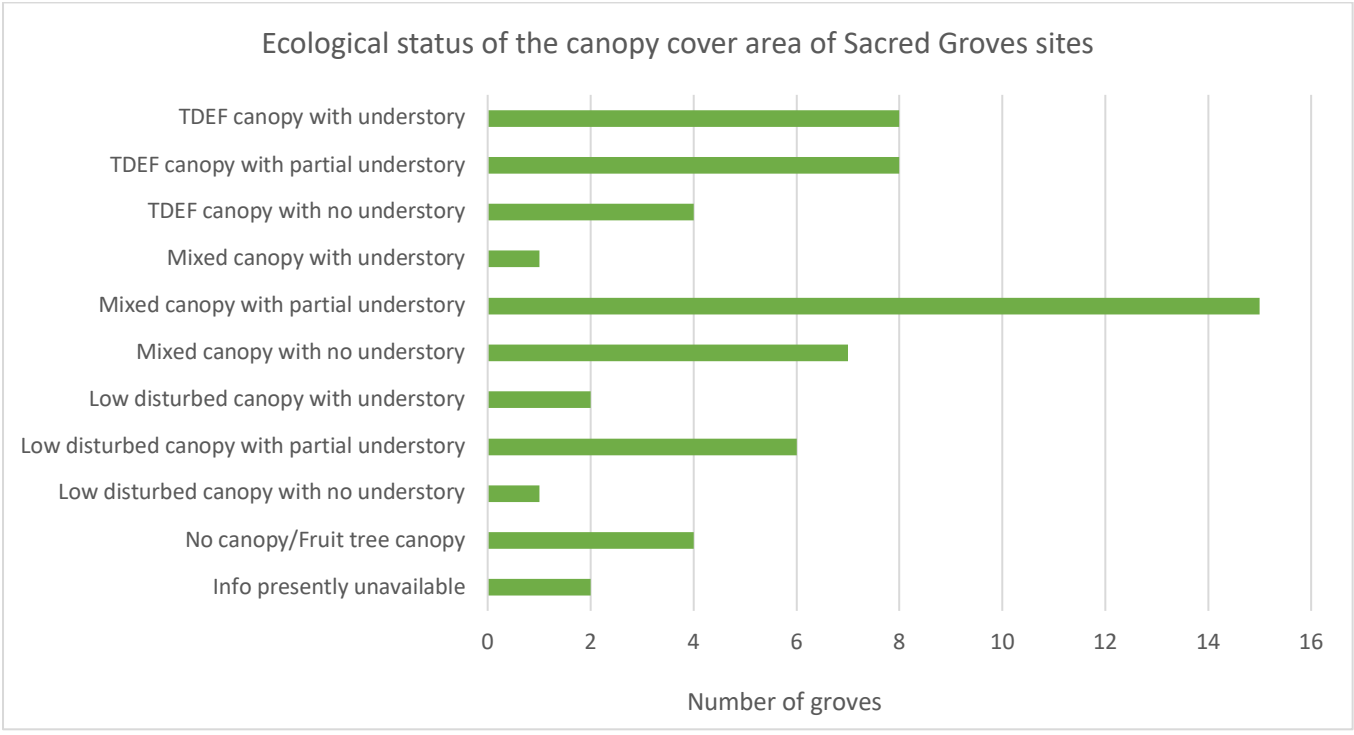


Figure 19 – Ecological status of the vegetation of the sacred grove sites.

To illustrate how these different categories reflect upon the full set of 58 groves, the pie chart below was created to enable each category to be expressed as a percentage, see *figure 20*:

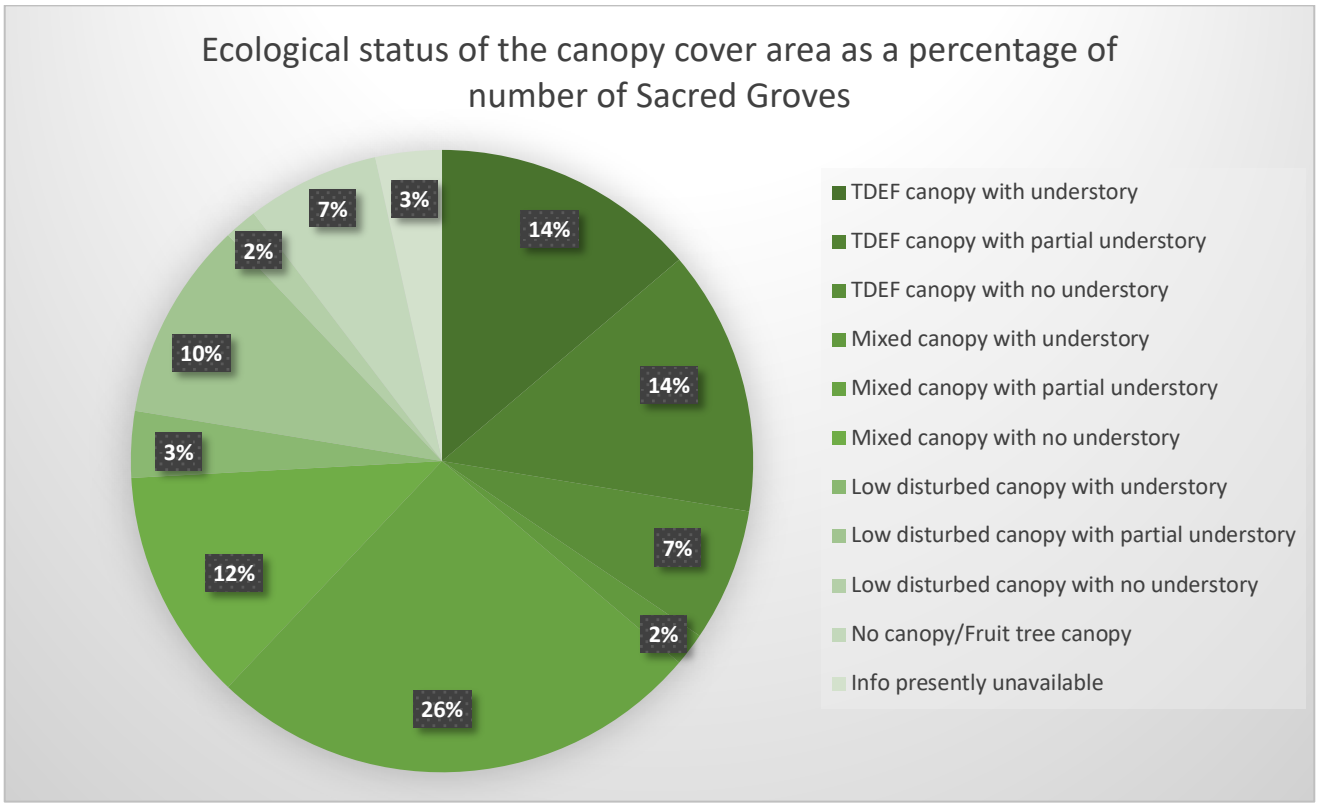


Figure 20 – Ecological status of the vegetation relative to the number of sacred groves.

How this breakdown of categorised vegetation found in groves relates to the actual area covered, in context to the total area of 120 hectares the sacred groves cover, can be seen below in *figure 21*:

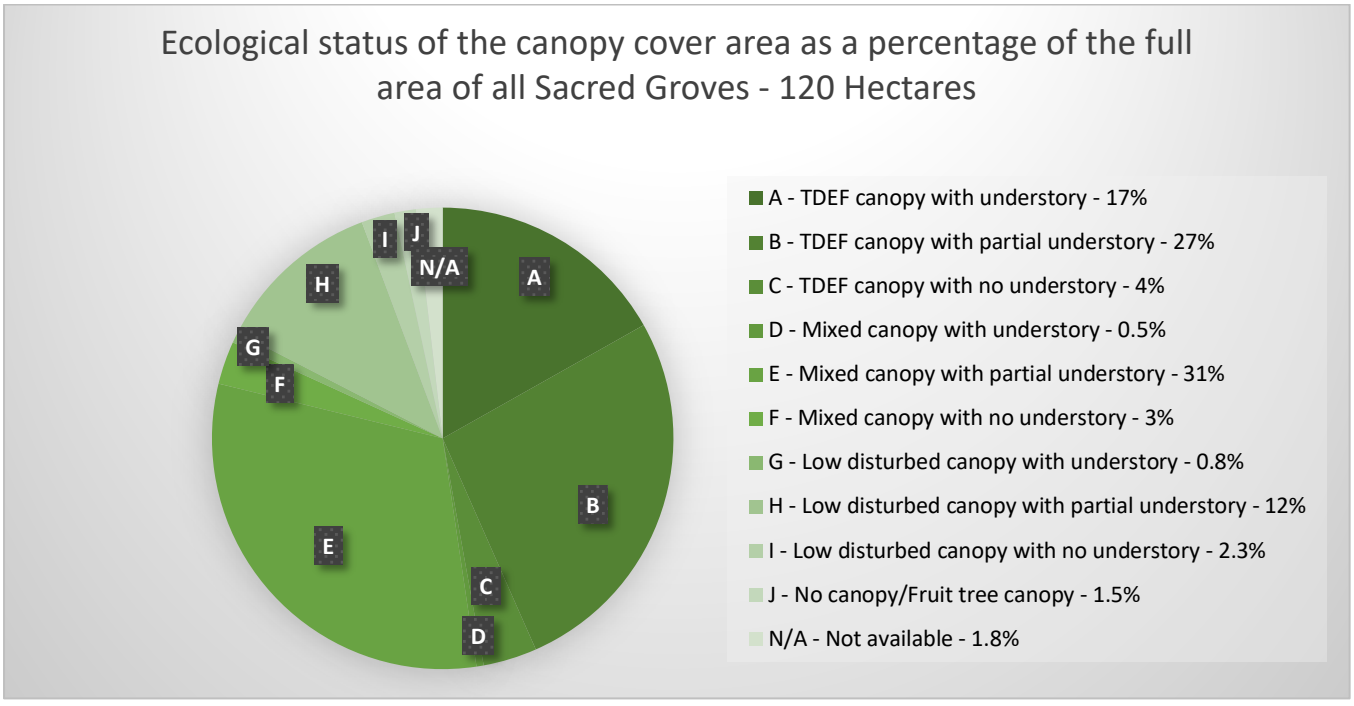


Figure 21 – Ecological status of the vegetation relative to the full surface area of all the sacred groves.

To summarise the qualitative data, see the table below, *figure 22*, which breaks down the number of groves, the area and percentage of the total area for each vegetative category:

Description of Vegetation	No. of Groves	Area - Hectares	% of the Total Grove Area
TDEF canopy with understory	8	20.1	17.0
TDEF canopy with partial understory	8	31.7	27.0
TDEF canopy with no understory	4	4.5	4.0
Mixed canopy with understory	1	0.6	0.5
Mixed canopy with partial understory	15	37.2	31.0
Mixed canopy with no understory	7	3.6	3.0
Low disturbed canopy with understory	2	0.9	0.8
Low disturbed canopy with partial understory	6	14	12.0
Low disturbed canopy with no understory	1	2.8	2.3
No canopy/Fruit tree canopy	4	1.8	1.5
No Information presently available	2	2.2	1.8

Figure 22 –Table of number of groves, area and percentage of total area for each category.

As these 58 groves are potentially holding the last remnants of the TDEF in this sector of the projected TDEF zone, and in some form hold groups of species in a natural environment, it was necessary to understand how these groves faired in an assessment of how much they represented a TDEF ecology. Though the method of categorisation does have limitations of human error on assessment, it was felt that the observations came from extensive field site visits by the team.

It can be deduced that only 8 groves had an overall vegetation in a state that could be assessed as a TDEF canopy and understory, which could indicate a remnant forest, this equates to only 20 hectares, or 17% of the full area of 120 hectares this set of groups represent. *Figure 23* below captures a grove within this category, Pudur sacred grove, with a TDEF canopy, undisturbed understory and interconnecting lianas, also with rare large specimens of Diospyros ebenum – the Indian ebony.

Figure 23 – Pudur sacred grove

Having stated this, it can also be observed that TDEF canopy with partial understory equates to 32 hectares, therefore within this category there would also be areas that would indicate a remnant forest, it is only when looking at the grove as a whole it shows understory disturbance. An example of this is the Puthupet sacred grove, which is one of the largest at 10.2 hectares and one of the best remnants known. The fact that this grove is very popular and the temple area has developed, has led to problems of lopping of the understory for firewood, areas being cleared for pujas and of a large amount of plastic/glass waste suffocating regeneration, (see *figure 24*), it was assessed as TDEF canopy with partial understory though it still contained some of the largest areas that indicate a remnant TDEF.

Figure 24 – Puthupet sacred grove with a disturbing amount of waste present.

On the other end of scale there is the example of Manupattu which is one of the smallest groves at 0.18 hectares but not disturbed. Due to its size, it holds only limited species but due to its state it was categorised a TDEF canopy and understory. It can also be observed that some of the groves that were categorised mixed canopy with understory and partial understory, depending on their size, also contained areas that indicate a remnant forest. Therefore, based on all these factors it would be difficult to apply this qualitative data precisely. This is why this information is used in an indicative way. Overall, it would be fair to extrapolate the following:

- Within the last 20 years, 4 scared groves, representing 1.76 hectares no longer have any TDEF vegetation.
- In 16 groves there could be found areas with a TDEF canopy along with an understory, indicating a remnant, of varying degrees of coverage of the grove.
- In another 16 groves, though having the presence of non-TDEF species within the grove, also contained areas with a TDEF canopy along with an understory, indicating a remnant, of varying degrees of coverage of the grove.
- A further 11 groves contained a canopy or partial canopy of TDEF species but with no understory, and hence not the natural regeneration of species required needed for it to be representative of a remnant forest.
- A further 9 groves could be categorised as highly disturbed.

4. Sacred grove species diversity and spatial distribution

Based on the data from the site visits, combined with the biodiversity surveys conducted by the AV botanical team in the early 2000s, where all the woody and perennial species were surveyed as well as the annual climbers, it can be observed that for the 58 groves studied the average number of species per grove was 69, with the minimum being 28 species and the maximum being 114.

From the sample set of the main 40 evergreen/brevi-evergreen trees and woody shrubs that was decided upon to study, 25 were trees and 15 shrubs. Their presence in each grove was noted and the following charts indicate the frequency of groves they were observed, *figure 25* for the set of trees and figure 26 for the set of shrubs:

Figure 25 Number of groves that the sample of 25 evergreen/brevi-evergreen trees were present

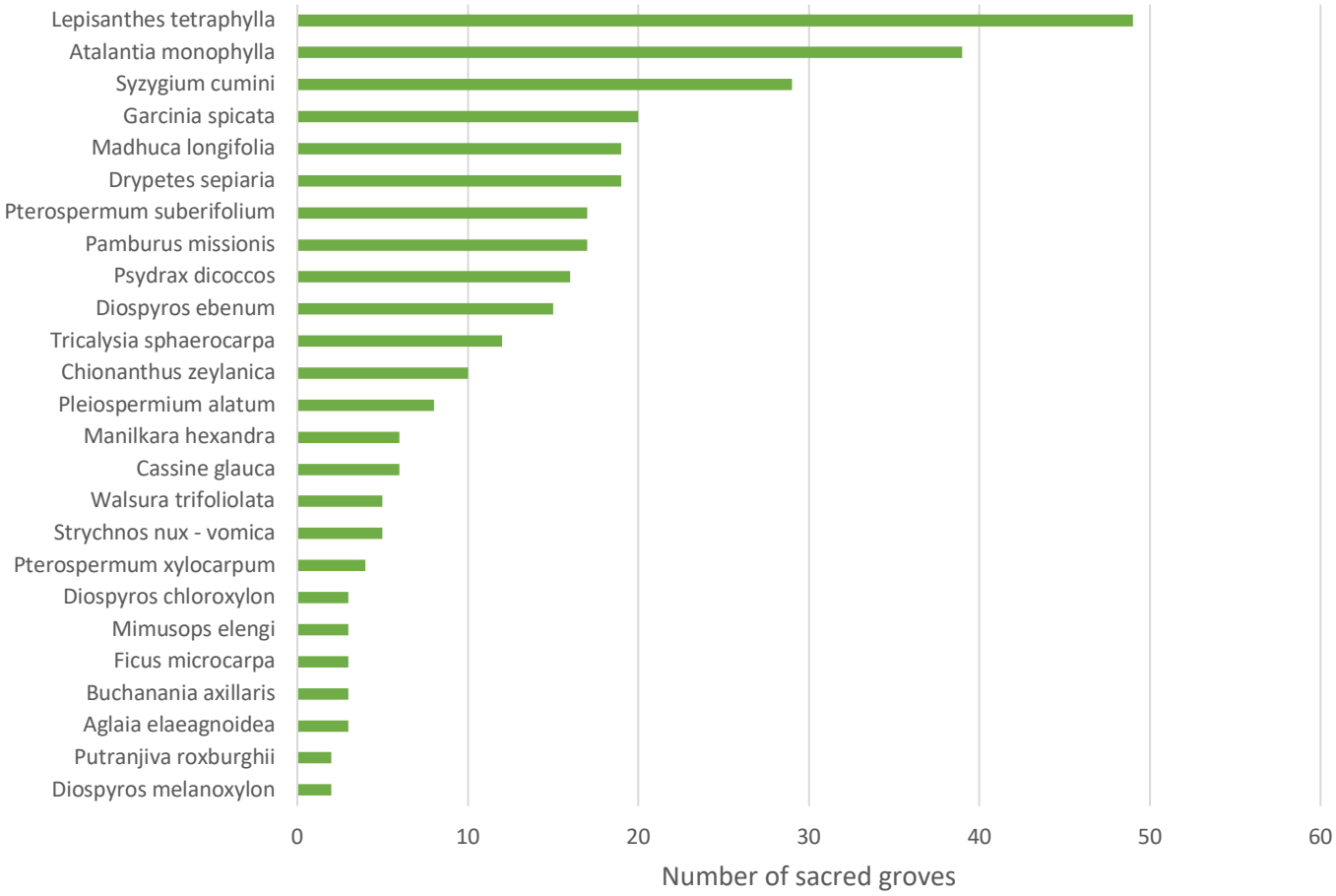
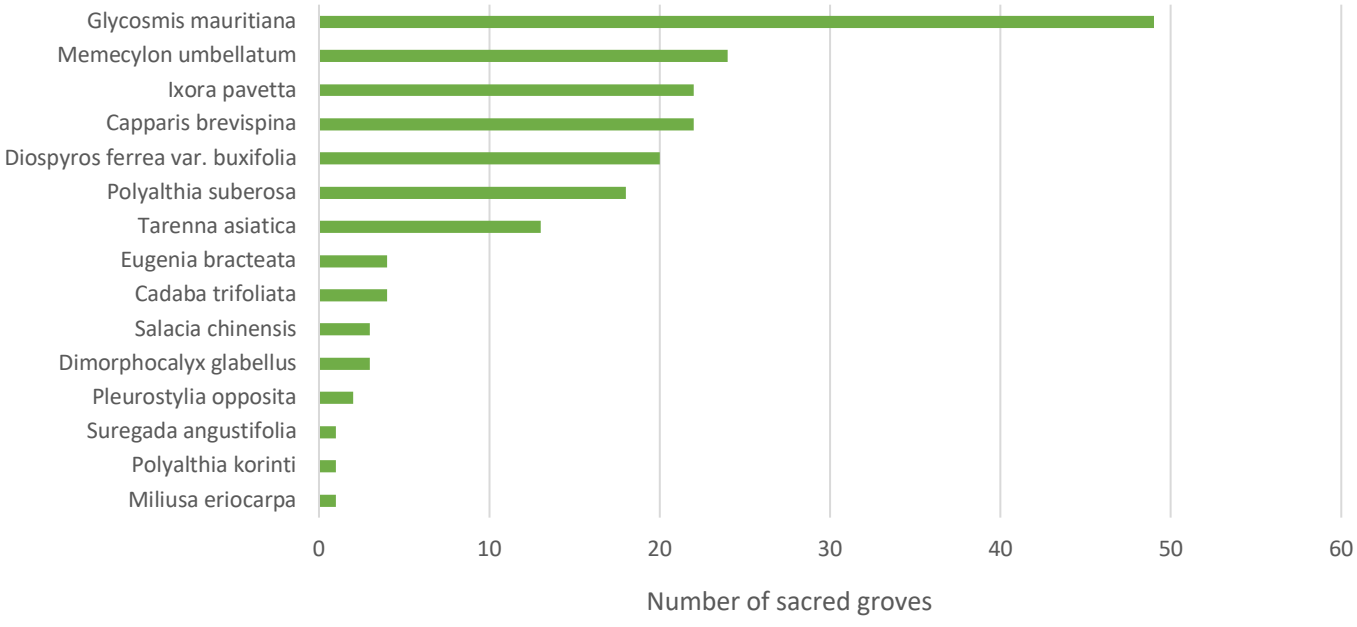


Figure 26 Number of groves that the sample of 15 evergreen/brevi-evergreen woody shrubs were present



For the tree species distribution, it can be observed that 22 species out of the 25, that being 88% of the sample set, are only present in less than 20 of the sacred groves. Therefore, only 3 species are found in more than 50% of the groves studied. These 3 species, especially *Lepisantes tetraphyla* which exists in nearly all the groves, could be seen as secure as not only are they observed in most groves and in mature form, but they are present in groves with canopy and good undergrowth, and were found in varying sizes of regeneration. Out of the 22 species, 9 species were observed as only being present in between 10 and 20 groves, thus they could be considered vulnerable, for example *Diospyros ebenum*, which being a dioecious species, needs both male and female mature specimens to reproduce, and is seen to have limited regeneration. Also, these 9 species are present in some groves with no understory, hence restricting the regeneration and continuous lineage of the specimens. The remaining 13 species out of the 22, were found in less than 10 of the groves, these species could be considered as very vulnerable, some being present in only a few groves. An example could be made with *Walsura trifoliata*, which exists in only 5 groves, out of which 2 groves had no apparent regeneration.

For the shrub distribution, it can be observed that 11 species out of the 15, that being 73% of the sample set, are only present in less than 20 of the sacred groves. Only 1 species has a widespread distribution of 49 groves out of the 58, that being *Glycosmis mauritiana*. It can be observed that 6 species are present between 13 and 24 groves, these species would be considered as less vulnerable, especially as the cycle to maturity of approximately 3 years bolsters their ability to regenerate and become viable specimens, unlike that of the evergreen trees. A further 8 out of the 15 species, more than half of the sample set, is present in less than 5 groves, this indicates that these species are very vulnerable and prone to biodiversity loss.

To visualise the spatial distribution, using the GIS data collected, each species was mapped. Below in *figures 27 and 28* we can see the grove distribution of the two most frequent evergreens, *Lepisanthes tetraphylla* and *Glycosmis mauritiana*:

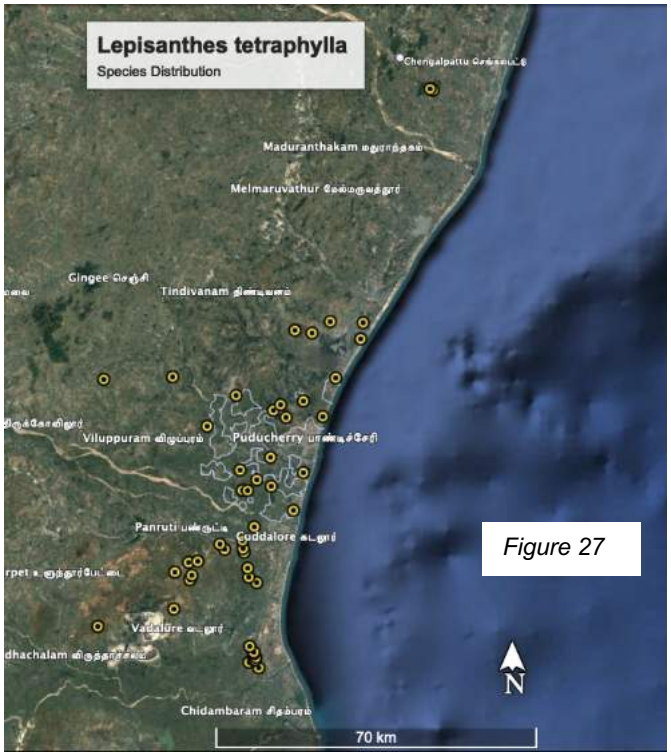


Figure 27

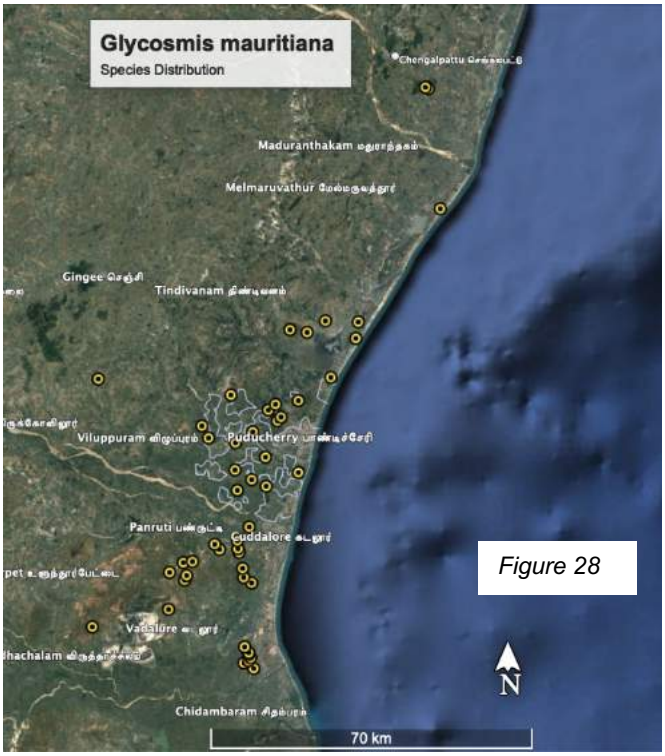


Figure 28

The distribution for these two species is spread across the whole range and they are only absent from a small percentage of groves. The *Lepisanthes tetraphylla* is also found in reserve forests, on hillocks and tank bunds, but still, it is not common enough to be seen on roadsides, hedge rows or in gardens. As for the *Glycosmis mauritiana*, it is a common woody shrub in this area with quite a widespread presence outside of the sacred groves.

In *figure 29 and 30* we can see the grove distribution of two of the less frequent evergreens, *Diospyros ebenum* and *Garcinia spicata*:

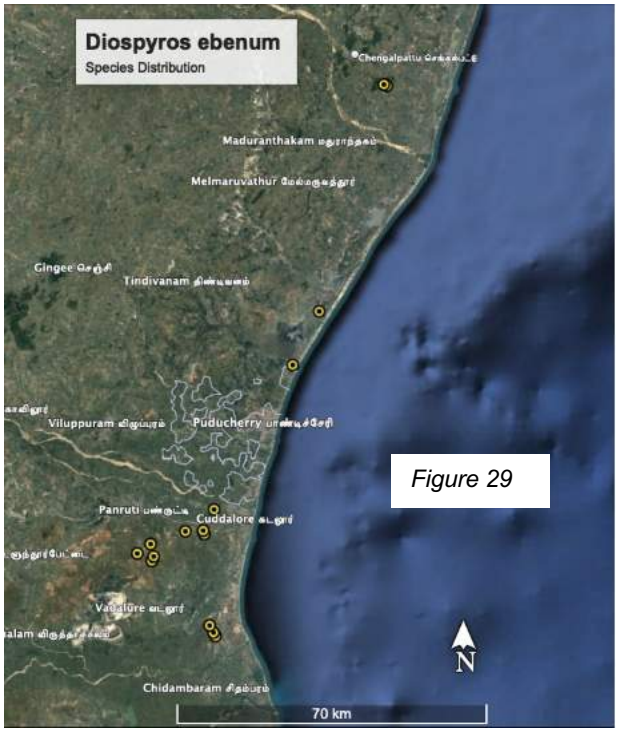


Figure 29

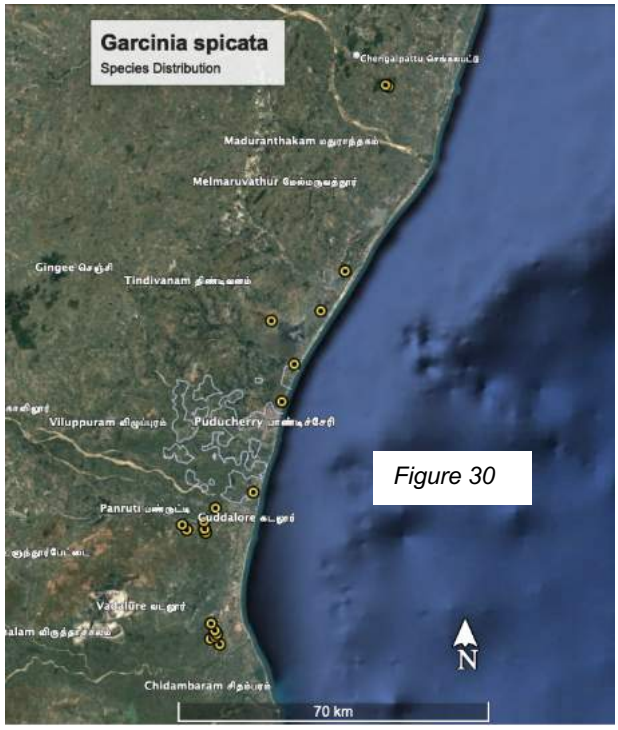


Figure 30

The distribution for these two species is clearly less frequent, but it is still distributed across the range, though more frequent south of Cuddalore in both cases. In *figures 31 and 32* we can see the grove distribution of two of the infrequent evergreens, *Cadaba trifoliata* and *Dimorphocalyx glabellus*:

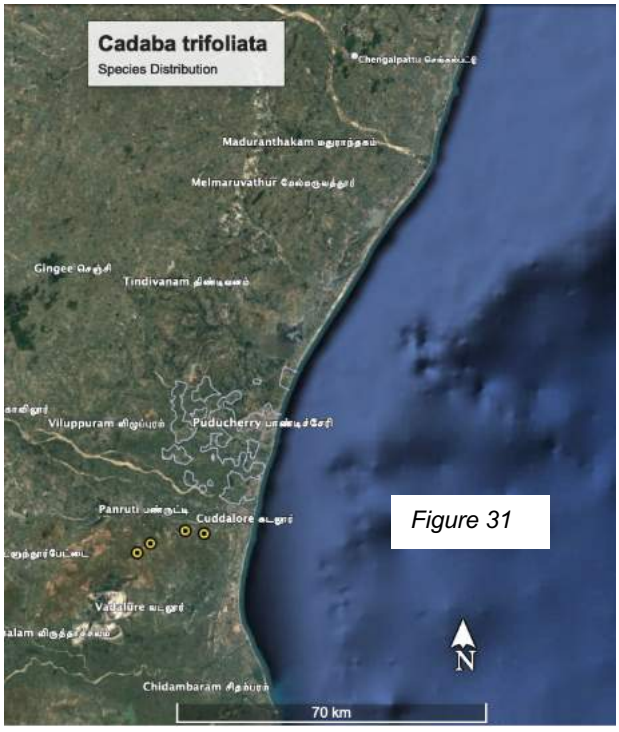


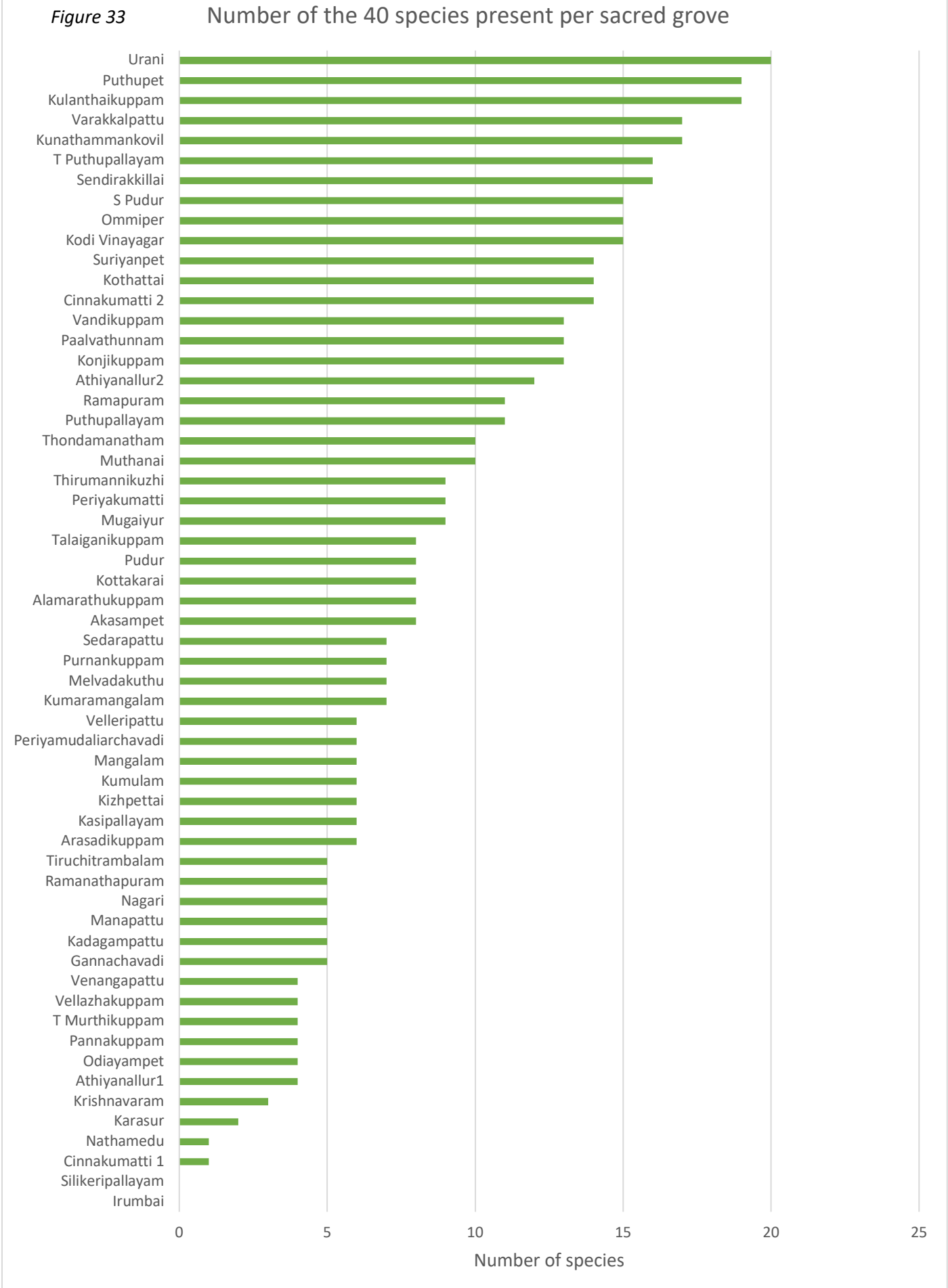
Figure 31

Figure 32

The distribution for these two infrequent species is clearly not dispersed across the range, but their minor frequency is concentrated in a small area, around and south of Cuddalore.

To understand the dynamics of these 40 main evergreen/brevi-evergreen species as groups within each grove, the overall number was calculated and tabulated. The *figure 33*, illustrates this for each grove.

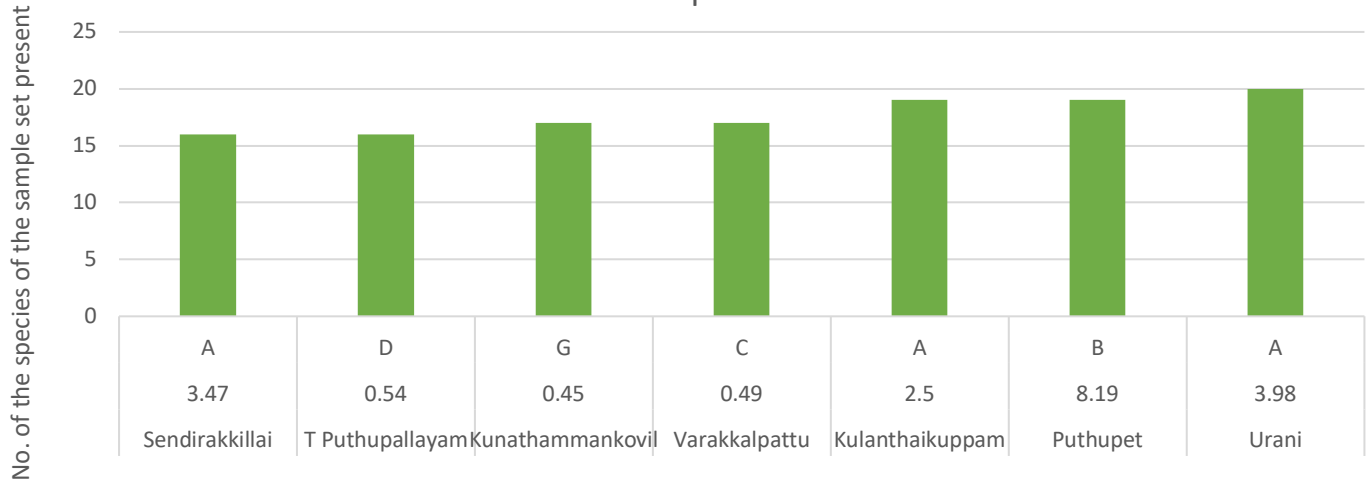
Figure 33


Number of the 40 species present per sacred grove
Urani
Puthupet
Kulanthaikuppam
Varakkalpattu
Kunathammankovil
T Puthupallayam
Sendirakkillai
S Pudur
Ommiper
Kodi Vinayagar
Suriyanpet
Kothattai
Cinnakumatti 2
Vandikuppam
Paalvathunnam
Konjikuppam
Athiyanallur2
Ramapuram
Puthupallayam
Thondamanatham
Muthanai
Thirumannikuzhi
Periyakumatti
Mugaiyur
Talaiganikuppam
Pudur
Kottakarai
Alamarathukuppam
Akasampet
Sedarapattu
Purnankuppam
Melvadakuthu
Kumaramangalam
Velleripattu
Periyamudaliarchavadi
Mangalam
Kumulam
Kizhpettai
Kasipallayam
Arasadikuppam
Tiruchitrambalam
Ramanathapuram
Nagari
Manapattu
Kadagampattu
Gannachavadi
Venangapattu
Vellazhakuppam
T Murthikuppam
Pannakuppam
Odiayampet
Athiyanallur1
Krishnavaram
Karasur
Nathamedu
Cinnakumatti 1
Silikeripallayam
Irumbai
0
5
10
15
20
25
Number of species

From the above chart it can be clearly seen that no grove contained more than 20 of the main 40 evergreen/brevi-evergreen species.

To try to understand the ecological dynamics of the groves containing the most of these evergreen species, an analysis of the top 7 groves, those that contained between 16 and 20 species was undertaken, See *figure 34* below:

Figure 34 Details of the groves containing the most evergreen trees and shrubs - Top 7



Firstly, it can be seen that the grove's canopy size did not affect this concentration of species as the size ranges from 0.45 to 8.19 Ha.

What can be seen is that out of the 7 groves, 3 were categorised A - *An area with mainly TDEF evergreen canopy trees, with lianas along with an understory*, 1 was categorised B - *An area with mainly TDEF evergreen canopy trees, with some lianas and an understory partially disturbed or cleared* and 1 that was categorised D - *An area with TDEF trees mixed with common/opportune species e.g., Neem, Banyan, country mango, tamarind etc canopy, with an understory.* The diversity found in these 5 groves, based on the qualitative analysis previously mentioned in the report, is what would be expected. The other 2 groves were flagged up as anomalies.

There are anomalies that seem to occur like the 2 groves out of the top 7, Kunathammankovil which is categorised as G - *An area with low vegetation, sometimes with palmyra clumps and thorny/non thorn climbers and an undisturbed understory,* and Varakkalpattu which was categorised as C - *An area with mainly TDEF evergreen canopy trees, but with a highly disturbed or cleared understory,* but these can be explained. In the case of Kunathammankovil sacred grove, in the early 2000's the grove was almost cut down apart from a few large *Maduca longifolia's.* Since then, the grove has started to grow back from the regeneration held within the understory that was left over after the massive cutting. From the diversity of the regrowth, it can be said that prior to cutting the grove was in a healthy state, and it is clearly a grove worth monitoring to see how and how long a grove can be re-established after such a large disturbance. In the case of Varakkalpattu sacred grove, due to a road development and temple expansion, the grove is now but a collection of large interesting specimen trees with no understory, though on the periphery of the grove some of the evergreen woody shrubs still survive in a disturbed state, hence the biodiversity is not yet lost. This draws attention to the importance of site visits to really understand the data created and analysed.

Conclusion

The sacred groves of this TDEF forest zone still contain valuable plant biodiversity and areas of remnant forest. However, looking at the results of the aspects studied, it can be clearly observed that the ecology of the groves is under pressure and thus it is degrading. Whether it be, the loss to the overall canopy cover these groves offer or the diminishing of quality and biodiversity as trees are cut, lowering the canopy height and thus allowing niche invasive species to move in and smother the TDEF plants. Furthermore, the constant cutting and lopping of understory species and natural regeneration which breaks down the natural life cycle of the ecosystem and the situation that many species are only now found in a handful of groves, compounds the problem. Putting these together, with the relatively new phenomena of the groves understory having to compete with plastic and glass waste, all highlight comprehensively that the ecology of the groves is under threat. This also means that the last remnants of the TDEF are therefore under threat.

The main reason for this can be deduced that though, most groves are religiously active, and that a large percentage have undergone temple infrastructural development and enhancement, the religious cultural belief that the surrounding forest is sacred has weakened to a point where it has lost its value in many cases. The fact that so much cutting, lopping and clearing is happening, along with the issue of waste being present under the forest areas of the grove, indicates a different priority given to these once sacred areas. This is compounded by population growth which has increased the number of pilgrims visiting these groves. The other reasons could be determined as being related to temple infrastructural development, to private land encroachment, and in some cases to the expansion of water bodies and road development.

It could also be concluded that though there are indications are there that the ecology of the groves is on a downward trajectory, they still contain amazingly diverse remnants, and are still holding an important biodiversity gene bank. Nearly all groves hold plants of value. Therefore, if there is a will, there is still time to reverse the downward direction. Through awareness campaigns and education, the value of these groves not only on a sacred level, but on the level of the value and uniqueness of the biodiversity that is contained within the groves, their present fragility and the importance to protect this rare ecosystem, could be disseminated.

Epilogue

Late last year, our rapid assessment visits took us to a small sacred grove with a long name, Periyamudaliarchavadi, situated on the ECR road close to the international township of Auroville and about 8.5 km from Puthupet Sacred Grove. During previous visits to this grove which started over 25 years prior, it was always hard to understand why it did not contain *Diospyros ebenum* (the Indian ebony). Being so close to Puthupet where this rare species is quite present, it shares similar soil and has a similar proximity from the ocean. The only reason that could explain this would be that it could not survive the rigors of time. That is why on this afternoon we were surprised to find under the shade of a huge *Syzgium cumini,* a 1 metre high ebony seedling! After some thought we realised that 1 km “as the crow flies” (or maybe more appropriately “as the fruit bat flies”), a small forest called Shakti Forest exists, which is a non-contiguous part of the larger Auroville reafforestation effort. Clearly not a historical remnant TDEF, but an intensely planted young forest of over 40 years old, which consequently was a barren area of approximately 10 hectares before this effort began. It now contains most of the 40 main evergreen species, and it was one of the first Auroville forests to re-introduce the ebony tree. Most of the evergreens have reached maturity there, and like the ebony, with the help of the vectors, in this case the *Pteropus medius* the Indian fruit bat, are being dispersed, spreading its rich biodiversity into the surroundings. In this roundabout way, the Indian ebony returns to the Periyamudaliarchavadi sacred grove probably after a very long time. Let us hope this time round it can survive the rigors of time and get re-established, giving hope that these majestic sacred groves can return to their splendour.

Resource material

Information on the sites and species of the TDEF can be found on the Web resource developed by the Auroville Botanical Gardens on: https://auroville-tdef.info

Information on tropical species and their identification can be found on the Web resource developed by the Auroville Botanical Gardens on: https://www.plantekey.com

The Auroville Virtual Herbarium which contains digital samples of flora of the Coromandel Coast, India can be found on the Web resource developed by the Auroville Botanical Gardens and Pitchandikulam Bio Resource Centre on: https://www.aurovilleherbarium.org

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Appendix 1- Canopy images for each sacred grove, past and present

Akasampet
Canopy 06/2011

Akasampet
Canopy 02/2022

Alamarathukuppam
Canopy 03/2010

Alamarathukuppam
Canopy 02/2022

Arasadikuppam
Canopy 03/2011

Arasadikuppam
Canopy 09/2021

Athiyanallur1
Canopy 10/2010

Athiyanallur1
Canopy 04/2021

Athiyanallur2
Canopy 03/2011

Athiyanallur2
Canopy 04/2021

Cinnakumatti 1
Canopy 10/2010

Cinnakumatti 1
Canopy 04/2021

Cinnakumatti 2
Canopy 10/2010

Cinnakumatti 2
Canopy 05/2021

Gannachavadi
Canopy 03/2011

Gannachavadi
Canopy 04/2021

Kadagampet
Canopy 06/2011

Kadagampet
Canopy 09/2021

Karasur
Canopy 03/2010

Karasur
Canopy 09/2021

Kasipallayam
Canopy 03/2012

Kasipallayam
Canopy 02/2022

Kizhpettai
Canopy 01/2005

Kizhpettai
Canopy 01/2022

Kodi Vinayagar
Canopy 09/2012

Kodi Vinayagar
Canopy 02/2022

Konjikuppam
Canopy 03/2011

Konjikuppam
Canopy 01/2022

Kothattai
Canopy 03/2011

Kothattai
Canopy 04/2021

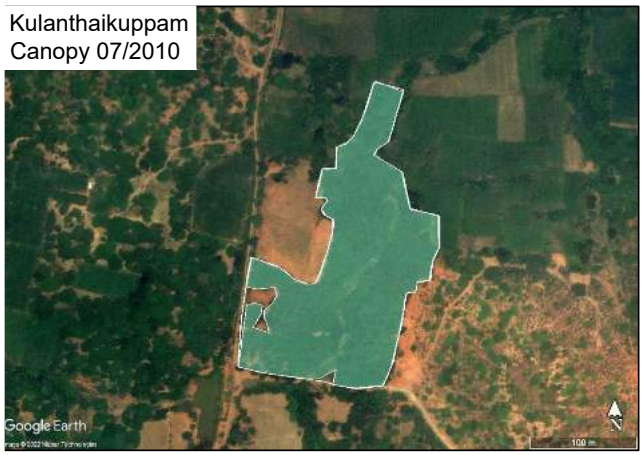
Kottakarai
Canopy 06/2011

Kottakarai
Canopy 09/2021

Krishnavaram
Canopy 06/2010

Krishnavaram
Canopy 02/2022

Kulanthaikuppam
Canopy 07/2010



Kulanthaikuppam
Canopy 04/2021

Kumaramangalam
Canopy 06/2010

Kumaramangalam
Canopy 02/2022

Kumulam
Canopy 03/2010

Kumulam
Canopy 09/2021

Kunathammankovil
Canopy 09/2012

Kunathammankovil
Canopy 02/2022

Mangalam
Canopy 09/2005

Mangalam
Canopy 09/2021
Red line-Agriculture area(coconut and papaya)

Manapattu
Canopy 06/2010

Manapattu
Canopy 02/2022

Melvadakuthu
Canopy 03/2011

Melvadakuthu
Canopy 02/2022

Mugaiyur
Canopy 03/2009

Mugaiyur
Canopy 02/2022

Muthanai
Canopy 03/2011

Muthanai
Canopy 04/2021

Nagari
Canopy 03/2010

Nagari
Canopy 09/2021

Nathamedu
Canopy 06/2010

Nathamedu
Canopy 02/2022

Odiayampet
Canopy 07/2011

Odiayampet
Canopy 02/2022

Ommiper
Canopy 03/2005

Ommiper
Canopy 09/2021

Paalvathunnam
Canopy 10/2010

Paalvathunnam
Canopy 04/2021

Palayermadam
Canopy 02/2005

Palayermadam
Canopy 01/2022

Pannakuppam
Canopy 01/2005

Pannakuppam
Canopy 02/2022

Periyakumatti
Canopy 03/2011

Periyakumatti
Canopy 02/2022

Periyamudaliarchavadi
Canopy 01/2005

Periyamudaliarchavadi
Canopy 09/2021

Pudur
Canopy 03/2011

Pudur
Canopy 09/2021

Purnankuppam
Canopy 03/2010

Purnankuppam
Canopy 09/2021

Puthupallayam
Canopy 06/2006

Puthupallayam
Canopy 09/2021

Puthupet
Canopy 01/2002

Puthupet
Canopy 01/2022

Ramanathapuram
Canopy 03/2010

Ramanathapuram
Canopy 03/2022

Ramapuram
Canopy 03/2011

Ramapuram
Canopy 02/2022

S Pudur
Canopy 03/2011

S Pudur
Canopy 03/2022

Sedarapattu
Canopy 03/2010

Sedarapattu
Canopy 09/2021

Sendirakkillai
Canopy 10/2010

Sendirakkillai
Canopy 07/2020

Suriyanpet
Canopy 03/2011

Suriyanpet
Canopy 09/2021

T Murthikuppam
Canopy 06/2010

T Murthikuppam
Canopy 09/2021

T Puthupallayam
Canopy 07/2010

T Puthupallayam
Canopy 09/2021

Talaikanikuppam
Canopy 05/2012

Talaikanikuppam
Canopy 09/2021

Thirumannikuzhi
Canopy 06/2010

Thirumannikuzhi
Canopy 09/2021

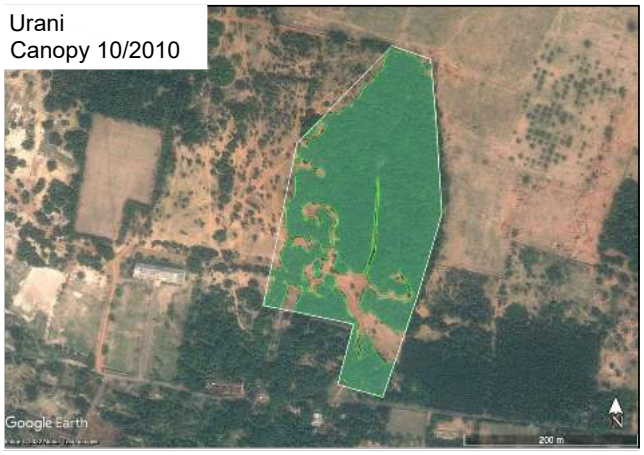
Thondamanatham
Canopy 03/2011

Thondamanatham
Canopy 03/2022

Tiruchitrambalam
Canopy 11/2012

Tiruchitrambalam
Canopy 02/2022

Urani
Canopy 10/2010



Urani
Canopy 01/2022

Vandikuppam
Canopy 08/2006

Vandikuppam
Canopy 09/2021

Varakkalpattu
Canopy 05/2011

Varakkalpattu
Canopy 09/2021

Vellazhakuppam
Canopy 05/2011

Vellazhakuppam
Canopy 02/2022

Venangapettu
Canopy 10/2010

Venangapettu
Canopy 09/2021

Annex 1

The Heritage Specimens of the TDEF Sacred Groves

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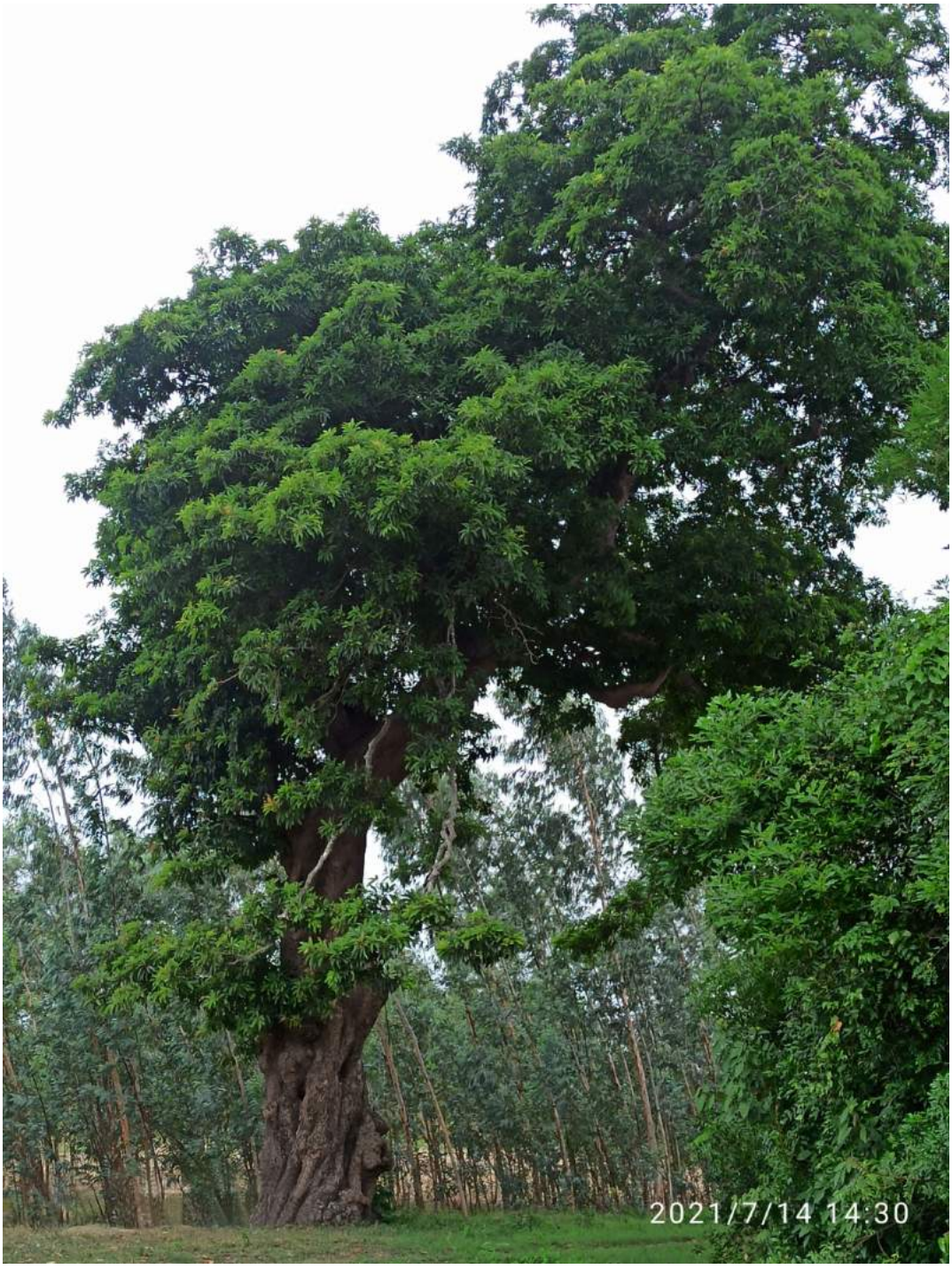

Madhuca longifolia at Athiyanallur Sacred Grove.

Introduction

During the rapid assessment field visits that were implemented in year one of the project, one of the areas that data was collected and studied was that of large specimens. It was considered important to start a register of these large, heritage specimens for many reasons. Firstly, due to the rarity of these plants, the knowledge of their whereabouts and subsequent monitoring, in itself creates a situation where more people become aware of such grand individuals, which could help in their long term protection. Secondly, for education and promotion of conservation of the TDEF, this exercise creates sharable data, while offering a glimpse at the potential of the TDEF that these large specimens offer. Lastly, this information can be shared for research and amongst others that are studying or just passionate about plants, or looking for resources to use in conservation drives.

Methodology

As it was not possible to measure all specimens in a grove during this more general rapid assessment exercise, it was decided to concentrate only those that stood out as large specimens. As this factor is very species determined, e.g. a very large *Diospyros ebenum* specimen would be a relatively common size for *Syzygium cumini*, it was therefore left to the experience that the team had gained with working over the years with the TDEF species to determine at what point to consider a specimen large.

It was also decided to follow the standard measurement of Diameter at Breast Height (DBH) in centimetres. For the occasional specimen that had already become multi-stemmed at breast height, the standard calculation/conversion to DBH was applied. It should be noted that the decision to not measure the *Ficus benghalensis,* the Banyan tree*,* was made as it is a very difficult tree to measure and also there are widespread large specimens existing throughout the TDEF zone, and it could be considered as common.

For each individual measured, a geo-referenced file was created using an under canopy handheld GPS unit, for locating the specimen later and also for data sharing.

This was stored in a file that is sharable for anyone with the universal program Google Earth, this maximises their shareability. Once opened, the file will give information of the location of the site and the specimen, an example of this can be seen below in *figure 1*.

Sharable details of Urani Sacred Grove with large species.

Observations

From the site visits conducted, at total of 143 large specimens were measured with a species range of 46. Please see below *table 1* for the top 50 largest specimens measured.

Location	Species Name	DBH - cm	Location	Species Name	DBH - cm
Akasampet	Mitrgyna parvifolia	166	Kumaramangalam	Lepisantes tetraphla	83
Kothattai	Syzygium cumini	160	Periyamudaliarchavadi	Lepisantes tetraphylla	81
Periyamudaliarchavadi	Syzgium cumini	140	Suriyanpet	Baringtonia acutangula	80
Paalvathunnam	Syzygium cumini	131	Thirukazhukundram	Strychnos potatorum	80
Puthupet	Ficus amplissima	128	Kunathammankovil	Madhuca longifolia	78
Pannakuppam	Mangifera indica	126	Varakkalpattu	Mimusops elengi	78
Purnankuppam	Syzygium cumini	123	Puthupet	Garcinia spicata	74
Ramanathapuram	Azadirachta indica	121	Talaikanikuppam	Pterocarpus marsupium	74
Ommiper	Terminalia bellerica	120	Kodi Vinayagar	Albizia lebbeck	72
Muthanai	Maduca longifolia	115	Irumbai Tank	Madhuca longifolia	72
Puthupet	Drypetes sepiaria	110	Kumaramangalam	Alangium salviifolium	70
Ommiper	Terminalia bellerica	106	Puthupet	Drypetes sepiaria	70
Puthupet	Drypetes sepiaria	99	Kottakarai	Lepisanthes tetraphylla	70
Ommiper	Terminalia bellerica	98	Urani	Pterospermum suberifolium	70
Ramanathapuram	Azadirachta indica	93	Puthupet	Walsura trifoliata	70
Varakkalpattu	Lepisanthes tetraphylla	93	Puthupet	Dalbergia panniculata	69
Cinnakumatti 2	Pongamia pinnata	93	Cinnakumatti 2	Drypetes sepiaria	67
Velleripattu	Lepisanthes tetraphylla	92	Puthupet	Pterospermum suberifolium	67
Thirumannikuzhi	Samanea saman	92	Kadagampet	Lepisanthes tetraphylla	66
Athiyanallur1	Lepisanthes tetraphylla	90	Kadagampet	Lepisanthes tetraphylla	62
Purnankuppam	Maduca longifolia	90	Mangalam	Madhuca longifolia	62
Varakkalpattu	Albizia lebbeck	86	Paalvathunnam	Pterospermum suberifolium	62
Varakkalpattu	Lepisanthes tetraphylla	86	Ramanathapuram	Strebuls asper	61
Muthanai	Walsura trifoliolata	86	T Puthupallayam	Diospyros ebenum	60
Kottakarai	Albizia lebbeck	83	Kottakarai	Lepisanthes tetraphylla	60

Table 1 – The largest 50 specimens measured

From the data of 143 measured specimens it was interesting to see how they set a bench mark as the largest and thus most protected specimens, and gave indications of the growth potential of certain species. It was decided to take a closer look at evergreen species which generally, in this zone grow slower and do not become as large as the deciduous/brevi-deciduous species. See *table 2* below:

Table 2 – The large evergreen specimens measured relative to the no. of groves.

Species	No. Large specimens	No. of locations large specimens found	Total No. of Sacred Groves present	Size range - DBH - cm
Aglaia elaeagnoidea	2	1	3	35 to 86
Atalantia monophylla	3	2	54	26 to 31
Cassine glauca	1	1	11	54
Diospyros ebenum	11	6	15	30 to 60
Diospyros melanoxylon	7	2	2	29 to 46
Drypetes sepiaria	7	4	14	38 to 110
Garcinia spicata	9	6	23	40 to 74
Lepisanthes tetraphylla	17	13	54	42 to 93
Madhuca longifolia	5	5	22	62 to 115
Memceylon umbellatum	3	3	31	25 to 73
Mimusops elengi	2	2	3	45 to 78
Pamburus missionis	5	5	23	30 to 51
Strychnos nux-vomica	6	3	8	32 to 39
Tricalysia sphaerocarpa	6	3	12	31 to 45
Walsura trifoliata	4	2	5	57 to 86

This data will help with the overall assessment of the ecological status of the TDEF, as not only does it give indicators of the size range of large specimens but also the frequency of groves they are still present in this large form. For example, it is interesting to observe that for *Lepisanthes tetraphylla,* there were 17 large specimens within the range of 42 and 93cm, and these specimens where dispersed amongst 13 groves, though *Lepisanthes tetraphylla* is present in 54 groves.

Obviously, this data can only give us indications as mentioned before, as not all specimens were measured.

Further Outputs

This data is being incorporated into a tree finding app that is presently being developed at the Auroville Botanical Gardens. This will be a geo referenced phone application resource that will allow the user to find a whole variety of tree species within the TDEF zone and hopefully beyond.

Photographs

Please see in the following sheets photographs from the field visits of some of these large specimens that were measured and geo referenced.

Garcinia spicata – Puthupet Sacred Grove

Combretum albidum (Liana) – Urani Sacred Grove

Mitrigyna parvifolia – Akasampet Sacred Grove

Walsura trifoliata – Muthanai Sacred Grove

Diospyros ebenum – Pudur Sacred Grove

Azidhiracta indica – Ramanatapuram Sacred Grove

Tricalyisia sphaerocarpa – Pudur Sacred Grove

Diospyros ebenum – Puthupet Sacred Grove

Drypetes sepiaria – Puthupet Sacred Grove

Ramco CSR Program 2021 - 2022

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