



Diversity and Distribution of mangroves of Kundapura, Udupi District, Karnataka, Southwest Coast of India

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Abstract

The present study documents the diversity and distribution of true mangroves and their associates, from four sampling stations of Kundapura, Udupi district, Karnataka, Southwest Coast of India. These four sampling points selected along the backwaters of the river Haladi. Nine true mangrove floral species belonging to six families and ten mangroves associated floral species belonging to nine families were identified. In order to study the distribution pattern of mangrove species, Quadrature analysis was adopted. This paper highlights the need of present study to further gain knowledge about the mangrove flora in order to help the conservation of mangrove ecosystem.

Keywords: Diversity, True mangroves, Mangrove floral species, Quadrature analysis, Conservation.

Introduction

Mangroves are coastal wetland forests established at the intertidal zones of estuaries, backwaters, deltas, creeks, lagoons, marshes and mudflats of tropical and subtropical latitudes¹. Mangrove forests are among one of the world's most productive tropical ecosystems. They are endowed with rich and diverse living resources that provide forestry and fishery products to a large human population². Mangrove as, "a tree, shrub, palm or ground fern, generally exceeding one and half metre in height, and which normally grows above mean sea level in the intertidal zone of marine coastal environments, or estuarine margins"³. The word mangrove has traditionally been used to describe either the total community or the individual tree/bushes, growing in the clayey, silty, inter-tidal coastal zones, deltaic and estuarine coasts and backwaters/sheltered regions, in the tropical/subtropical belts of the world⁴. Mangrove forests serve as ecotones between land and sea and elements from both are stratified horizontally and vertically, between the forest canopy and subsurface soil⁵. Mangroves play an important role in the functioning of adjacent ecosystems, including terrestrial wetlands, peat swamps, salt marshes, sea grass beds and coral reefs⁶.

Material and methods

Study area: Our study area was at Kundapura, 445 kilometers west of Bangalore and 36 kilometers north of Udupi, at 13° 37' 24" N latitude and 74° 41' 30" E longitude and maximum elevation of 18 m asl. Four study sites along the coastline of Kundapura were separated by approximately five kilometers. The study sites are islands along the backwaters of the Haladi River.

Table-1
Study sites

Study sites	Latitude	Longitude	Elevation
Site-1.Herikudru	13°38'28"N	74°42'01"E	28'
Site-2.Uppinakudru	13°39'21"N	74°41'59"E	25'
Site-3.Jaladi	13°39'41"N	74°42'16"E	16'
Site-4.Hemmadi	13°40'46"N	74°41'20"E	32'

Data collection and curation: Regular surveys were made along the beaches, deltaic regions, river channels and the mouth of estuaries to explore the successful results of the true mangroves and their associates. The mangroves and mangrove associated vegetation were plucked during their flowering and fruiting seasons for identification and took photographs with the help of camera. The nomenclature of the specimens followed^{7,8}.

Community analysis: Community analysis is carried out in rainy season when majority of the plants are at the peak of their growth. In each study sites, 10 quadrats of 10 m X 10 m (100 sq m) size are randomly laid on to study the tree and shrub species. The tree species include all the saplings, poles and trees present in the study area. The herbaceous species is studied through 15 quadrats of 1m X 1m (1sq m) size randomly in each study site.

Quantitative analysis: The important quantitative analysis such as density, frequency, and abundance of tree species, shrubs and herbs species are determined⁹.

Density: Density is an expression of the numerical strength of a species where the total number of individuals of each species in all the quadrates is divided by the total number of quadrates studied.

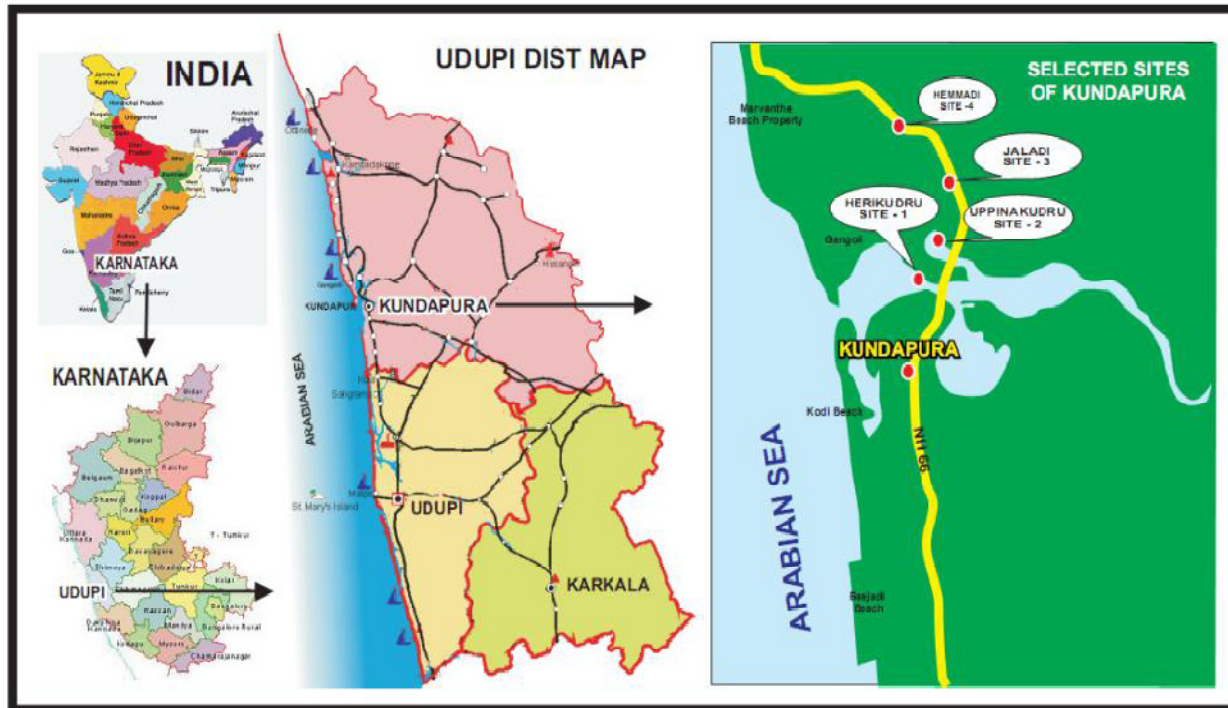


Figure-1
 Map showing the geographical location of study sites

Density is calculated by the equation:

$$\text{Density} = \frac{\text{Total number of individuals of a species in all quadrates}}{\text{Total number of quadrates studied}}$$

Frequency (%): This term refers to the degree of dispersion of individual species in an area and usually expressed in terms of percentage occurrence. It was studied by sampling the study area at several places at random and recorded the name of the species that occurred in each sampling units. It is calculated by the equation:

$$\text{Frequency (\%)} = \frac{\text{Number of quadrates in which the species occurred} \times 100}{\text{Total number of quadrates studied}}$$

After determining the percentage frequency of each species, various species are distributed among the five frequency classes as shown in the table-2.

Abundance: It is the study of the number of individuals of different species in the community per unit area. By quadrates method, samplings are made at random at several places and the number of individuals of each species was summed up for all the quadrates divided by the total number of quadrates in which the species occurred. It is represented by the equation:

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

species occurred

Table-2
 Frequency (%) and Frequency class

Sl. No.	Frequency (%)	Frequency class
1	0-20	A
2	21-40	B
3	41-60	C
4	61-80	D
5	81-100	E

Results and Discussion

Nine true mangrove floral species of six families and ten mangroves associated floral species of nine families are identified with the inundated and adjacent regions in the study area. Frequency, density and abundance of true mangroves and mangrove associates are recorded. Similar observations are reported in Kumbalam Island of Kerala¹⁰.

The study site is an island along the back waters of the river Haladi. The area is dominated by *Rhizophora mucronata*, followed by *Excocaria agallocha*, *Avicennia officinalis* and in the borders *Acanthus ilicifolius*. A few trees of *Bruguiera gymnorrhiza*, *Aegicerus corniculatum*, *Kandelia candel*, *Rhizophora apiculata*, *Sonneratia alba* were recorded. Mangrove associates such as *Acrostichum aureum*, *Chlerodendron inerme*, *Derris trifoliata*, *Caesalpinia crista*, *Ipomoea pes-carpae*, *Sesuvium portulacastrum*, *Aeluropus lagopoides* and *Fimbristylis ferruginea* were recorded.

Table-3
Site-1 Frequency, density and abundance of true mangrove floral species

Sl. No	Species	Quadrates laid down (10mX10m) = 10	Density	Frequency	Frequency class	Abundance
		Total number of plants				
1	<i>Avicennia officinalis</i>	72	7.2	100	E	7.2
2	<i>Rhizophora mucronata</i>	178	17.8	100	E	17.8
3	<i>Rhizophora apiculata</i>	11	1.1	40	B	2.75
4	<i>Bruguiera gymnorrhiza</i>	34	3.4	70	D	4.85
5	<i>Kandelia candel</i>	30	3.0	100	E	3.0
6	<i>Sonneratia alba</i>	37	3.7	90	E	4.11
7	<i>Aegicerus corniculatum</i>	31	3.1	100	E	3.1
8	<i>Acantus ilicifolius</i>	52	5.2	100	E	5.2
9	<i>Excocaria agallocha</i>	82	8.2	100	E	8.2

Table-4
Site-2 Frequency, density and abundance of true mangrove floral species

Sl. No	Species	Quadrates laid down(1mX1m)=15	Density	Frequency	Frequency class	Abundance
		Total number of plants				
1	<i>Chlerodendron inerme</i>	15	1	40	B	2.5
2	<i>Derris trifoliata</i>	64	4.26	87	E	4.92
3	<i>Dalbergia spinosa</i>	-	-	-	-	-
4	<i>Acrostichum aureum</i>	40	2.66	33	B	8
5	<i>Ipomoea pes-carpae</i>	14	0.93	33	B	2.8
6	<i>Pandanus odoratissimus</i>	-	-	-	-	-
7	<i>Sesuvium portulacastrum</i>	10	0.66	33	B	2
8	<i>Caesalpinia crista</i>	16	1.06	60	C	1.77
9	<i>Aeluropus lagopoides</i>	1503	100.2	40	B	250.5
10	<i>Fimbristylis ferruginea</i>	1211	80.73	40	B	201.83

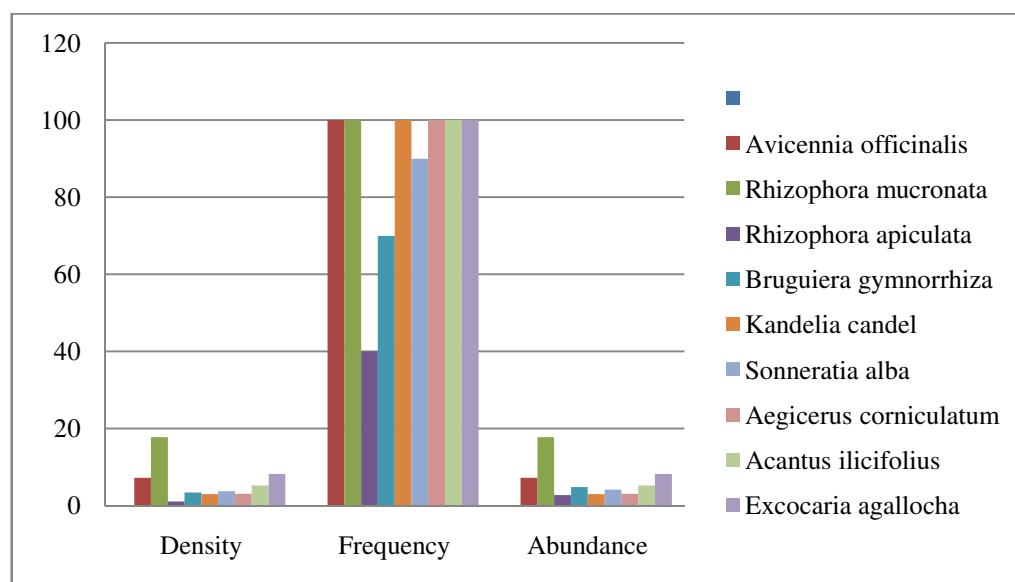


Figure-2
Graph showing the density, frequency and abundance of true mangrove floral species

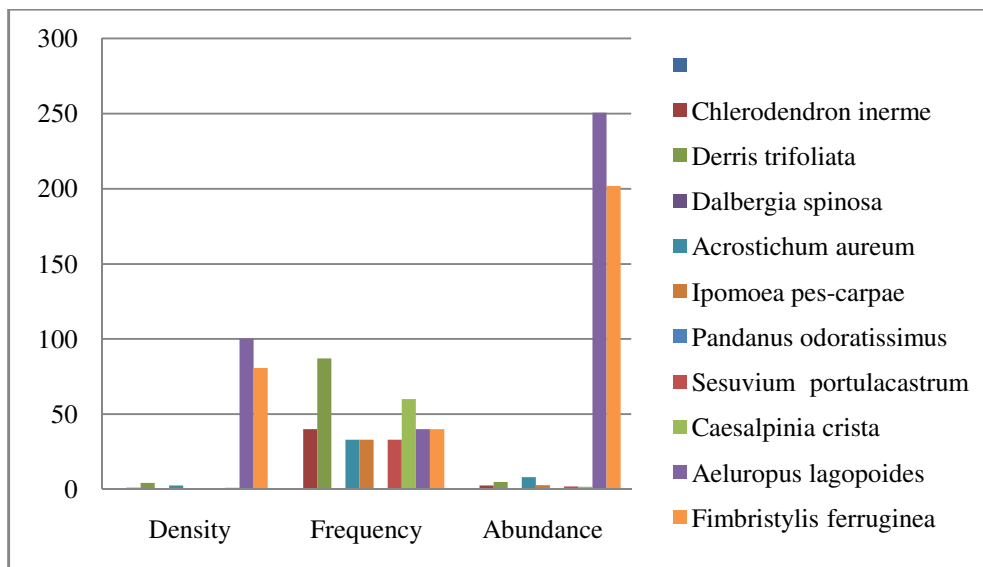


Figure-3
 Graph showing the density, frequency and abundance of true mangrove floral species

Frequency: The frequency of true mangroves, *Avicennia officinalis*, *Rhizophora mucronata*, *Kandelia candel*, *Aegicerus corniculatum*, *Acantus ilicifolius*, *Excocaria agallocha* shown 100% and positioned in class E, *Sonneratia alba* shown 90% and positioned in class E, *Bruguiera gymnorrhiza* shown 70% and positioned in class D, *Rhizophora apiculata* shown 40% and positioned in class B. The frequency of associated mangrove floral species, *Derris trifoliata* shown 87% and positioned in class E, *Caesalpinia crista* shown 60% and positioned in class C, *Chlerodendron inerme*, *Aeluropus lagopoides*, and *Fimbristylis ferruginea* shown 40%, *Acrostichum aureum*, *Ipomoea pes-carpae*, and *Sesuvium portulacastrum* shown 33% and positioned in class B.

Density: The density analysis of true mangroves reveals that, *Rhizophora mucronata* is the densest species having the value 17.8, whereas *Excocaria agallocha* 8.2, *Avicennia officinalis* having 7.2, *Acantus ilicifolius* 5.2 and *Sonneratia alba* 3.7 followed by *Bruguiera gymnorrhiza* 3.4, *Aegicerus*

corniculatum 3.1, *Kandelia candel* 3.0, *Rhizophora apiculata* 1.1. The density analysis of associated mangroves reveals that, *Aeluropus lagopoides* having the value 100.2, *Fimbristylis ferruginea* 80.73, *Derris trifoliata* 4.26, *Acrostichum aureum* 2.66, *Caesalpinia crista* 1.06, *Chlerodendron inerme* 1, *Ipomoea pes-carpae* 0.93, and *Sesuvium portulacastrum* 0.66.

Abundance: Analysis of the abundance of true mangroves shows that, *Rhizophora mucronata* (17.8) is the most abundant species. *Avicennia oficinalis* (7.2), *Excocaria agallocha* (8.2), *Acantus ilicifolius* (5.2), *Bruguiera gymnorrhiza* (4.85), *Sonneratia alba* (4.11), *Aegicerus corniculatum* (3.1), *Kandelia candel* (3.0), *Rhizophora apiculata* (2.75). Analysis of the abundance of associated mangroves shows that, *Fimbristylis ferruginea* (201.83), *Aeluropus lagopoides* (250.5), *Acrostichum aureum* (8), *Derris trifoliata* (4.92), *Ipomoea pes-carpae* (2.8), *Chlerodendron inerme* (2.5), *Sesuvium portulacastrum* (2), *Caesalpinia crista* (1.77).

Table-5
 Site-3 Frequency, density and abundance of true mangrove floral species

Sl.No	Species	Quadrates laid down(10mX10m)=10	Density	Frequency	Frequency class	Abundance
		Total number of plants				
1	<i>Avicennia officinalis</i>	74	7.4	100	E	7.4
2	<i>Rhizophora mucronata</i>	220	22	100	E	22
3	<i>Rhizophora apiculata</i>	-	-	-	-	-
4	<i>Bruguiera gymnorrhiza</i>	23	2.3	70	D	3.28
5	<i>Kandelia candel</i>	19	1.9	60	C	3.16
6	<i>Sonneratia alba</i>	13	1.3	40	B	3.25
7	<i>Aegicerus corniculatum</i>	37	3.7	60	C	6.16
8	<i>Acantus ilicifolius</i>	38	3.8	80	D	4.75
9	<i>Excocaria agallocha</i>	47	4.7	60	C	7.83

Table-6
Site-4 Frequency, density and abundance of true mangrove floral species

Sl. No	Species	Quadrates laid down(1mX1m)=15	Density	Frequency	Frequency Class	Abundance
		Total number of plants				
1	<i>Chlerodendron inerme</i>	22	1.46	73.33	D	2
2	<i>Derris trifoliata</i>	40	2.66	86.66	E	3.07
3	<i>Dalbergia spinosa</i>	-	-	-	-	-
4	<i>Acrostichum aureum</i>	14	0.93	46.66	C	2
5	<i>Ipomoea pes-carpae</i>	18	1.2	40	B	3
6	<i>Pandanus odoratissimus</i>	5	0.33	20	A	1.66
7	<i>Sesuvium portulacastrum</i>	15	1	53.33	C	1.87
8	<i>Caesalpinia crista</i>	21	1.4	80	D	1.75
9	<i>Aeluropus lagopoides</i>	2642	176.13	66.66	D	264.2
10	<i>Fimbristylis ferruginea</i>	2361	157.4	53.33	C	295.12

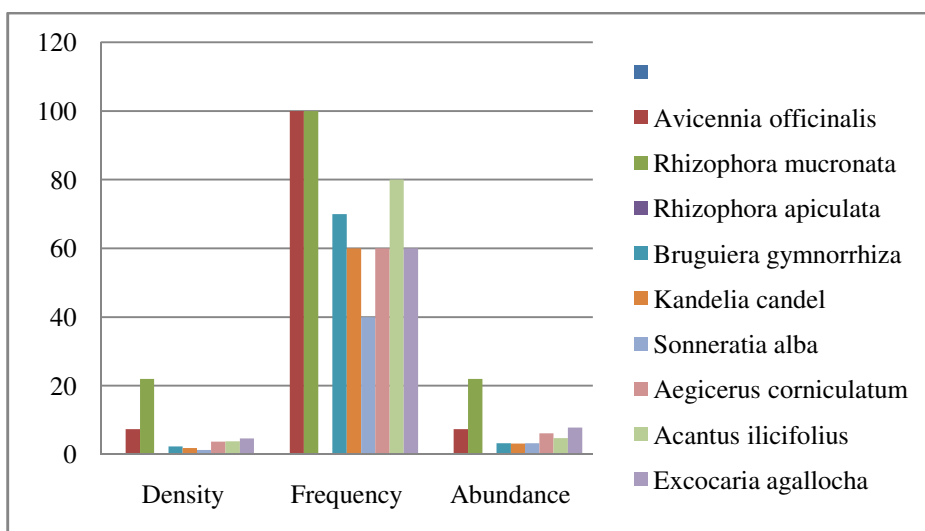


Figure-4

Graph showing the density, frequency and abundance of true mangrove floral species

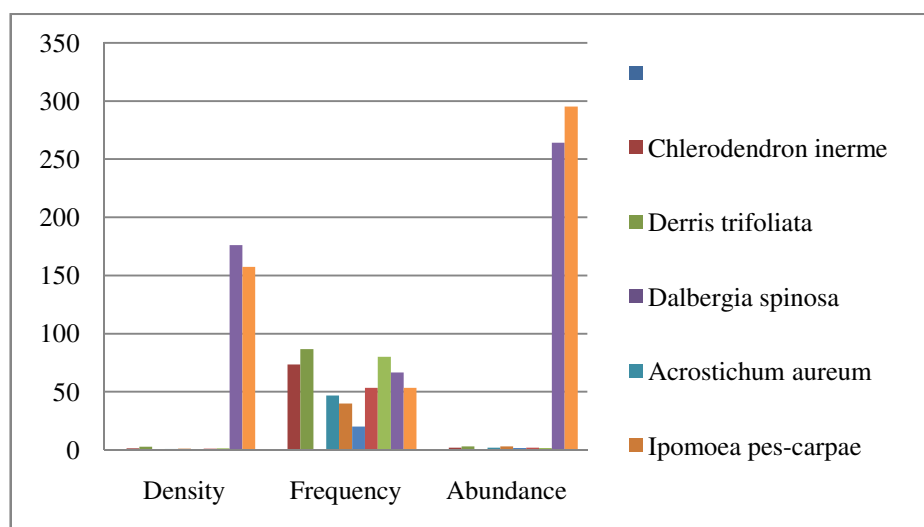


Figure-5

Graph showing the density, frequency and abundance of associated mangrove floral species

The study site is an island along the back waters of the river Haladi. This area is being completely under the tidal influx. There are several mangrove patches measuring about 1 to 4 acres. The area is completely dominated by *Rhizophora mucronata* with good growth, followed by *Avicennia officinalis*, *Excocaria agallocha*, *Acanthus ilicifolius*, *Aegicerus corniculatum*, *Bruguiera gymnorrhiza*, *Kandelia candel*, and *Sonneratia alba*. Mangrove associates such as *Acrostichum aureum*, *Chlerodendron inerme*, *Derris trifoliata*, *Ipomoea pes-carpae*, *Sesuvium portulacastrum*, *Pandanus odoratissimus*, *Aeluropus lagopoides*, *Caesalpinia crista* and *Fimbristylis ferruginea* were recorded during the study period.

Frequency: On analyzing the frequency of true mangroves, *Avicennia officinalis*, *Rhizophora mucronata* shows 100% are positioned in class E, *Acanthus ilicifolius* shows 80%, *Bruguiera gymnorrhiza* shows 70% are positioned in class D, *Kandelia candel*, *Aegicerus corniculatum*, *Excocaria agallocha* shows 60% are positioned in class C, *Sonneratia alba* shows 40% are positioned in class B. On analyzing the frequency of associated mangroves, *Derris trifoliata* shows 86.66% are positioned E, *Caesalpinia crista* shows 80%, *Chlerodendron inerme* shows 73.33%, and *Aeluropus lagopoides* shows 66.66% are positioned in class D, *Sesuvium portulacastrum* shows 53.33%, *Fimbristylis ferruginea* shows 53.33%, and *Acrostichum aureum* shows 46.66%, are positioned in class C, *Ipomoea pes-*

carpae shows 40% are positioned in class B, *Pandanus odoratissimus* 20% are positioned in class A.

Density: The density analysis of true mangroves reveals that, *Rhizophora mucronata* is the densest species having the value 22, *Avicennia officinalis* 7.4, *Excocaria agallocha* 4.7, *Acanthus ilicifolius* 3.8, *Aegicerus corniculatum* 3.7, *Bruguiera gymnorrhiza* 2.3, *Kandelia candel* 1.9, *Sonneratia alba* 1.3. The density analysis of associated mangroves reveals that, *Aeluropus lagopoides* 176.13, *Fimbristylis ferruginea* 157.4, *Derris trifoliata* 2.66, *Chlerodendron inerme* 1.46, *Caesalpinia crista* 1.4, *Ipomoea pes-carpae* 1.2, *Sesuvium portulacastrum* 1, *Acrostichum aureum* 0.93, and *Pandanus odoratissimus* 0.33.

Abundance: Analysis of the abundance of true mangroves shows that, *Rhizophora mucronata* (22) is the most abundant species. *Excocaria agallocha* (7.83), *Avicennia officinalis* (7.4), *Aegicerus corniculatum* (6.16), *Acanthus ilicifolius* (4.75), *Bruguiera gymnorrhiza* (3.28), *Sonneratia alba* (3.25), *Kandelia candel* (3.16). Analysis of the abundance of associated mangroves shows that, *Fimbristylis ferruginea* 295.12, *Aeluropus lagopoides* 264.2, *Derris trifoliata* 3.07, *Ipomoea pes-carpae* 3, *Acrostichum aureum* 2, *Chlerodendron inerme* 2, *Sesuvium portulacastrum* 1.87, *Caesalpinia crista* 1.75, and *Pandanus odoratissimus* 1.66.

Table-7
Site-1 Density, frequency and abundance of associated mangrove floral species

Sl. No	Species	Quadrates laid down(10mX10m) = 10	Density	Frequency	Frequency class	Abundance
		Total number of plants				
1	<i>Avicennia officinalis</i>	70	7	100	E	7
2	<i>Rhizophora mucronata</i>	390	39	100	E	39
3	<i>Rhizophora apiculata</i>	25	2.5	50	C	5
4	<i>Bruguiera gymnorrhiza</i>	32	3.2	60	C	5.33
5	<i>Kandelia candel</i>	40	4	80	D	5
6	<i>Sonneratia alba</i>	33	3.3	80	D	4.22
7	<i>Aegicerus corniculatum</i>	50	5	60	C	8.33
8	<i>Acanthus ilicifolius</i>	84	8.4	90	E	9.33
9	<i>Excocaria agallocha</i>	40	4	30	B	13.33

Table-8
Site-2 Density, frequency and abundance of associated mangrove floral species

Sl. No	Species	Quadrates laid down(1mX1m)=15	Density	Frequency	Frequency Class	Abundance
		Total number of plants				
1	<i>Chlerodendron inerme</i>	77	5.13	73.33	D	7
2	<i>Derris trifoliata</i>	121	8.06	86.66	E	9.30
3	<i>Dalbergia spinosa</i>	4	0.26	6.66	A	4
4	<i>Acrostichum aureum</i>	43	2.86	33.33	B	8.6
5	<i>Ipomoea pes-carpae</i>	50	3.33	26.66	B	12.5
6	<i>Pandanus odoratissimus</i>	-	-	-	-	-
7	<i>Sesuvium portulacastrum</i>	-	-	-	-	-
8	<i>Caesalpinia crista</i>	12	0.8	20	A	4
9	<i>Aeluropus lagopoides</i>	3620	241.33	40	B	603.33
10	<i>Fimbristylis ferruginea</i>	3541	236.06	40	B	590.16

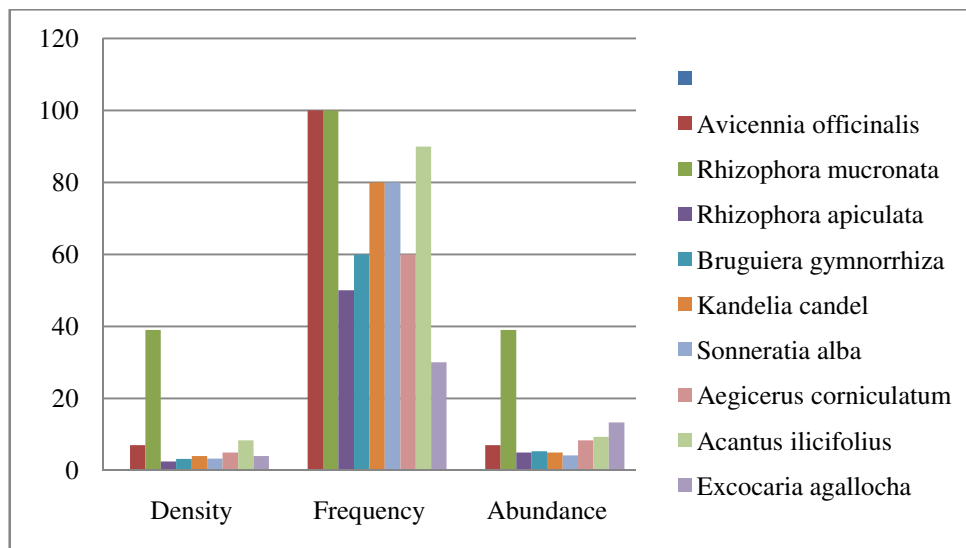


Figure-6

Graph showing the density, frequency and abundance of associated mangrove floral species

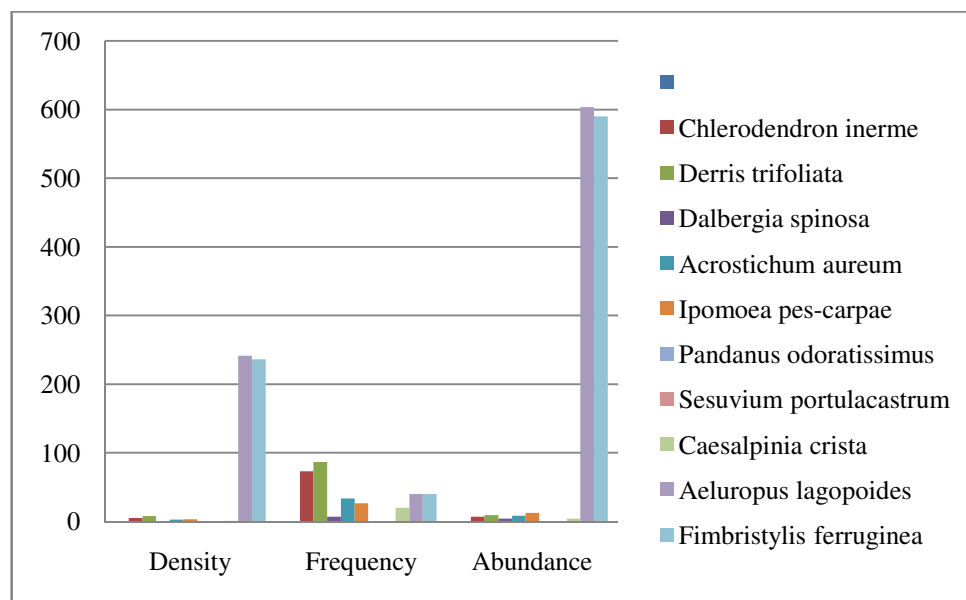


Figure-7

Graph showing the density, frequency and abundance of associated mangrove floral species

It is an area covering the backwaters of the river Haladi. This area is known as Jaladi or Rajadi bridge and is completely under tidal influence. In view of this situation there is a good formation of mangroves. The trees here are about 70 years old. In frequently, patches of land have been planted by *Rhizophora mucronata* and *Avicennia officinalis* to protect their agricultural fields from erosion and floods. Totally about 20-25 acres of land is reserved for mangrove regeneration. The area is completely dominated by pure formations of *Rhizophora mucronata* and on the borders *Acanthus ilicifolius* was seen measuring 2m in height. Only a few trees of *Bruguiera gymnorrhiza*, *Avicennia officinalis*, *Sonneratia alba*, *Rhizophora apiculata* and *Kandelia candel* are observed. *Excocaria agallocha* is found sparsely

distributed along the banks. *Aegicerus corniculatum* is found distributed in groups in association with *Acanthus ilicifolius*. Mangrove associates such as *Acrostichum aureum*, *Dalbergia spinosa*, *Chlerodendron inerme*, *Derris trifoliata*, *Ipomoea pes-carpae*, *Aeluropus lagopoides*, *Caesalpinia crista* and *Fimbristylis ferruginea* were recorded during the study period.

Frequency: On analyzing the frequency of true mangroves, *Avicennia officinalis*, *Rhizophora mucronata* shows 100%, *Acanthus ilicifolius* shows 90% are positioned in class E, *Kandelia candel*, *Sonneratia alba* 80% are positioned in class D, *Rhizophora apiculata* 50%, *Bruguiera gymnorrhiza*, *Aegicerus corniculatum* 60%, are positioned in class C,

Excocaria agallocha, 30% are positioned in class B. On analyzing the frequency of associated mangroves, *Derris trifoliata* shows 86.66% are positioned in class E, *Chlerodendron inerme* shows 73.33% are positioned in the class D, *Fimbristylis ferruginea* 40%, *Aeluropus lagopoides* 40%, *Acrostichum aureum* 33.33%, and *Ipomoea pes-carpae* 26.66% are positioned in the class B, *Caesalpinia crista* 20%, and *Dalbergia spinosa* 6.66% are positioned in the class A.

Density: The density analysis of true mangroves reveals that, *Rhizophora mucronata* is the densest species having the value 39, followed by *Acantus ilicifolius* 8.4, *Avicennia officinalis* 7, *Aegicerus corniculatum* 5, *Kandelia candel* 4, *Excocaria agallocha* 4, *Sonneratia alba* 3.3, *Bruguiera gymnorrhiza* 3.2, *Rhizophora apiculata* 2.5. The density analysis of associated mangroves reveals that, *Aeluropus lagopoides* 241.33,

Fimbristylis ferruginea 236.06, *Derris trifoliata* 8.06, *Chlerodendron inerme* 5.13, *Ipomoea pes-carpae* 3.33, *Acrostichum aureum* 2.86, *Caesalpinia crista* 0.8, and *Dalbergia spinosa* 0.26.

Abundance: Analysis of the abundance of true mangroves shows that, *Rhizophora mucronata* (39) is the most abundant species, *Excocaria agallocha* (13.33), *Acantus ilicifolius* (9.33), *Aegicerus corniculatum* (8.33), *Bruguiera gymnorrhiza* (5.33), *Rhizophora apiculata* and *Kandelia candel* (5), *Sonneratia alba* (4.22). Analysis of the abundance of associated mangroves shows that, *Aeluropus lagopoides* 603.33, *Fimbristylis ferruginea* 590.16, *Ipomoea pes-carpae* 12.5, *Derris trifoliata* 9.30, *Acrostichum aureum* 8.6, *Chlerodendron inerme* 7, *Dalbergia spinosa* and *Caesalpinia crista* 4.

Table-9
Site-3 Density, frequency and abundance of associated mangrove floral species

Sl. No	Species	Quadrates laid down(10mX10m)=10	Density	Frequency	Frequency class	Abundance
		Total number of plants				
1	<i>Avicennia officinalis</i>	63	6.3	100	E	6.3
2	<i>Rhizophora mucronata</i>	360	36	100	E	36
3	<i>Rhizophora apiculata</i>	8	0.8	50	C	1.6
4	<i>Bruguiera gymnorrhiza</i>	28	2.8	50	C	5.6
5	<i>Kandelia candel</i>	4	0.4	20	A	2
6	<i>Sonneratia alba</i>	-	-	-	-	-
7	<i>Aegicerus corniculatum</i>	18	1.8	60	C	3
8	<i>Acantus ilicifolius</i>	94	9.4	100	E	9.4
9	<i>Excocaria agallocha</i>	18	1.8	50	C	3.6

Table-10
Site-4 Density, frequency and abundance of associated mangrove floral species

Sl. No	Species	Quadrates laid down(1mX1m)=15	Density	Frequency	Frequency Class	Abundance
		Total number of plants				
1	<i>Chlerodendron inerme</i>	23	1.53	40	B	2.83
2	<i>Derris trifoliata</i>	172	11.46	100	E	11.46
3	<i>Dalbergia spinosa</i>	-	-	-	-	-
4	<i>Acrostichum aureum</i>	30	2	13.33	A	15
5	<i>Ipomoea pes-carpae</i>	-	-	-	-	-
6	<i>Pandanus odoratissimus</i>	-	-	-	-	-
7	<i>Sesuvium portulacastrum</i>	-	-	-	-	-
8	<i>Caesalpinia crista</i>	25	1.66	73.33	D	2.27
9	<i>Aeluropus lagopoides</i>	3335	222.33	40	B	555.83
10	<i>Fimbristylis ferruginea</i>	3491	232.73	40	B	581.83

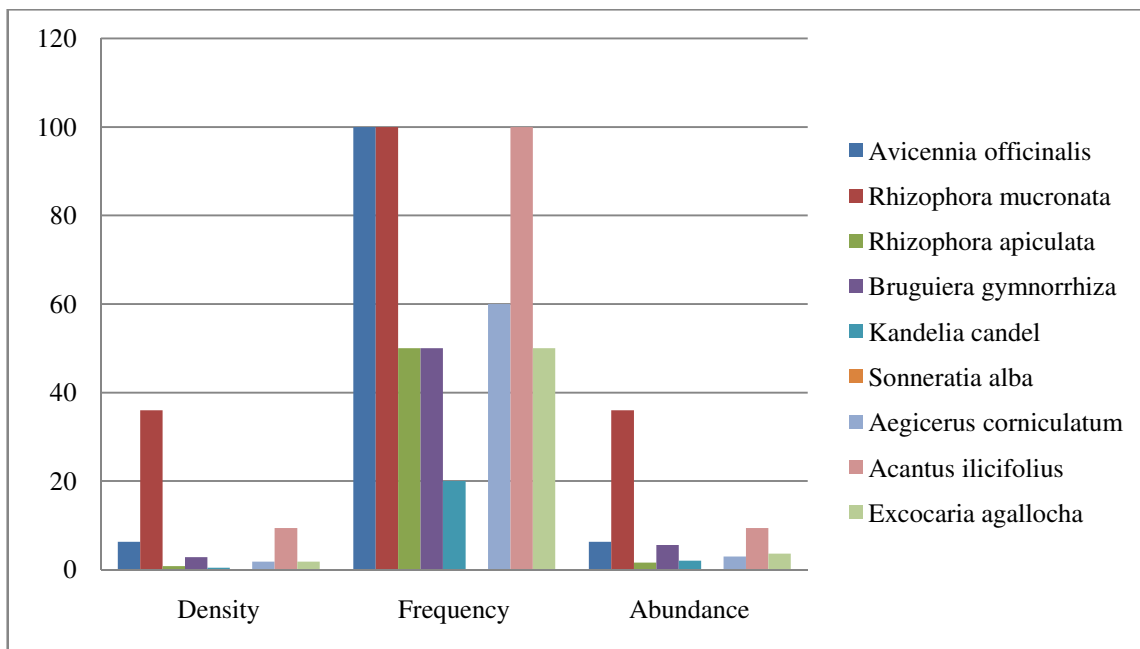


Figure-8
 Graph showing the density, frequency and abundance of associated mangrove floral species

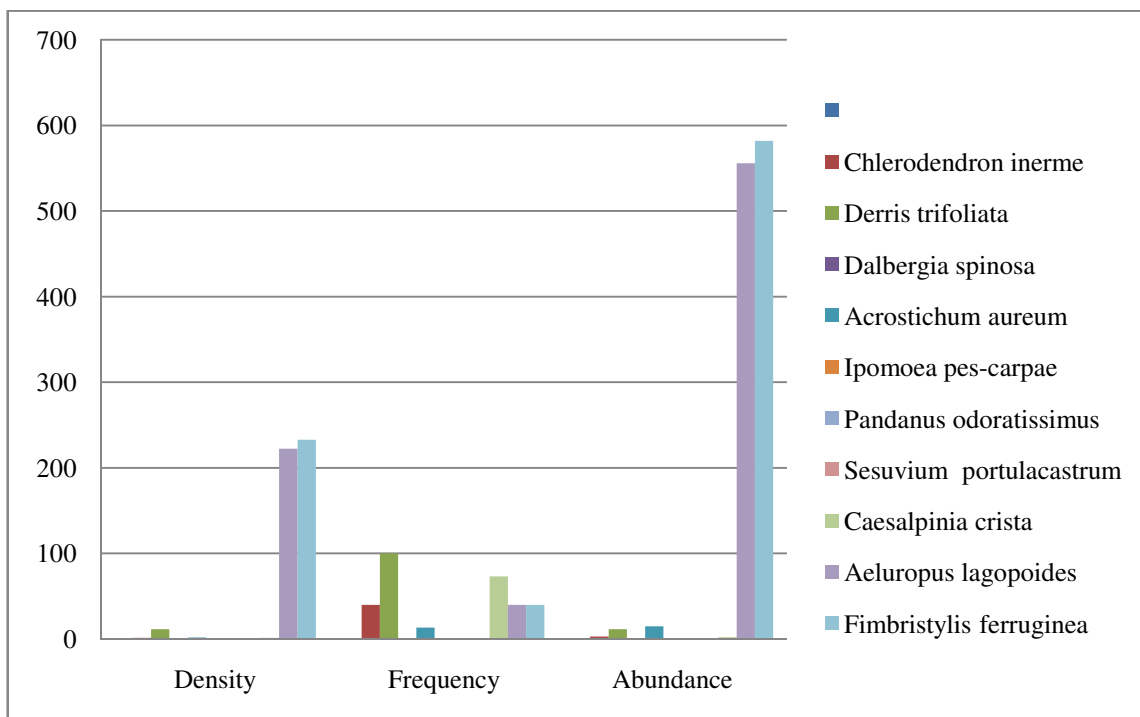


Figure-9
 Graph showing the density, frequency and abundance of associated mangrove floral species

The study site is a riverine bank along the back waters of the river Haladi and the area is completely under the tidal influence. Good formations of mangroves were recorded. This area is dominated by *Rhizophora mucronata*, and *Avicennia officinalis*. *Acanthus ilicifolius* is seen all along the banks reaching to a height of 2 metres, in association with *Aegicerus corniculatum*.

Excocaria agallocha, *Rhizophora apiculata*, *Bruguiera gymnorrhiza*, *Kandelia candel* are found sparsely distributed along the banks. Mangrove associates such as *Acrostichum aureum*, *Chlerodendron inerme*, *Derris trifoliata*, *Aeluropus lagopoides*, *Caesalpinia crista* and *Fimbristylis ferruginea* were recorded during the study period.

Frequency: On analyzing the frequency of true mangroves, *Avicennia officinalis*, *Rhizophora mucronata*, *Acanthus ilicifolius*, shows 100% are positioned in class E, *Aegicerus corniculatum* shows 60% are positioned in class C, *Rhizophora apiculata*, *Bruguiera gymnorrhiza*, *Excocaria agallocha* shows 50% are positioned in class C, *Kandelia candel* shows 20% are positioned in class A. On analyzing the frequency of associated mangroves, *Derris trifoliata* shows 100% are positioned in the class E, *Caesalpinia crista* shows 73.33% are positioned in the class D, *Chlerodendron inerme* 40%, *Aeluropus lagopoides* 40%, and *Fimbristylis ferruginea* 40% are positioned in the class B, *Acrostichum aureum* 13.33%, are positioned in the class A.

Density: The density analysis of true mangroves reveals that, *Rhizophora mucronata* is the densest species having the value 36, followed by *Acanthus ilicifolius* 9.4, *Avicennia officinalis* 6.3, *Aegicerus corniculatum* 1.8, *Kandelia candel* 0.4, *Excocaria agallocha* 1.8, *Bruguiera gymnorrhiza* 2.8, *Rhizophora apiculata* 0.8. The density analysis of associated mangroves reveals that, *Fimbristylis ferruginea* 232.73, *Aeluropus lagopoides* 222.33, *Derris trifoliata* 11.46, *Acrostichum aureum* 2, *Caesalpinia crista* 1.66, and *Chlerodendron inerme* 1.53.

Abundance: Analysis of the abundance of true mangroves shows that, *Rhizophora mucronata* (36) is the most abundant species, followed by *Acanthus ilicifolius* (9.4), *Avicennia officinalis* (6.3), *Bruguiera gymnorrhiza* (5.6), *Excocaria agallocha* (3.6), *Aegicerus corniculatum* (3), *Kandelia candel* (2), and *Rhizophora apiculata* (1.6). Analysis of the abundance of associated mangroves shows that, *Fimbristylis ferruginea* (581.83), *Aeluropus lagopoides* (555.83), *Acrostichum aureum* (15), *Derris trifoliata* (11.46), *Chlerodendron inerme* (2.83), and *Caesalpinia crista* (2.27).

Conclusion

The rich diversity of mangrove species were seen in all the selected sites, this is due to availability of suitable habitat, low lying marshy land, brackish water with low salinity and the addition of fresh water from various rivers, channels and canals favour the growth and development of this vegetation. Saenger *et al* (1983) have summarized the role of fresh water on the mangrove ecosystem. Blasco (1984) suggested that both temperature and rainfall are the two essential bioclimatic factors for mangrove and other terrestrial ecosystems. The edaphic factor with the micronutrients, rainfall, temperature, humidity and pH of water also favour the growth and development of mangroves (N. Balachandran *et al.* 2009).

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