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Floristic Quality Index Value of Trees in Vallanadu Blackbuck Sanctuary, Thoothukudi, Peninsular India

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ABSTRACT

Floristic Quality Assessment (FQA) provides a standardized approach to evaluating ecological integrity by integrating species composition, abundance, and distributional rarity. In this study, we applied the Floristic Quality Index (FQI) to assess the floristic condition of Vallanadu Blackbuck Sanctuary, a tropical thorn forest fragment in Thoothukudi District, Tamil Nadu, India. Vegetation data were compiled from 700 plots (10 m × 10 m), recording 35 woody species. Conservatism coefficients (C-values) were assigned through a novel district-based weighting system that incorporates both nativity and occurrence frequency across Tamil Nadu's 38 districts, thereby capturing regional rarity. The mean C-value was 6.17±2.02, resulting in an unweighted FQI of 34.34. Dominant species such as *Vachellia mellifera*, *Commiphora berryi*, and *Ziziphus xylopyrus* strongly influenced FQI values, while restricted taxa such as *Fernandoa adenophylla* contributed to the sanctuary's regional distinctiveness. Overall, Vallanadu represents a moderately intact thorn forest ecosystem with conservation value for its biogeographic uniqueness.

INTRODUCTION

The Floristic Quality Index (FQI) is an ecological assessment tool that evaluates the conservation value and integrity of plant communities (Swink & Wilhelm, 1979). Unlike traditional diversity indices that treat all species equally, FQI incorporates species-specific coefficients of conservatism (C-values), which reflect the ecological fidelity and rarity of species in a given region (Herman et al., 2001). Higher C-values indicate species restricted to undisturbed habitats, while lower values correspond to generalists and disturbance-tolerant taxa. This approach helps distinguish between species that thrive in disturbed environments and those restricted to undisturbed, high-quality habitats (Taft et al., 1997). Although FQI has been extensively applied in prairies, wetlands, and grasslands of North America (Freyman et al., 2016; Matthews, 2003). In India, and particularly Tamil Nadu, applications of FQI remain largely unexplored despite the state's exceptional plant diversity and high anthropogenic pressures (Chaudhary & Kumar, 2018). The present study applies FQI to Vallanadu Blackbuck Sanctuary, a tropical thorn forest (TTF) fragment in Thoothukudi district, Tamil Nadu, introducing a novel district-based weighting scheme for C-values that reflects the regional rarity of species across the 38 administrative districts of the state.

2. Materials and methods

2.1. Study Area

Vallanadu Blackbuck Sanctuary (VBS) is a protected reserve located in Thoothukudi District, Tamil Nadu, India, between 8°40′–8°44′ N latitude and 78°05′–78°10′ E longitude (Figure 1). The sanctuary, established in 1987, covers 16.41 km² and was primarily notified for the conservation of the endangered blackbuck (*Antilope cervicapra*). It lies along the eastern flank of the southern Western Ghats within the Deccan semi-arid biogeographic zone. The terrain consists of gently undulating plains interspersed with low rocky hillocks, with an elevation range of 90–180 m above sea level. The climate is semi-arid, with hot summers, mild winters, and mean annual rainfall of about 700–800 mm, predominantly received during the northeast monsoon (October–December). Shallow soils and rocky substrates favor the growth of xerophytic vegetation typical of tropical thorn forest (TTF). The flora is dominated by drought-tolerant woody taxa such as *Vachellia mellifera*, *Commiphora berryi*, *Dalbergia spinosa*, *Ziziphus mauritiana*, and *Ziziphus xylopyrus*, interspersed with climbers and shrubs. Besides its flagship blackbuck population, the sanctuary supports Indian hare (*Lepus nigricollis*), small carnivores like mongoose, and a rich avifauna. Its small size, coupled with high ecological distinctiveness, makes Vallanadu Blackbuck Sanctuary a critical biodiversity enclave and an ideal site for evaluating floristic quality within Tamil Nadu's dry forest landscape.

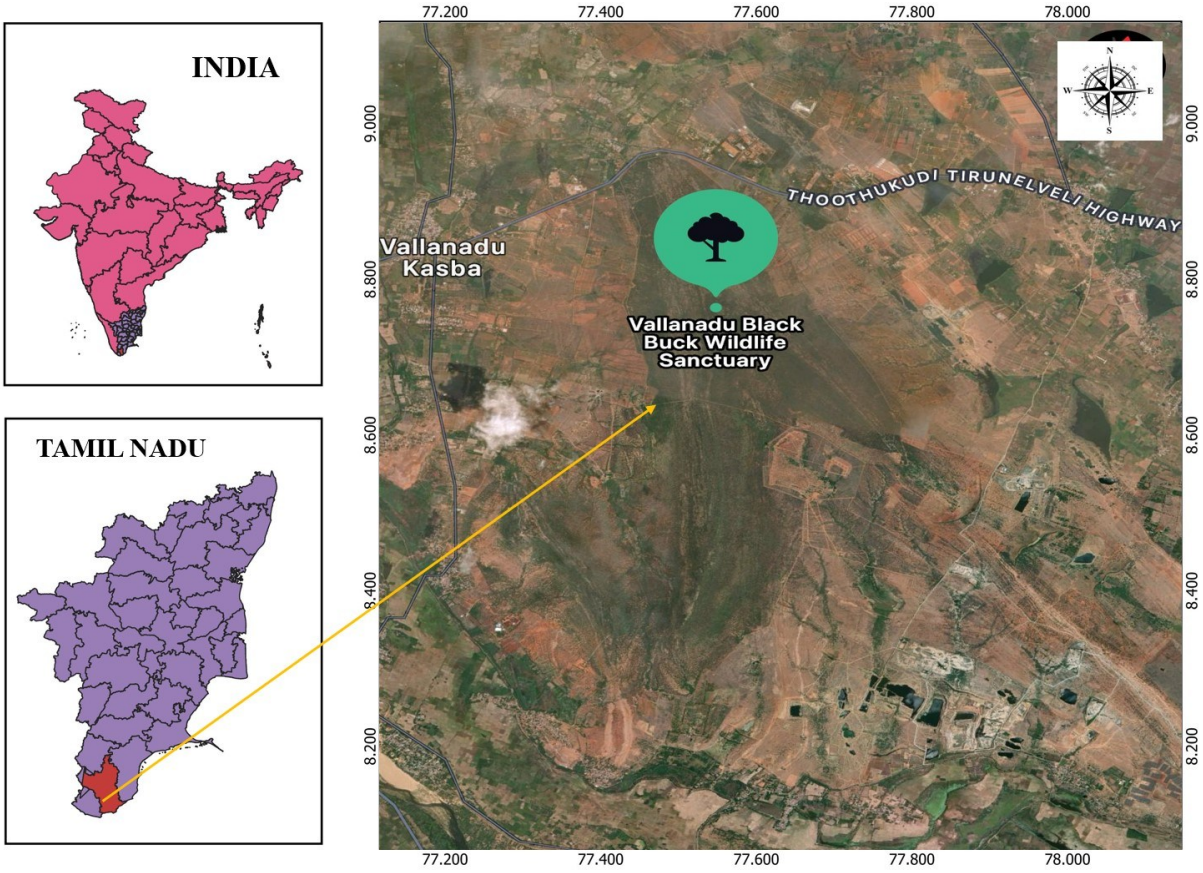

Figure 1. Map of study area wherein floristic quality index of trees recorded.

2.2. Assigning coefficient of conservatism (C-values)

Each plant species is assigned a C-value that reflects its tolerance to disturbance and habitat specificity. In this study, all native species receive a baseline score of 5, while additional weighting is based on the number of districts (out of 38 in Tamil Nadu) in which the species occurs. Thus, species restricted to few districts receive higher scores, while widespread species receive lower additional scores.

$$C_i = 5 + \left(1 - \frac{d_i}{38}\right) \times 5$$

Where C_i Coefficient of conservatism for species i, d_i = number of districts in Tamil Nadu where the species is recorded, 38 = total districts. The second term accounts for rarity (fewer districts → higher rarity → higher score). Thus, the maximum possible C-value approaches 10 (species restricted to 1 district), while widespread species occurring in all districts receive a lower value (5 if d_i=38).

2.3. Mean C value (*C*)

Once C-values were assigned to all native species, the mean coefficient of conservatism was calculated: $\bar{c} = \frac{\sum Ci}{N}$; where N is the number of native species in the site

2.4. Floristic quality index (FQI)

The Floristic Quality Index was then calculated as: FQI = $\bar{C} \times \sqrt{N}$; where $\bar{C}$ = mean C-value of native species, and N = number of native species in the site (Taft et al., 1997; Herman et al., 2001).

2.5. Uniqueness of the Present Study

The novelty of this study lies in the district-based rarity weighting that adapts the traditional FQI to the biogeographic context of Tamil Nadu. While global applications of FQI assign C-values based on expert consensus, this approach introduces an objective and scalable criterion—the number of districts of occurrence—thereby reducing subjectivity. This refinement emphasizes species with restricted ranges, which are critical for conservation in tropical thorn forests where habitat fragmentation is pronounced. Applying this method to Vallanadu Blackbuck Sanctuary is significant because: (i) It is among the first attempts to systematically compute FQI in southern India; (ii) It incorporates regional rarity into conservation value assessments; and (iii) It provides a replicable framework that can be extended to other protected areas and vegetation types across Tamil Nadu. Further, by aligning rarity with district boundaries, the approach facilitates integration with biodiversity planning and protected area management.

2.6. Limitations

The FQI, while robust, has certain limitations. Assigning C-values involves subjectivity and requires expert consensus (Matthews, 2003). The method was originally developed for temperate floras and requires adaptation for tropical ecosystems with high endemism and ecological complexity (Chaudhary & Kumar, 2018). The FQI emphasizes floristic composition but does not directly capture invasive species dominance, habitat structural degradation, or faunal interactions. Further, the district-level distribution data may not fully capture ecological rarity, as some species could be widespread but locally rare.

3. Results

The floristic assessment of Vallanadu Blackbuck Sanctuary, based on 700 plots (10 m × 10 m), recorded 35 woody species. Trees native to India alone considered for FQI estimation. The mean C-value across species was 6.17±2.02, yielding an unweighted FQI of 34.34 (Table 1). The widely used FQI score guidelines provided in Table 2.

Table 1. Botanical name, occurrence in districts and C score for trees recorded from Vallanadu Blackbuck sanctuary, Thoothukudi, Tamil Nadu.

No.	Plant name	District	C Score
1	*Albizia amara* (Roxb.) B.Boivin	38	5
2	*Albizia lebbeck* (L.) Benth.	38	5

3	*Anogeissus pendula* Edgew.	2	9.74
4	*Azadirachta indica* L.	38	5
5	*Bauhinia racemosa* Lam.	38	5
6	*Canthium parviflorum* Lam.	38	5
7	*Carissa spinarum* L.	38	5
8	*Catunaregam spinosa* (Thunb.) Tirveng.	38	5
9	*Commiphora berryi* (Arn.) Engl	38	5
10	*Crateva magna* (Lour.) DC.	2	9.74
11	*Crateva religiosa* G.Forst	38	5
12	*Dalbergia spinosa* Roxb.	3	9.61
13	*Dichrostachys cinerea* (L.) Wight & Arn	3	9.61
14	*Fernandoa adenophylla* (Wall. ex G.Don) Steenis	1	9.87
15	*Flueggea leucopyrus* Willd.	38	5
16	*Gmelina asiatica* L.	38	5
17	*Grewia rotundifolia* Juss.	38	5
18	*Hardwickia binata* Roxb.	38	5
19	*Lannea coromandelica* (Houtt.) Merr.	38	5
20	*Morinda coreia* Buch.-Ham	38	5
21	*Mundulea sericea* (Willd.) A.Chev.	8	8.95
22	*Pongamia pinnata* (L.) Pierre	38	5
23	*Premna tomentosa* Willd	38	5
24	*Santalum album* L.	38	5
25	*Tecomella undulata* (Sm.) Seem.	2	9.74
26	*Vachellia horrida* (L.) Kyal. & Boatwr.	8	8.95
27	*Vachellia leucophloea* (Roxb.) Maslin, Seigler	38	5
28	*Vachellia planifrons* (Wight & Arn.) Ragup., Seigler, Ebinger & Maslin	38	5
29	*Wrightia tinctoria* R.Br.	38	5
30	*Ziziphus mauritiana* Lam.	38	5
31	*Ziziphus xylopyrus* (Retz.) Willd	38	5
		Mean±S.D.	6.17±2.02

Table 2. Guidelines for score interpretation (while absolute thresholds can vary by region, these general patterns are often used); *These ranges are indicative; local calibration using regional floras and protected area comparisons is recommended.

FQI Range*	Ecological Interpretation	Example Context
0–20	Very low floristic quality	Heavily degraded, urban, or invasive-dominated areas
20–40	Low floristic quality	Moderately disturbed forests, secondary growth, or grazed areas
40–60	Moderate floristic quality	Semi-natural habitats with a mix of disturbance-tolerant and sensitive species
60–80	High floristic quality	Well-preserved natural habitats, moderate rarity species present
80+	Very high floristic quality	Pristine habitats with many rare, specialist, or restricted-range species

The distribution of C-values showed that most species clustered around 5, with only a few attaining higher scores associated with restricted distribution across Tamil Nadu. The tree community is strongly influenced by dominant taxa such as *Vachellia mellifera, Commiphora berryi, Dalbergia spinosa, Ziziphus mauritiana, and Ziziphus xylopyrus*.

Taken together, these results indicate that Vallanadu Blackbuck Sanctuary retains a semi-intact tropical thorn forest character, with moderate floristic integrity. The abundance of a few dominant species contributes disproportionately to community structure and floristic quality, highlighting both the ecological resilience and potential vulnerability of this dry forest ecosystem.

DISCUSSION

Applying FQI to Vallanadu Blackbuck Sanctuary highlights its utility in quantifying floristic integrity in a tropical thorn forest. Unlike diversity indices that treat all species equally, FQI emphasizes restricted and disturbance-sensitive species, thereby prioritizing conservation efforts. The district-based rarity weighting ensures regional relevance and highlights locally restricted taxa, many of which are crucial for ecosystem

stability. This approach aligns with global practices where FQI has been successfully used to evaluate wetlands (Taft et al., 1997), grasslands (Freyman et al., 2016), and forest ecosystems (Herman et al., 2001). Its adaptation in Tamil Nadu can facilitate long-term ecological monitoring, cross-site comparisons, and integration into management plans for protected areas. A key strength of this study lies in the refinement of conservatism coefficients (C-values) by incorporating district-level distribution data from Tamil Nadu. This approach uniquely adjusts for regional rarity, assigning higher weights to taxa with restricted distributions. As a result, the metric captures not only ecological fidelity but also biogeographic distinctiveness at the state scale. Moreover, aligning floristic assessments with administrative boundaries facilitates the use of FQI in policy-making, biodiversity planning, and protected area management. The present study is unique in contextualizing the index to a district-level biodiversity framework.

The present study provides one of the first quantitative assessments of floristic integrity in Vallanadu Blackbuck Sanctuary using the Floristic Quality Index (FQI). The FQI of 34.34 indicates a moderate level of floristic integrity, consistent with expectations for tropical thorn forest ecosystems subject to anthropogenic pressures in peninsular India. Compared to large, species-rich reserve forests in Tamil Nadu (FQI=116.93; Narayanaswamy, 2020) and mid-range Indian hill reserves (FQI=42.33; Deendayal & Aalum, 2025), Vallanadu scores modestly, reflecting its smaller species pool, local dominance structure, and probable anthropogenic influences. With targeted management (invasive control, microhabitat protection, connectivity), the proportion and abundance of more conservative, locally restricted species can be increased and that improvement would be captured by rises in both mean C and FQI in future monitoring.

Ecologically, the sanctuary is characterized by a small set of dominant species, including *Senegalia mellifera, Commiphora berryi*, *Dalbergia spinosa, Ziziphus mauritiana*, *and Ziziphus xylopyrus*. The floristic integrity of the site therefore reflects a balance between widespread dominants and rarer, more localized elements such as *Fernandoa adenophylla* and *Anogeissus pendula*. This structural pattern suggests both resilience and vulnerability: resilience because dominant thorn-forest taxa maintain ecological identity, and vulnerability because excessive dependence on a few high-abundance species may reduce long-term community stability.

The FQI framework applied here highlights Vallanadu Blackbuck Sanctuary as a moderately intact tropical thorn forest with unique regional elements. By integrating distributional rarity into C-value assignment, this study establishes a replicable protocol for evaluating floristic quality in Indian ecoregions. Future applications across multiple sanctuaries and districts could provide a valuable comparative baseline for conservation prioritization and long-term monitoring.

CONCLUSION

Floristic Quality Index offers a scientifically robust yet interpretable framework for assessing ecological integrity. By incorporating district-level rarity weighting, it becomes more suited to the ecological context of Tamil Nadu. While limitations exist, FQI provides conservationists and policymakers with a practical metric that complements other biodiversity indicators. In Vallanadu Blackbuck Sanctuary, this method allows a refined evaluation of floristic quality and provides a framework for replicable, region-specific conservation monitoring. Further, the FQI can serve as a long-term ecological monitoring tool and a benchmark for evaluating restoration and management success.

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