Research Article

Species Richness and Diversity in Sub-Tropical Chir Pine Forest in Abbottabad City

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Abstract | Species richness is generally measured by counting the number of distinct species within a specific area or sample. Species richness serves as a physiologically meaningful indicator for alpha (α) diversity. The purpose of this research was to examine the biodiversity of the chir pine forests in the Abbottabad city region. Because this kind of forest is a distinct and significant ecological habitat, the researchers aimed to learn more about the different animals that call it home. The researchers employed a methodology to guarantee that their findings would accurately represent the entire forest. 72 plots, each 20 by 20 meters, were chosen randomly from the forest. They meticulously recorded the quantity and kinds of different tree species they came across in each of these plots. This study's findings were quite informative. It was discovered that *Pinus roxburghii,* a species of pine tree, constituted a significant 87% of the total species composition in the forest. 5% of the composition was made up of *Eucalyptus camaldulensis*, and 1.7% was *Quercus incana.* Notable species included in the composition of the total species were *Platanus orientalis, Dodonaea viscosa, Pistacia integerrima, Juglans regia,* and *Populus ciliata,* albeit in smaller amounts ranging from 0.51% to 0.962%. The study's key discovery was that, in comparison to other types of forests, the species diversity in the chir pine forest was comparatively low. This implies that a small number of important species, mainly *Pinus roxburghii*, dominate the ecosystem of the chir pine forest. The study also mentioned the comparatively high frequencies of alien species, such as *Eucalyptus camaldulensis*. It is important to remember that these exotic species are non-native to the area, which may have an impact on the native species and ecosystem's equilibrium. A few major challenges to the ecosystem of the chir pine forest were also identified by the study. These dangers included the building of infrastructure, fuelwood gathering, animal overgrazing, and forest fires.

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Introduction

The presence of a variety of species within communities holds significant importance due to its frequent association with community functionality and its capacity for change (Stachowicz *et al.*, 2007). Diversity, in this context, represents the livelihood that two randomly selected individuals from a community

will belong to different species. Consequently, diversity hinges upon two other fundamental community characteristics: Species richness and evenness (Magurran, 2013). Species richness serves as a biologically relevant metric for alpha (α) diversity and is typically quantified as the number of species per unit of sampling (Whittaker, 1972). Evenness gauges the extent of similarity in species abundance within the community (Khan *et al*., 2021).

Biodiversity encompasses two distinct elements, namely, species richness and evenness. These aspects gauge the quantity of species within a community and the degree of similarity in the abundance of those species, respectively (Magurran and McGill, 2011). The distribution of species abundances in relation to one another can vary greatly, from a highly even distribution to a highly skewed one, where the majority of individuals are concentrated in just one or a few species. This is similar to how species richness can differ significantly among local communities. For simplicity's sake, most research on the variables impacting biodiversity and its outcomes uses species richness as a stand-in for measuring diversity. Stevens (1992), proposed that the number of plant species in a given area would decrease linearly with elevation over a wide geographic range; however, Shimono *et al*. (2010), found that plant species richness and elevation positively correlate throughout the Tibetan Plateau. Furthermore, as noted by Pausas and Austin (2001), species richness may increase in response to increased water availability. On the other hand, a positive quadratic association, resembling a humped curve, was reported by Hawkins *et al*. (2003) and O'Brien (1993) between species richness and water availability (Janne *et al*., 2013).

The current study area includes the chir pine forest in the subtropical Abbottabad location, which is a hilly region. These mountain forests provide numerous benefits to residents living upstream and downstream. The longevity and conservation of watersheds and transportation networks rank highest among these advantages. In addition to being important locations for tourism and recreation, these mountainous areas are also highly significant as centers of biodiversity, suppliers of fuelwood, lumber, and non-timber resources, and they are regarded as sacred places. Furthermore, they are becoming more widely acknowledged as potential carbon sinks that can help to mitigate climate change (Khan *et al*., 2013).

Understanding the primary mechanisms responsible for shaping plant communities has been a central challenge in the field of community ecology (McCune and Grace, 2002). Variations in edaphic, topographic, soil, and climatic variables, along with changes in biogeochemistry, can result in a variety of possible limiting factors, and these factors can have different effects on the structure and function of vegetation at both local and regional scales (Hulshof and Spasojevic, 2020). In this case, environmental considerations have been quite important. As seen by the few studies carried out thus far, the contribution of climatic conditions to the distribution of pine, coniferous, and broadleaved forests in northern Pakistan is still not well understood, as observed in studies conducted by Ansari *et al*. (2022). Subtropical Chir pine forests because of the needles and other plant components that are left on the forest floor as well as the hot, dry weather, chir pine woods are particularly vulnerable to wildfires throughout the summer. The combination of a hot temperature and vegetation increases a wildfire's susceptibility (Kanga *et al*., 2017).

Materials and Methods

Our selected study region is Abbottabad, a city characterized by its distinct character and scenic beauty. It is tucked away within the enticing boundaries of the sub-tropical chir pine zone a name that suggests the incredible diversity of this area. If one is looking for Abbottabad, the exact location is 34 degrees 92 minutes North latitude and 73 degrees 13 minutes East longitude. This city is not just any dot on the map; it's an elevated one, sitting at an altitude of 1,256 meters (4,121 feet) above sea level, an attribute that adds an extra layer of charm to this already captivating locale. However, Abbottabad's appeal is not just confined to its own borders; to the north, it provides a splendid gateway to the picturesque Kaghan Valley.

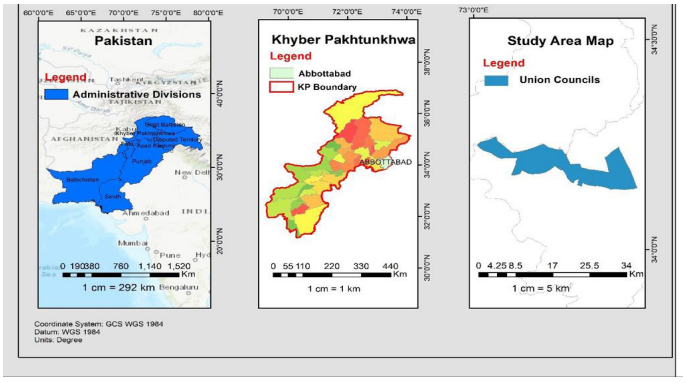

Figure 1: *Location of sample plots in Abbottabad city.*

Abbottabad, a city rich in natural beauty and ecological value, has 27 different forest compartments that together encompass 7,203 acres of forested land. These forest compartments are essential parts of the city's ecosystem, supporting biodiversity and general environmental health. Within the Gallies Forest Division, research has been conducted to determine the species variety richness in sub-tropical chir pine forests. Within the forest compartments, a carefully selected set of 72 sample plots have been developed for this study project (as shown in Figure 1). These sample plots were chosen using a scientifically rigorous 0.1 percent sampling intensity, guaranteeing their representativeness of the larger forested area.

Sampling intensity = Sample area/ Total Forest area
Number of plots = Sample area/ Plot size
Sampling intensity is 0.1% according to (Negi *et al.*, 2022)
Sample area = 0.1% * 7203/ 100
Sample area = 7.203 acre
No of sample plots = Sample area/ Plot size
Plot size is taken as 0.1 acre according to (Zhao *et al.*, 2022)
No of plots = 7.203/ 0.1
No of plots = 72

In this study, plots are chosen randomly using a basic random sampling technique. Clinometer is used to measure slope, whereas GPS is used to record elevation and coordinates. A 20×20-meter square plot radius, or 11 m, which is equal to 0.1 acres in size, was surveyed. In this study, measuring tapes are used to measure the dimensions of sample plots, clinometers are used to measure slope, GPS units are used to measure coordinates and elevation, and MS Excel is used to enter and analyse data.

Results and Discussion

Figure 2 depicts the species composition percentages of sampled plots within chir pine forest of Abbottabad city i.e., (contribution of each plant species to the vegetation). The sampled tree species includes both conifers and broadleaves.

The data reveals that *Pinus roxburghii* is the predominant tree species in the area, making up a significant 87% of the total species composition. This high prevalence of *Pinus roxburghii* suggests a robust ecological niche for this species within the region, possibly due to its adaptability to local conditions. Following this dominant species, *Eucalyptus camaldulensis* accounts for 5%, indicating a notable presence. This diversity in tree species is indicative of a complex ecosystem, where various species have found their respective niches. Furthermore, *Quercus incana* represents 1.7% of the species, *Platanus orientalis* stands at 1.2%, *Dodonaea viscosa* at 1.6%, *Pistacia integerrima* at 0.51%, *Juglans regia* at 0.74%, and *Populus ciliata* at 0.962% of the total species composition. While these percentages may seem relatively small in comparison to *Pinus roxburghii*, they collectively contribute to the overall biodiversity of the region.

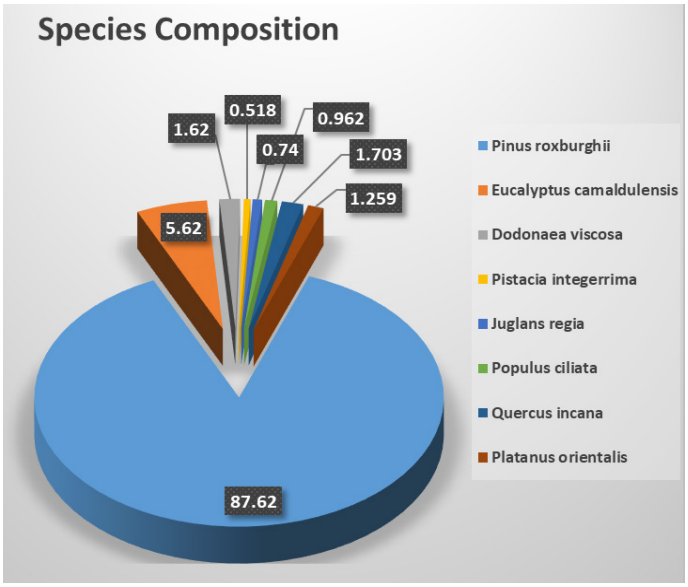

Figure 2: *Species composition of chir pine forest.*

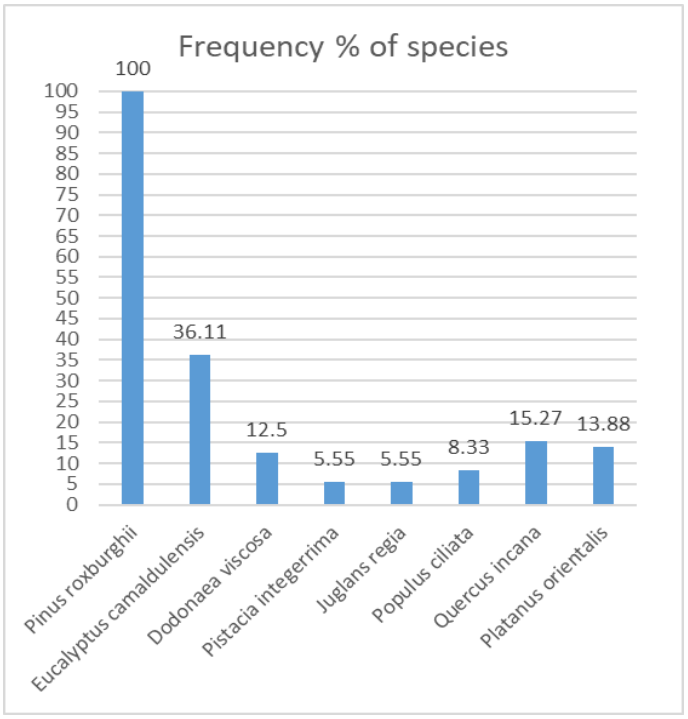

Figure 3: *Frequency percentage of species.*

Frequency is the number of times a plant species occurs in a given number of plots or quadrats (Aberdeen, 1958) or generally, frequency is the occurrence across landscape.

A total of 1350 trees were recorded during the inventory. The tree species sampled constitutes both conifers and broad leaved. The data in Figure 3 reveals the dominance of different conifer species within a specific context. *Pinus roxburghii* stands out as the most prevalent species at 100%, signifying that it is the overwhelmingly dominant conifer in this particular ecosystem or data set. Following this, we have *Eucalyptus camaldulensis* at 36.11%, which suggests a significant presence but not as dominant as *Pinus roxburghii*. *Quercus incana* contributes 15.27%, and *Platanus orientalis* makes up 13.88% of the conifer composition. *Dodonaea viscosa* accounts for 12.5%, while *Populus ciliata* represents 8.33%. Both *Pistacia integerrima* and *Juglans regia* share a similar presence at 5.55%. These percentages provide valuable insights into the relative abundance of various conifer species within the studied area, aiding in ecological and botanical research or resource management decisions.

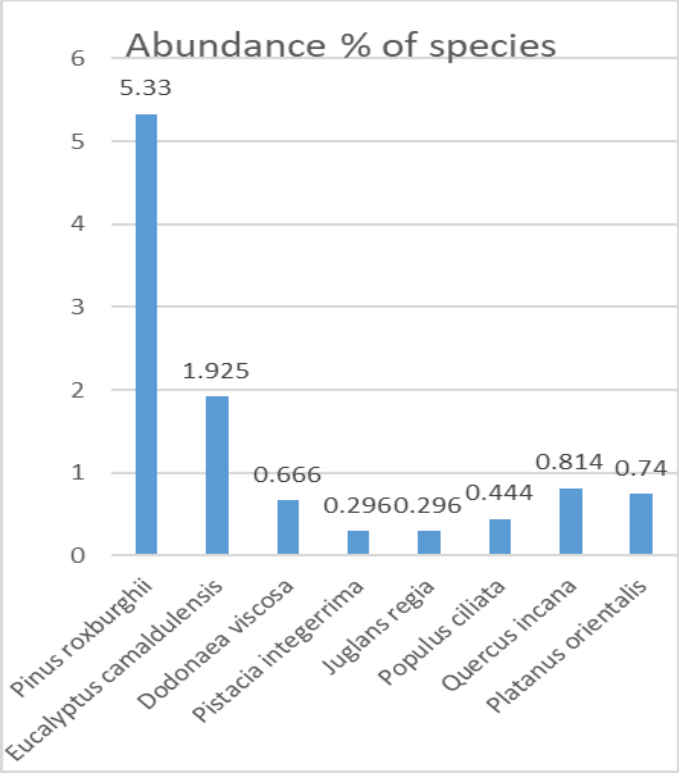

Figure 4: *Abundance percentage of species.*

Figure 4 provides insights about the abundance percentages of various species within the study area i.e (Local relative number of individuals or species (Magurran and Magurran, 1988; Magurran, 2007) or generally it is defined as a measure of how common or rare a species is relative to other species (Wikipedia). The prominence of *Pinus roxburghii*, accounting for 5.33% of the total species composition, underscores its ecological significance. This conifer species is clearly a dominant component of the ecosystem, potentially playing a crucial role in shaping the environment's characteristics. Its high percentage suggests adaptability or a competitive edge over other species in the given conditions. *Eucalyptus camaldulensis*, following as the second most prevalent species at 1.925%, adds to the diversity of the area's flora. Although not as dominant as *Pinus roxburghii*, it is still a substantial contributor to the ecosystem, indicating its capacity to thrive in the local environment. The presence of *Quercus incana* at 0.814% and *Platanus orientalis* at 0.74% reflects the coexistence of deciduous species alongside conifers. This diversity can contribute to the complexity of the ecosystem, potentially supporting a wider range of wildlife and ecological interactions. The prevalence of *Dodonaea viscosa* at 0.666% highlights the significance of shrubby species, which may have unique ecological roles, such as providing habitat and food sources for local fauna. The shared presence of *Pistacia integerrima* and *Juglans regia* at 0.296% each suggests a balanced coexistence of these species, which may have specific ecological interactions or niche differentiation within the ecosystem. Finally, *Populus ciliata*, contributing 0.444%, adds to the variety of species in the area, enriching the overall biodiversity. Understanding these percentages is vital for ecological studies, resource management, and conservation efforts, as it provides insights into the dynamics of plant species in the area and how they interact with each other and the environment. This knowledge can inform decisions related to land use, preservation, and sustainable ecosystem management.

Conclusions and Recommendations

According to studies done in the subtropical chir pine forest in Abbottabad city, *Pinus roxburghii* is the most common species, accounting for a significant 87% of the total species composition. On the other hand, *Eucalyptus camaldulensis*, which makes up 5.62% of the forest, is considered exotic in this subtropical chir pine forest because it is not native to it. *Dodonaea viscosa* takes up 1.62% of the species makeup, whereas *Quercus incana* makes up 1.703%. *Juglans regia* contributes 0.74 percent, *Populus ciliata* 0.962%, and *Platanus orientalis* and *Pistacia integerrima* 0.518%

and 1.259%, respectively. The subtropical chir pine zone, which is dominated by *Pinus roxburghii*, often known as chir pine, has a substantially lower species diversity than other forest zones. Furthermore, mentioned are the introductions of non-native plants like *Eucalyptus camaldulensis* and *Platanus orientalis*. This zone is essential and needs to be preserved since it supplies the neighbourhood with fodder, lumber, and fuel wood. It is recommended that alternative fuels be made available to reduce dependency on trees, that construction be prohibited on forest areas, and that the Forest Department handle any encroachments in order to increase sustainability. Developing ecotourism strategies can also help to preserve the area's biological integrity. Furthermore, ancient trees found in the areas should be designated as cultural heritage, proper training and awareness should be given to common masses and field staff in order to minimize the forest fire incidents as it is very common in chir pine zone according to the research studies.

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Novelty Statement

This work offers fresh perspectives on species variety and richness in Abbottabad's subtropical Chir pine forests, revealing unseen patterns of biodiversity that highlight the special ecological significance of this forest type. This study provides important information for sustainable forest management by analyzing species composition and identifying important conservation requirements.

Author's Contribution

Hammad Ali: Principal Author, Writing - Original draft.
Basheer Ahmad: Supervision.
Asim Karim: Writing-eiditing and data curation.
Saifullah: Critical review.
Salman Ahmad: Formal analysis.

Conflict of interest
The authors have declared no conflict of interest.

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