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Research Article

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Regeneration status of *Albizia lebbeck* Benth. in different Forest Types of Uttarakhand, Northern India

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ABSTRACT

The ability of a species to survive in the community under a range of environmental circumstances depends on its regeneration. This study evaluates the regeneration status of *Albizia lebbeck* across Uttarakhand's various forest types. The species was found in five different forest types and the overall regeneration was determined to be 'Good'. The highest seedling density (900 ha^{-1}) was recorded for West Gangetic Moist Mixed Deciduous Forest, while the lowest (100 ha^{-1}) was observed in the Upper or Himalayan Chir Pine Forest. The highest adult density (70 ha^{-1}) was found in Ban Oak Forest and West Gangetic Moist Mixed Deciduous Forest and the least (20 ha^{-1}) was found in Northern Dry Mixed Deciduous Forest. There was a complete absence of sapling stages in the Northern Dry Mixed Deciduous Forest (5B/C2) and Upper or Himalayan Chir Pine Forest (9/C1b) which indicates disturbances in these regions.

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KEYWORDS: Regeneration, Environmental conditions, Seedlings, Samplings

INTRODUCTION

Trees are the basic component of a forest, as they occupy a large portion of the habitat's physical space and influence the resources for almost all other forest organisms. Regeneration capacity under a variety of environmental situations is the primary determinant of a tree's survival in a forest. *Albizia lebbeck* also called 'Kala Siris' is a valuable nitrogen-fixing tree with several applications. In the forest areas of Uttarakhand, it is found between altitude of 300 and 1600 m.

One essential mechanism for the survival of a species in a community under a variety of environmental circumstances is regeneration. After a variety of disturbances, regeneration preserves the intended species composition and stocking, making it an essential component of forest management (Khumbongmayum *et al.*, 2005). According to Halle *et al.* (1978), regeneration is the process through which trees and forest endure over time. In both space and time, the potential regeneration condition of the species present in a forest stand determines the forest's wealth (Jones *et al.*, 1994). A crucial process in which new trees take the place of older ones is forest regeneration (Malik & Bhatt, 2016). The ability of any species to regenerate is limited to specific habitat circumstances along with extent of those requirements greatly influences the species' geographic range. Successful forest species regeneration is demonstrated by the population structure, which is described by "presence of adequate number of seedlings, saplings, as well as adults. Additionally, sapling's presence beneath canopies of adult trees is indicative of successful forest species regeneration (Pokhriyal *et al.*, 2010). Successful regeneration of tree species relies on three primary components: the capacity to produce new seedlings, the survival rate of seedlings" as well as saplings, along with the growth potential of seedlings as well as saplings (Good & Good, 1972).

According to Zasada *et al.* (1978), the size of seed crop and the establishment of seedlings have a substantial influence on the vegetation's capacity for regeneration. According to their population's diameter structure, several researchers anticipated the regeneration status of tree species (Pritts & Hancock, 1983). Since it is typically impossible to follow a long-lived species's life cycle from birth to death, there are several ways to examine the regeneration status, including the population structure (Saxena & Singh, 1984), a density-diameter curve (Saxena & Singh, 1982), along with a dominance-diversity curve (Whittaker, 1972). Due to its ability to predict the desired species composition and stocking based on population structure, regeneration is the crucial phase of forest management. According to Khan *et al.* (1987), the existence of significant number of seedlings, saplings, along with young trees within a population implies effective regeneration whereas population structure may indicate free regeneration.

MATERIALS AND METHODS

The research was conducted in various Uttarakhand forest regions (Figure 1). Nine of sixteen Forest types are found in Uttarakhand (Champion & Seth, 1968). Random quadrats were set up and a thorough field survey was conducted. The species-area curve method (Mishra, 1968) and the running mean method (Kershaw, 1973) were used to assess size and number of quadrats respectively. On each site, quadrats were laid at random. For trees, saplings and seedlings, quadrats of 10 m × 10 m, 3 m × 3 m, and 1 m × 1 m were maintained, respectively. Each tree's GBH (girth at breast height at 1.37 m above ground level) was determined as well as recorded individually for each quadrat. Regeneration of species was classified according to the size of seedlings, saplings, as well as adult populations according to Dutta and Devi (2013), modified from Khan *et al.* (1987), Shankar (2001) and Khumbongmayum *et al.* (2006). Tree species have been classified into the following categories:

1. Good regeneration: if seedlings >saplings > adults
2. Fair regeneration: if seedlings>or ≤ saplings ≤ adults if seedlings ≤ saplings > adults if seedlings ≥ saplings and the species had no adults
3. Poor regeneration: if a species survives only in the sapling stage but no seedlings (though saplings may be<, >, or = adults)
4. No regeneration: if it is absent both in the seedling and sapling stages but found only in adults
5. New regeneration: if species have no adults but only saplings or seedlings

RESULTS AND DISCUSSION

Albizia lebbeck's regeneration status in various forest types is shown in Figures 2, 3, 4, 5 and 6. Five different forest types were evaluated for species regeneration status and graphs indicate that overall regeneration was assessed as 'Good.' However, there were significant variations in the proportion in each stage. "West Gangetic Moist Mixed Deciduous Forest (3C/C3a) had the highest estimated seedling density (900 ha^{-1}) whereas Upper or Himalayan Chir Pine Forest (9/C1b) had the lowest (100 ha^{-1}). The density of saplings in all assessed forest types was strikingly low. In Northern Dry Mixed Deciduous Forest (5B/C2) and Upper or Himalayan Chir Pine Forest (9/C1b), sapling stages were altogether absent. The highest adult density (70 ha^{-1}) was observed in Ban Oak Forest (12/C1a) and West Gangetic Moist Mixed Deciduous Forest (3C/C3a), while the least (20 ha^{-1}) was in Northern Dry Mixed Deciduous Forest (5B/C2).

For the sustainable existence of any species, regeneration plays a crucial role in which an appropriate number of seedlings, saplings, and adult individuals must be present. It varies greatly in different climatic and edaphic conditions. An assessment of A. *lebbeck* regeneration in Uttarakhand's various forest types was attempted in this study. Various researchers reported regeneration status of different species from Uttarakhand (Singhal & Soni, 1989; Ballabha *et al.*, 2013; Pala *et al.*, 2013; Singh *et al.*, 2016). Diameter classes in different forest types in the present study showed the 'good' regeneration

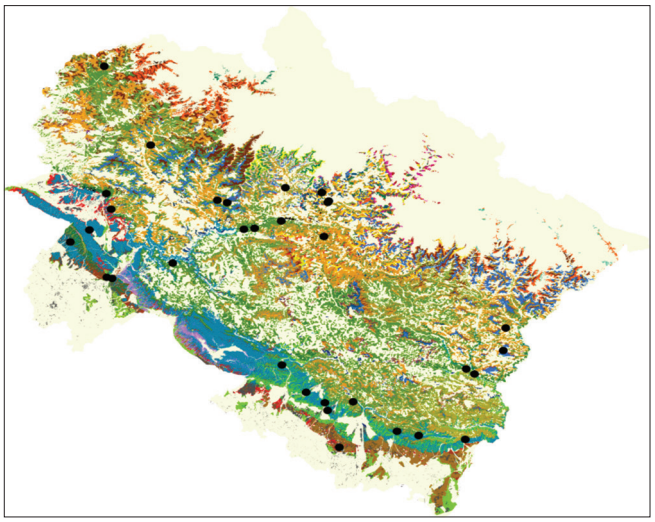

Figure 1: Distribution Map of *Albizia lebbeck* in different forest types

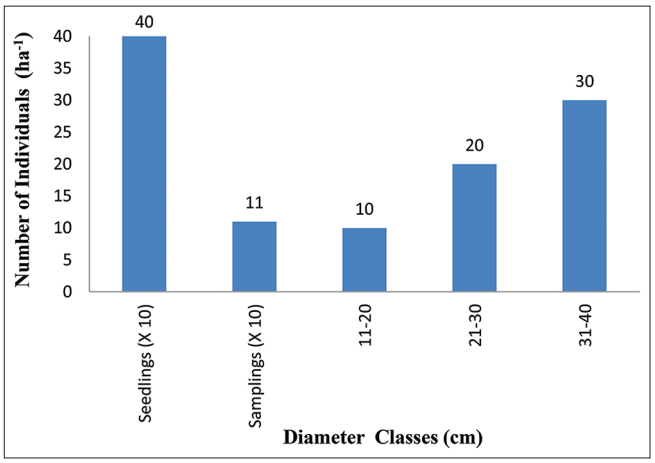

Figure 2: Regeneration status of *A. lebbeck* in Moist Shiwalik Sal Forest

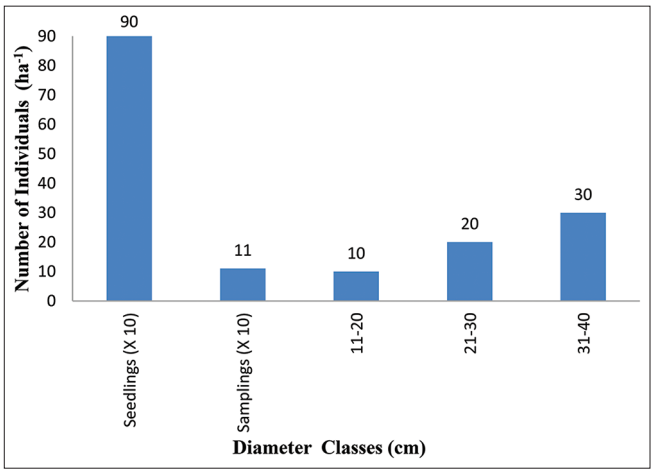

Figure 3: Regeneration status of *A. lebbeck* in West Gangetic Moist Mixed Deciduous Forest

(reverse-shaped curve), which is similar to outcomes obtained from Northeast India (Upadhaya *et al.*, 2004; Mishra *et al.*, 2005; Tynsong & Tiwari, 2011; Sarkar & Devi, 2014), Eastern

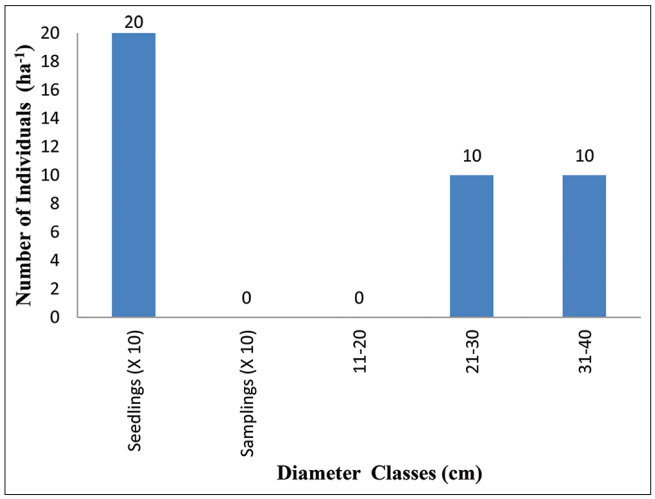

Figure 4: Regeneration status of *A. lebbeck* in Northern Dry Deciduous Forest

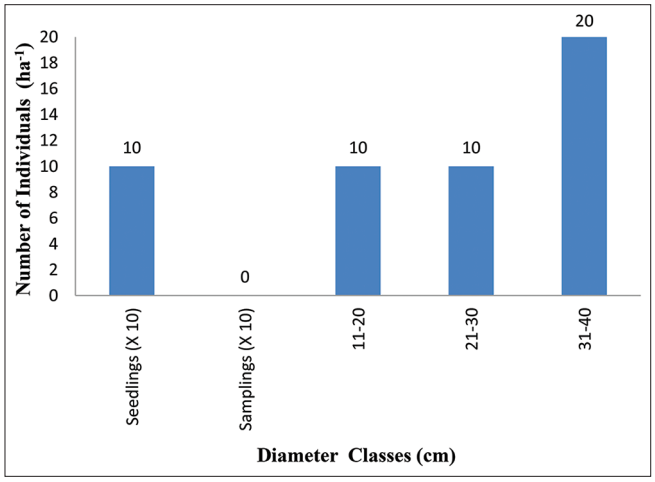

Figure 5: Regeneration status of *A. lebbeck* in Upper or Himalayan Chirpine Forest

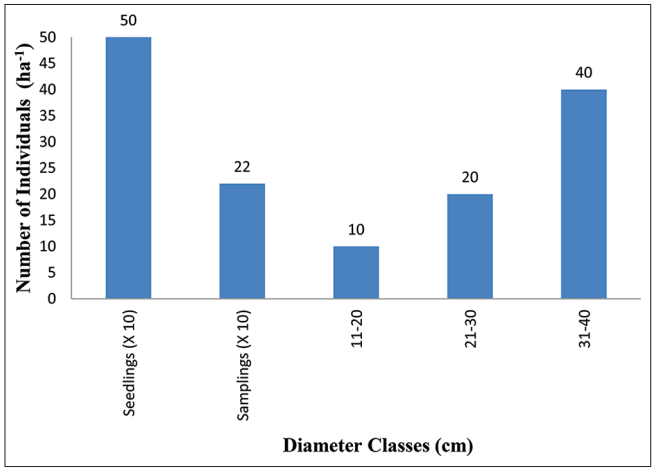

Figure 6: Regeneration status of *A. lebbeck* in Ban Oak Forest

Ghats (Kadavul & Parthasarathy, 1999; Sahu *et al.*, 2012) and Andaman Island (Rajkumar & Parathasarathy, 2008; Rasingam & Parthasarathy, 2009). 'Good' regeneration of tree species suggests stable type of population in the forest. Tree growth stages, such as seedlings, saplings, and adults, are influenced by microclimatic and edaphic elements that preserve population structure (Khumbongmayum *et al.*, 2006). High biotic potential of species is shown in the high density of smaller diameter classes, which may be caused by favorable edaphic and climatic conditions. In general, anthropological factors (Khan & Tripathi, 1989; Barik *et al.*, 1996; Sukumar *et al.*, 1998; Iqbal *et al.*, 2012) as well as natural disasters (Welden *et al.*, 1987) influence a species's ability to regenerate. The Upper or Himalayan Chir Pine Forest (9/C1b) as well as Northern Dry Mixed Deciduous Forest (5B/C2)" in the current study had no sapling stages in general, indicating disturbances in the regions.

CONCLUSION

Any species' sustainable management, utilization and conservation depend heavily on an understanding of its regeneration status along with population structure. According to the overall population structure of A. *lebbeck* at the study location, seedlings made up the largest portion of the population, followed by saplings as well as mature trees. In the absence of significant environmental stress, it indicates that species regeneration in forests is 'good' and that future communities will be maintained. Disturbances are indicated by the absence of sapling stages in the Upper or Himalayan Chir Pine Forest (9/C1b) as well as Northern Dry Mixed Deciduous Forest (5B/C2). Sustainability of species in these types of forests may be threatened if the current situation persists. The preservation of biodiversity is hampered by anthropological practices, including encroachment, grazing and the cutting down of trees for fuelwood, fodder, as well as wood. It is necessary to identify these activities and generate appropriate management plans. People who live on the fringes of forests should be aware of the significant and negative consequences of biodiversity loss to stop the careless use of forest resources. Through mass awareness campaigns, villagers should be educated about the sustainable use of plant diversity. State forest department authorities will find the study's conclusions useful in carrying out their current management plans and developing new plans for the sustainable use of forest resources.

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