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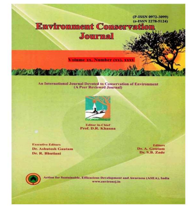

Review on regeneration status of *Betulautilis* D. Don: A critically endangered multipurpose timber line species in Indian Himalayan region

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ABSTRACT

The Himalayan birch (*Betulautilis* D. Don), also known as *Bhojpatra* in India, is one of the Himalayan region's most important ethnobotanicaltreelinespecies. It aids in the preservation of the Himalaya's fragile environment by preventing soil erosion and conserving the rest of the flora and wildlife below the treelinezone.*Betulautilis* has been identified for medical (anticancer, anti-HIV, antimicrobial, antioxidant, and anti-inflammatory) and ethno botanical relevance by several ethnic and non-ethnic communities living in the Himalaya and elsewhere, in addition to several ecological benefits.The bark of the *Betula* tree has long been used to write old manuscripts.It may also be used as a packing material, is waterproof, can be used to roof dwellings, umbrellas, and other items.The historical usage of *B. utilis*, as well as recent overharvesting to suit community and commercial demands, have put strain on the species natural populations. *B. utilis* faces numerous threats, including overharvesting, deforestation, erosion, grazing, global warming, and disease attack.Thus, it has been categorized as Critically Endangeredspecies.The main problem of the mountain forestsislack of adequateregenerationprocess. Very little information on population dynamics, regeneration, and physiology and seed germination is available from different parts of the country but no any systematic study has been done so far on multipurpose timberline tree species of Indian Himalayan Region. As a result, it's critical to keep an eye on these sensitive places and keystone species for future changes caused by climate or anthropogenic pressure, especially in locations where baseline data is scarce. The ease and suitability of propagation methods for this species is also not well documented in the literature. With these limitations in mind, the current study aims to document the status of *Betulautilis* regeneration in the Indian Himalayan region.

Introduction

The Himalayas are a mountain range in South and East Asia that separates the Indian subcontinent's lowlands from the Tibetan Plateau the most complex and diverse mountain system on the planet. It stretches for nearly 2500 kilometres, 80 to 300 kilometres broad, and rises to over 8000 meters above sea level.The Himalaya's climate is determined by its latitude, height, and monsoon flow. The Himalaya stretch over subtropical and temperate latitudes, and every 300 metres of elevation gain drops the temperature by 2 degrees Celsius. In the summer, when a low pressure area

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forms in Central Asia, the monsoon delivers warm, damp winds and precipitation to the Himalaya. The mountain rain-shadow effect, however, prevents precipitation from falling on the Tibetan Plateau even during the rainy summer monsoon (Owen*et al.,* 2008). The Himalayas have a diverse range of habitats, resulting in a high level of biodiversity (Zurick and Pacheco, 2006).The Indian Himalayan region stretches for around 2500 kilometres and is 220-330 kilometres wide. Jammu and Kashmir's hilly region is known as the Western Himalaya, Uttarakhand's as the Central Himalaya, Sikkim and Arunachal Pradesh's as the Eastern Himalaya, and these two states, along with Meghalaya, Assam, Manipur, Mizoram, Nagaland, and Tripura, are known as India's north-eastern hill region (Figure 1). The area of the north-eastern hill region, excluding Sikkim and Arunachal Pradesh, is commonly referred to as extension ranges because of its geological history, but in terms of climate-biodiversity-livelihood links, it closely resembles the main Himalaya.Climate regimes differ dramatically based on latitude, longitude, elevation, and weather phenomena such as rain shadow, valley exit jet, ridge lift, and wave cloud (Dash, 2013).The Indian Himalayan region is home to 50% of all flowering species and 30% of indigenous to the Indian subcontinent species and also home to 137 species classified in the Red Data Book, with 56 species exclusive to the western Himalaya, 71 species restricted to the eastern Himalaya, and 10 species common to both regions (Sharma and Rana, 2013).

TreelineEcotone

Treelinefrom the upper limit of closed forests to treeless vegetation, sometimes referred to as alpine meadows, the ecotone indicates a transition characterized by diminishing tree cover and tree height. According to (Holtmeier andBroll, 2017), timberline is the term used to describe the upper) limit of continuous forest (forest with at least 30% crown density). Trees become sparse above it, and forests become more open, finally grading into isolated and scattered trees with huge gaps. The alpine treeline is a theoretical or hypothetical line that connects the highest elevation trees**.** A tree with a height of 2 m or more is considered a single-stemmed tree by definition. In the context of the treelineecotone, another word is tree species line, which refers to individuals of tree species that are shorter than 2 m or multi-stemmed, and are typically crippled as a result of extreme weather events such as storms and snowfall. It's worth mentioning 'krummholz,' which is made up of dwarfed and crooked trees with malformed physiognomies (Figure 2). They can be manipulated both genetically and environmentally. *Rhododendron campanulatum* is a common krummholz-forming plant in the Himalayas. Krummholz, on the other hand, can be a forest species like fir or birch (Holtmeierand Broll, 2017). It should be noted that the definitions given above frequently differ in the literature (Holtmeier, 2009; Holtmeier and Broll, 2017; Körner, 2012). (Holmeier and Broll, 2017), for example, use the terms timberline and treeline interchangeably. The shape of the treeline varies based on abiotic and biotic elements as well as historical context. In general, treeline is widespread, with tree individuals becoming sparser and shorter as they rise above timberline. According to (Körner, 2012) some species, such as *Quercussemecarpifolia* in the western Himalayas, have a natural abrupt treeline**,** which may reflect self-control via seedling shelter effects. A finger-like treeline forms on mountain slopes with alternating concave (furrows) and convex (ridges) surfaces because snow accumulation prevents tree development in the concave region, therefore trees are confined to the convex surface. In the Himalayas, you can see the formation of an island-like treeline. In high elevations, pockets or islands of trees are surrounded by treeless vegetation. Treelines in the Himalayas have ten genera and 58 species, which is quite a number when compared to the global total of 18 genera and 122 treeline species (Holtmeier, 2009; Körner, 2012) but there is no comprehensive list of Himalayan treeline species available. Pinaceae and Betulaceae are the most common treeline families worldwide. *Juniperus* (juniper), *Abies* (fir), *Betula* (birch) and *Rhododendron* are common treeline genera in the Himalayas; nevertheless, *Picea, Pinus* (*P. wallichiana*), *Larix*(larch), and Tsuga may also reach treelines. While birch, junipers, and *Rhododendron campanulatum* are predominantly treelineecotone species, fir, spruce, pine, and oak are subalpine forest species that may reach treelineecotone. Despite an eastward increase in mesic conditions that suppress treeline (Körner, 2012), the treeline

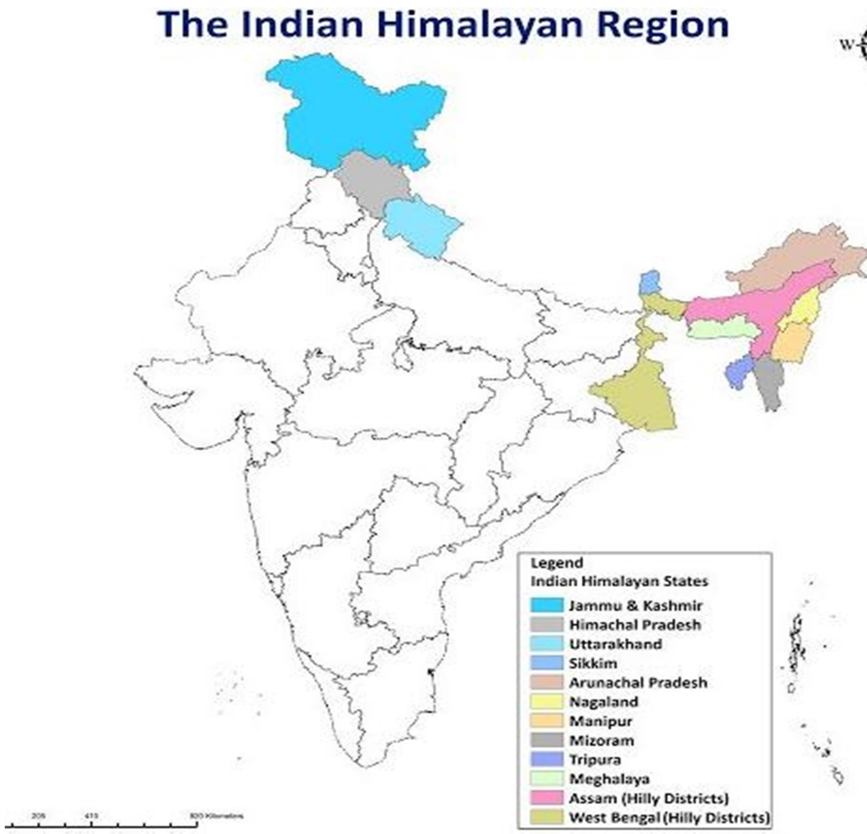

Figure 1: Map of Indian Himalayan Region
(Source:Department of science and technology)

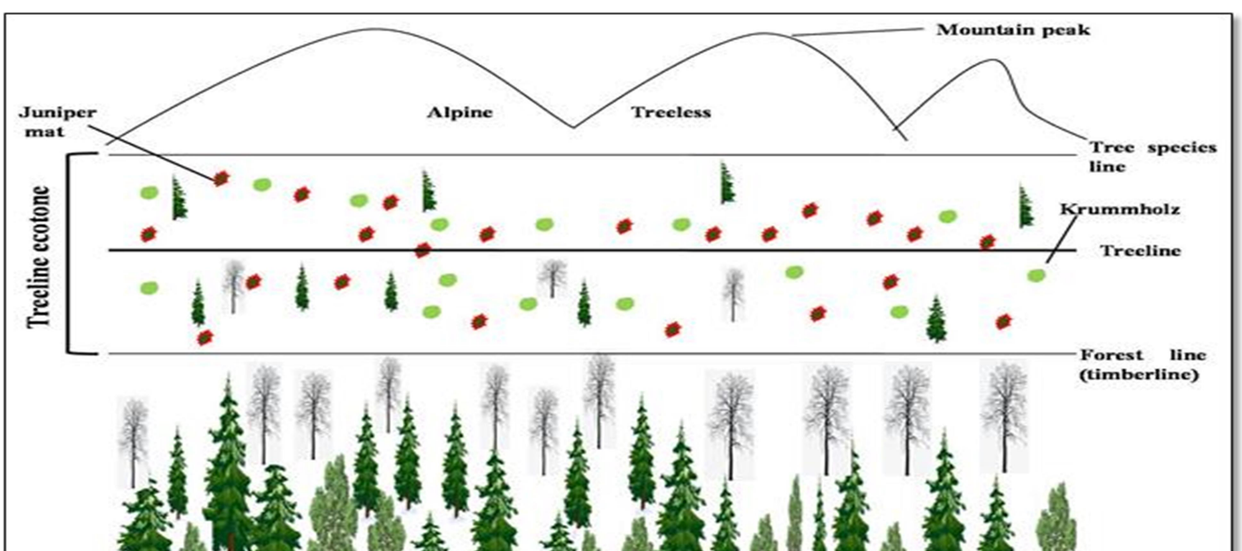

Figure 2: A representation of treeline ecotone in Himalayas, indicating timberline, treeline and tree species line. Amongst scattered tree individuals, patches of krummholz and mats are shown
(Source:Surendra P. Singh, 2018)

elevation in the Himalayas increases from NW to SE along the Himalayan Arc. The drop in latitude from NW to SE (range of around 10° N lat.) is substantially responsible. In a wet condition, treelines are lower globally (Körner, 2012), likely because to the extended stay of snow, which limits tree recruitment. (Korner, 2012) recorded that thegrowth period in treeline in a warm temperate zone (28°–42°N lat) is typically 140–150 days, which is significantly shorter than the growth period in Himalayan treelineecotones (roughly 200 days or more). The Himalayan treelines are closer to the subtropical zone (19°N–19°S) in terms of growth period, with 200–265 days (Körner, 2012).

Climatic factors impacting tree growth and treeline elevation

Temperature is the most important factor in determining treeline elevation, but precipitation can also influence it. The root zone soil temperature (at 10 cm depth) is 6.4±0.7 °C in the growth season and 7.8±1.1 °C in the warmest month on average throughout all bioclimatic areas of the planet. The minimum growing period required for tree growth is 94 days (Körner,2012), however in some parts of the Himalayas, it can be as long as 200 days. In treeline environments, water is often not a limiting factor because low temperatures keep evapo-transpiration loss minimal (Körner, 2012). Other abiotic elements that influence treeline elevation include temperature, elevation mass effect, latitude, geographical position, aspect, nature of slope, wind speed, height of nearby mountains, pre-monsoon drought (March to May), snow cover, and moisture. In Scandinarian mountains, latitude and mountain height together account for 89 % in timberline generated by *Betulapubescens* (Odland, 2015). As a result, in a warming climate, the lack of high mountain ranges above timberlines would limit its uplift (Odland, 2010). Studies on various treeline species, including *Abiesspectabilis*, *A. pindrow, Piceasmithiana, Juniperus sp.,* and *Betulautilis* and others, show that pre-monsoon warmth without additional precipitation negatively affects tree ring growth. Pre-monsoon is a dry and warm period in a monsoon environment, and global warming appears to be making conditions even drier by increasing evapotranspiration loss. Warming in the winter, on the other hand, can help growth by increasing soil water supply due to more snow melt (Gaire*et al.,*2014). The mass elevation effect and the height of the nearby mountains have an impact on treelineelevation (Odland, 2015). A mountain of greater mass differs from the free atmosphere more than a mountain of lesser mass. Without the mass elevation effect, (Zhangand Yao, 2016) predicted that treelines in the Himalayas would not rise over 3500–3700 m elevations. Furthermore, the growth of treeline requires several hundred metres of mountain terrain above the timberline for tree species to move up (Körner, 2012). It's worth noting that, in much of the western Himalayas, treelines aren't always climatic treelines due to centuries of pastoralism. Because pastoralism was significantly less widespread in the eastern Himalayan region (Singh andThadani, 2015), treeline heights there may be closer to climatic treeline elevations, which could explain why treeline elevations in the SE Himalayan region are higher than in the NW region. Pastoralism is now on the decline in many locations, leading in treeline shift upslope (Chhetri *et al.*, 2016). The species composition of the treeline is also influenced by the aspect.

***Betulautilis* community at timberline**

The Himalayan birch belongs to family Betulaceae also known as *Bhojpatra,* is a major tree species on the Indian subcontinent's highlands. It isa long-lived species that can live for over 400 years. The Himalayan birch dominates the timberline zones, which serve as an ecotone or buffer zone between the coniferous forest zone and the sub-alpine and alpine habitats.Traditional hill societies have used these lands for thousands of years, providing vital ecosystem services such as animal grazing, medicinal and aromatic plant collecting, and water resources.This plant prefers to grow in shaded areas on north-facing hills. *B. utilis* is widely dispersed in the NW Himalaya at elevations between 3100 and 3700 m, although its distribution shifts to higher altitudes in the E Himalaya (mainly between 3800 and 4300 m). *B. utilis* thrives in coniferous and rhododendron-rich mixed forests, forming a thin forest belt between coniferous forests below and krummholz forests above (Schickhoff, 2005) (Figure 4). At the topmost limit of subalpine forests, pure birch stands with *Rhododendron campanulatum* and *Sorbusmicrophylla* in the understory are common (Schickhoff*et al.,* 2015).It generally grows in sub-montane to alpine near to moist places with the association of

Cedrusdeodara, *Taxusbaccata, Pinuswallichiana, Asculusindica, Abiespindrow, Acer acuminatum, Sorbusaucuparia, Prunuscornuta and Salix spp*. Figure 3 shows the pictorial views of *Betulautilis*in IHR.

Ethnobotanical Uses

Betulautilis is one of India's most important tree species, employed in a variety of indigenous medical systems and It is utilized in tridosa- 'vata' (air), 'pitta' (phlegm) and 'kaph' (cough). Infusions, powders, pastes, and decoctions are all used to make its herbal medication. Local people in its distribution region have long used *Betulautilis* as a valuable timber for house construction and local bridge construction. It features a dense and hard wood. During their stay at high altitude in the Himalaya, high altitude pastoral groups use its wood for firewood and hut construction. These people also employ the papery bark of *Betulautilis* to make roof tops and umbrella covers (Kala, 2018). Antiseptic and carminative effects are found in bark; outer bark is papery and was once used to create manuscripts (Selvam, 2008). According to(Angmo*et al.,* 2012) Jaundice, burns, leprosy, and bronchitis are all treated with the bark and roots of this plant. Papery barks are used to cover wounds as an antibacterial (Rokaya*et al.,* 2010). Bark Powder taken orally used for leprosy and convulsions; tonic (Mahmood*et al.,* 2012). A bark decoction can help with a sore throat and bark is also used to treat bacterial infections, skin problems, and coughs caused by bronchitis (Baral and Kurmi, 2006).According to (Kumar *et al.,* 2009) the bark decoction is antiseptic carminative used to treat anaemia, cough, obesity, urinogenital disorders, and other infections.(Rokaya *et al.,* 2010) studied that a hole is made in the earth for the storage of food grains, and the sides of the pit are covered with papery barks supported by young branches of *Pinuswallichiana* and food grains are strewn into the pit, which is then covered with soil and preserved for later use. Fever is treated using a mixture of bark and leaves combined with other herbs (Ghimire *et al.,* 2008; Gewali and Awale, 2008).According to (Phondani, 2010; Sharma, 2017) rheumatism, bone fractures, joint pain, swellings, asthma, and blood purification are all treated with the bark, leaves, and resin. The bark is also used to cure domestic animals; it is burned to ashes and then used as a plaster to deep cuts and sores (Sharma, 2017).

Pharmacological uses

Anticancer properties

Botulin, found in*Betulautilis,* is easily converted to betulinicacid.Previous studies have shown that betulinic acid can help slow the progression of malignant melanoma, lung cancer, and liver cancer. Betulinic acid is a well-known neuroectodermal, malignant tumour cell, and human melanoma growth inhibitor andapoptosis is also induced by betulinic acid in these cells. The antitumor cytotoxicity of betulinic acid was studied using a xenograft mouse model in a panel of cancer cells and a primary tumoursample.Betulinic acid has been found to be extremely cytotoxic to malignant melanoma cells. Singh *et al.* (2012) investigates betulinic acid's cytotoxicity in neuroectodermaltumour cells such as Ewing's sarcoma, medulloblastoma, glioblastoma, and neuroblastoma cells.

Anti-HIV properties

It has been observed that many of the betulinic acid derivatives that inhibit HIV infection in the early stages of the viral life cycle. Anti-HIV therapy, which is based mostly on the enzymes protease and transcriptase, is likely to benefit from these drugs (Singh *et al.* 2012).

Antimicrobial properties

Betulinic acid, derived from the bark of B. *utilis*, displays antibacterial action against Citrobacter sp., *Klebsiella pneumoniae*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Proteus mirabilis*, *Salmonella paratyphi*, *Shigellaboydii*, *Shigellasonnei*, *Shigellaflexneri*, *Streptococcus faecalis*, and *Staphylococcus aureus,*it also has an effect on gram-positive bacteria (Kumaraswamy *et al.,* 2008).The bark of a Himalayan birch tree was discovered to be active against *Aspergillusniger* and *Aspergillusflavus* after being dried and kept.

Antioxidant properties

The antioxidant activity of betulinic acid derived from the bark of *B. utilis* has been demonstrated by (Singh *et al.,* 2012) (Figure 5).

Anti-inflammatory properties

Inflammation is the body's reaction to cell damage caused by an external source.The propagation of oxidation of the methanolic and water extracts of

Figure 3: Pictorial views of *Betulautilis*

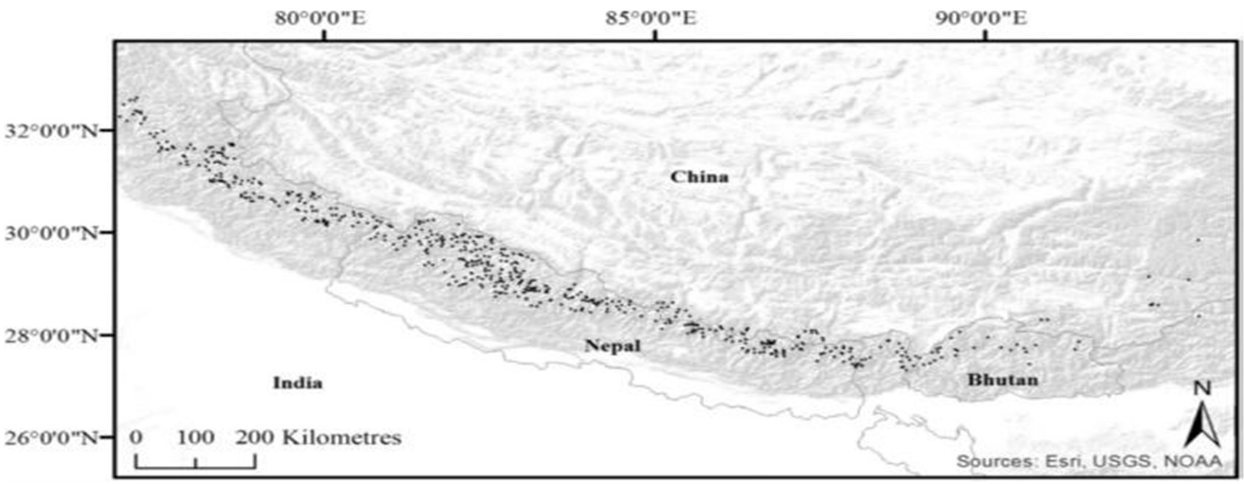

Figure 4: Occurrences of *Betulautilis* in the Himalayan Mountains (Source:Bobrowski *et al.,* 2017)

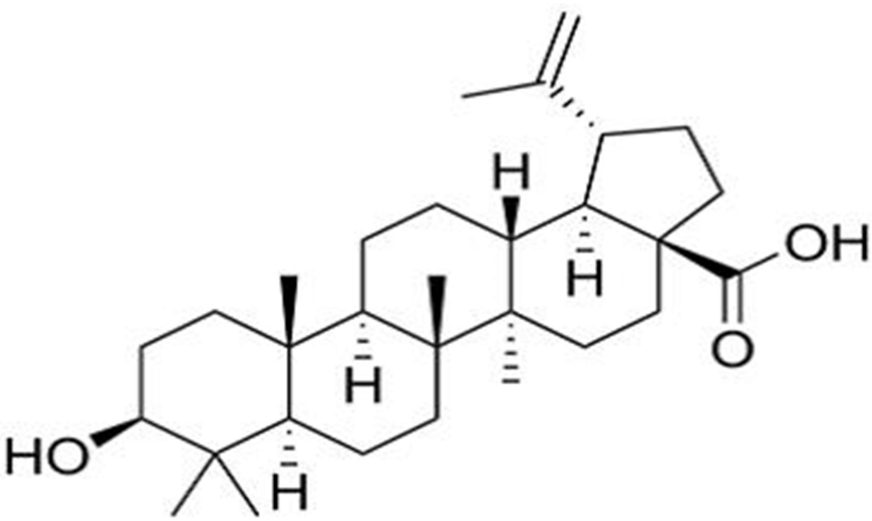

Figure 5: Structure of Betulinic acid-Active constituent of *Betulautilis* (Source:Singh *et al.,* 2012)

Himalayan birch has been observed to block the commencement of free radicals or the chain reaction. This demonstrates that Himalayan birch is effective in the treatment of inflammation.During inhibition, *B. utilis* activity was found to be lower than that of the lipoxygenase enzyme. This has the potential to influence free radicals, reduce inflammation, and so on.Lipoxygenases are particularly sensitive to antioxidants, and they primarily play a role in preventing the production of lipid hydroperoxide by scavenging lipidoxy or lipidperoxy radicals produced during enzymicperoxidation. This may reduce the availability of lipid hydroperoxide substrate for lipoxygenases catalytic cycle (Rackova *et al.,*2007).

Threats to the *Betulautilis* D.Don and the timberline

Anthropogenic pressures such as firewood, timber, and Medicinal and Aromatic Plant species (MAPs), as well as animal grazing, have resulted in significant degradation of timberline forests. For heating and cooking purposes, rural inhabitants rely heavily on *B.utilis* fuel wood(Figure 6).Trees and their regeneration are harmed by harsh weather conditions and longer periods of snow accumulation.At lower and higher timberline, *B. utilis* is continually under threat from villagers cutting down trees for fuel wood, fodder, and stem debarking.At a regional and global scale, the distribution pattern of the species at the timberline zone is projected to change due to rising global temperatures and the natural alpine tree line being controlled by low air temperature, soil temperature, and moisture during the growing season (Holtmeier, 2009; Dimri and Dash, 2012; Korner, 2012; Paulsen and Korner, 2014).The region's rich, diversified, and dynamic forest formations, which contain numerous Rare, Endangered, and Threatened (RET) tree species, require particular management measures in addition to the overall protection offered by the biosphere reserve authority, in the face of such disturbances.If current climatic variability and human disturbance in the timberline ecotone continue and accelerate, it may cause people to move to higher elevations or shift (especially *B. utilis*, which forms the timberline), which has a significant impact on high altitude biodiversity, species composition, and ecosystem balance in the Himalayan region.For forest ecosystems, natural plant generation is a critical ecological activity.This encompasses the progression of life stages from seed to adult plant, as well as the succession of forest ecosystems and their recovery following disturbance. It has important implications both at the population level by determining patterns of species turnover as influenced by interspecific differences in success or recruitment timing under various situations.

Plant regeneration, in turn, alters community dynamics, which is critical for forest biodiversity and ecosystem functioning, as well as conservation planning.Naturally occurring timberlines of the Himalaya are usually influenced by anthropogenic factors, where natural regeneration of dominant tree species is almost negligible. The major reason behind such a condition is long history of human use especially by migratory pastoral communities, who camp around timberline and use alpine meadows for grazing by sheep, goats and cattle.Increased tourism and Cordyceps gathering from high mountain locations are likely to have the exact opposite effect. Every summer, millions of collectors scrape dirt to gather Cordyceps from plant roots in the Alpine meadows and treeline areas of Uttarakhand, Nepal, and Tibet. They trample ground vegetation as well as gather firewood from treeline areas. However, because to increased anthropogenic impact, the treelines in the southern Himalayas are distorted. Researchers have yet to pay attention to *B.utilis* regeneration using forests and spatial patterns of seedling dispersal in the Indian Himalayan Region.Two of the main challenges in developing a management plan for the restocking of these high-mountain forests are a lack of information about the community, the features of this species, and its ecology (Shrestha *et al.,* 2007). ENVIS Centre on Conservation of Medicinal Plants, FRLHT, Bangalore has designated the Himalayan birch *Betula utilis* as a critically endangered tree in Kashmir (Anonymous, 2010). In contrast, the IUCN/SSC Global Trees Specialist Group has classed this species as data deficient in their study (Shaw *et al.,* 2014). Very little information on population dynamics, regeneration, and physiology and seed germination is available from different parts of the country but no any systematic study has been done so far on multipurpose timberline tree species of IHR. As a result, it's critical to keep an eye on these sensitive places and keystone species for future changes caused by climate or anthropogenic pressure, especially in locations where baseline data is scarce.The ease and suitability of propagation methods for this species is also not well documented in the literature. With these limitations in mind, the current study aims to document the state of *Betulautilis* regeneration in the Indian Himalayan region.

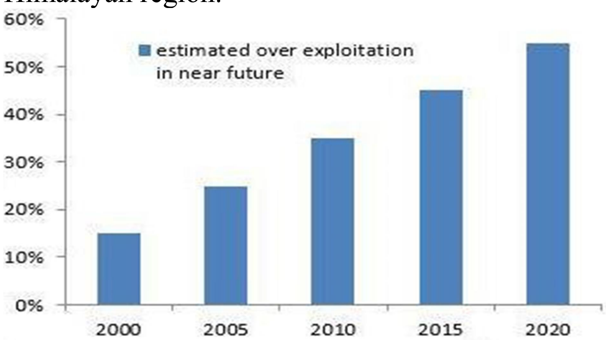

Figure 6: Estimated over-exploitation of *Betulautilis*in near future (Source:Safdar *et al.*, 2017)

Material and Methods

A comprehensive literature search was conducted to collect data on many characteristics of *Betulautilis*, including traditional applications, distribution patterns, population density, and regeneration patterns. Research papers, articles, theses, brochures, monographs, scientific reports, books, book chapters, scientific journals, conference proceedings, and online search engines, among other things, were concerned. Additional papers were located by searching the reference sections of these articles and reports.

Results and Discussion

Harsch and Bader, (2011) found that diffuse treelines, which are formed and maintained primarily by growth limitation, have an earlier, stronger response signal, whereas abrupt, island, and krummholztreelines, which are controlled by seedling mortality and dieback, have a comparatively unresponsive response signal. They confirmed the link between treeline form and dynamics established earlier (Lloyd, 2005; Harsch*et al.,* 2009) and supported the general suitability of treeline form for explaining the variability of response to climate warming. As previously stated, anthropogenic disturbances dominate treeline formations in the Himalaya.Abrupt treelines do occur (for example, Betulatreelines in Nepal's Manang Valley), but they are the result of land use (Shrestha *et al.,* 2007). The vast majority of Himalayan treelines that are less damaged or near-natural, primarily on north-facing slopes, should be classified as krummholztreelines. Diffuse treelines are mostly found in less disturbed or near natural areas in southern areas, and they're becoming increasingly rare. Near-natural Himalayan treelines will not adapt much to climate warming, at least in terms of treeline shifts, because treeline advances have been less prevalent in krummholztreelines (Harsch and Bader, 2011), and responsive dispersed treelines are unusual. Furthermore, near native Himalayan krummholztreelines give way to a dense alpine dwarf scrub heath at their upper limit, putting tree saplings under intense competition. Increased vertical stem growth and seedling recruitment have been documented from several krummholztreelines around the world (Harsch *et al.,* 2009), likely due to changes in snow and winter climate conditions, and can be expected at Himalayan treelines as well.Any upward elevational migration of alpine treelines is contingent on seedling establishment and performance during the early stages of their lives (Holtmeier, 2009; Smith *et al.,* 2009; Zurbriggen *et al.,* 2013). As a result, effective regeneration is regarded as a more important predictor of treeline sensitivity than morphological or physiological responses of older trees (Holtmeier and Broll, 2005). However, when interpreting tree recruitment as evidence of a reaction to recent environmental change, site, climatic, and species-specific regeneration cycles must be considered, as well as robust cause-and-effect analyses (Körner, 2012). A variety of environmental factors and processes affecting seed-based reproduction must be incorporated in respective analyses and associated with seedling establishment, survival, and growth to understand the underlying mechanisms of treeline dynamics. In recent years, a growing number of studies have looked at how treeline seedlings respond to changing environmental factors like soil temperature, soil moisture, soil nutrients, light conditions, herbivory, andcompetition/facilitation (Maher and Germino, 2006; Anschlag*et al.,* 2008; Batllori*et al.,* 2009; Hofgaard *et al.,* 2009; Kabeya, 2010; Munier *et al.,* 2010). In certain research, the relative importance of multiple factors has been clearly addressed (Barbeito*et al.,* 2012; Zurbriggen e*t al.,* 2013). Only a few research on treeline seedlings have been undertaken in the Himalaya to far, and tree recruitment in treelineecotones is poorly characterised (Schickhoff, 2005; Dutta *et al.,* 2014). However, some preliminary evidence about the use of regeneration as a treeline sensitivity indicator can be derived. The majority of seed-based regeneration research has taken place in Nepal. *Betula utilis* treeline forests in Manang Valley, Annapurna Conservation Area, Shrestha *et al.* (2007) discovered, enough generating with a reverse J-shaped diameter distribution. *Betula* seedlings and saplings were common along vertical transects up to an altitudinal distance of 50 m above the tree line. When tree density and basal area exceeded specific threshold values, however, seedlings were unable to establish themselves under their own canopy. Reproductive success was mostly determined by canopy cover (light) and soil moisture. There is a scarcity of detailed information on treeline seed-produced regeneration in other Himalayan sub regions. Some knowledge on regeneration dynamics in lower altitude forests has been acquired in the vast Indian Himalaya, but very little information from treelineecotones has been published. In Garhwal/Uttarakhand, (Gairola*et al.,*2008) documented significant recovery from less degraded high subalpine forests. A recent study by Rai *et al*. (2013) showed intense *Betula utilis* regeneration along treelines in Uttarakhand and Himachal Pradesh, as well as birch seedling invasion of alpine meadows. Effective nursery stock production from seed necessitates a thorough understanding of the germination methods and requirements for the species in question. The propagation needs for birches are poorly understood. This shortfall is attributable in part to a historical lack of demand for this species.Seeds with non-deep physiological dormancy become non-dormant when exposed to either cold (moist) or warm (wet) stratification. Seeds germinate during the start of the growing season when dormancy is broken by cold stratification in late autumn to early spring (Wang*et al.,* 2010).*Betulautilis* seeds taken from high altitudes germinated 90% after 12 weeks and 94 percent after 24 weeks of cold stratification (3000 m) (Wang*et al.,*2010).GA3, on the other hand, is an effective germination stimulant (Lavania*et al.,* 2006; Sofi and Bhardwaj, 2008). It's possible that the maximum germination after 90 days of stratification and 100 ppm GA3 treatment is related to hormone leaching and gibberellin production in seeds during germination (Kumar *et al*., 2014; 2012; Chen*et al.,* 2008).Stratification (Imbibition Followed By Moist Chilling) and GA3 have mostly been described as a strategy to overcome embryo dormancy. Many studies have shown that stratification improves germination speed and uniformity, both of which are critical factors in creating a uniform seedling crop. Certain criteria must be satisfied for stratification and GA3 to be effective in overcoming seed dormancy: an optimum moisture level, temperature, time, and access to oxygen (Mir *et al*., 2018; Sofi and Bhardwaj, 2008; Thapliyal and Gupta, 1980).The *Betulautilis* is increasingly being used to rehabilitate disturbed and degraded sub-alpine zones. However, a significant barrier limiting its usage in restoration is the absence of excellent planting materials due to a lack of knowledge about appropriate propagation procedures for the local environment. Given this, quantitative data on this species growth performance obtained from nursery research is required for species selection and reforestation programmes.One of the approaches available to produce healthy nursery stock is seedlings developed from stratified or GA3 treated seeds (Finch-Savage and Leubner-Metzger, 2006).The effect of GA3 and stratification on growth enhancement could be linked to fat and sugar synthesis and solubilization. Furthermore, the beneficial effects of GA3 and stratification on seed germination may be due to an increase in shoot growth.Gibberellins increase the embryo's growth potential and promote germination, according to (Finch-Savage and Leubner-Metzger, 2006), and are required to overcome the mechanical restraint imposed by the seed covering layers by weakening the tissues surrounding the radical, resulting in increased growth.Because the leaves and roots of *Betulautilis* are genetically invariable in vitro, they can be regenerated via callus, resulting in increased mass propagation of this clone. According to (Zaki *et al.,* 2011), morphogenetic growth was observed in 80 % of *B. utilis* cultures in tissue culture conditions (Figure 7). To ensure the species survival, harvesting must be long-lasting, and conservation methods must be used both *in situ* and *ex situ*. Tissue culture is one of the most promising methods for conserving and mass propagating many essential plants, allowing large-scale plant nurseries to be established. For medicinal plants like *Betulautilis* species, synthetic seed technology can be quite beneficial. Efforts must be made to ensure public engagement in conservation programs and awareness through training or the use of the media, as well as the development of permanent monitoring programs and conservation practices to protect threatened species. Clearing wilderness, chopping, and burning should be minimized as much as possible in order to preserve part of the remaining plant species, biodiversity, and gene pool for the future generation's settlement. Plant nurseries should be used to propagate endangered species, and botanical gardens should be used to preserve them. Because of the ecological and therapeutic value of *Betula utilis*, substantial research on its regeneration status and variables affecting regeneration in the Indian Himalayan Region is required.

Figure 7: Proliferated callus cultures of *Betula* after 4-5 weeks of inoculation (Source: Safdar *et al.,* 2017)

Conclusion

The Himalayas are one of the world's most data-deficient regions, which is a cause for concern because the region is fast rising and is intrinsically sensitive to such drastic changes. The Himalayan treeline is the least studied and appreciated as a conservation component among the many Himalayan regions. The Himalayan birch dominates the timberline zones, which serve as an ecotone or buffer zone between the coniferous forest zone and the subalpine and alpine zones. Trees and their regeneration are harmed by harsh weather conditions and longer periods of snow accumulation. Even if the seed generation was viable, it was clear that *Betulautilis* seedlings could not flourish beneath a closed *B.utilis* canopy.The production of the plant, and thus the continual regeneration of *Betulautilis* in mature stands, may be caused by the partial opening up of the canopy. Seedling establishment of *Betulautilis* beneath its own canopy may be hampered by low light and dense litter. Extremely high elevation Due to shifting climatic circumstances, the Himalayan forest is undergoing significant/dramatic change. Quantifying the existing forest composition and ridge top renewal processes is critical for assessing the significance of climate change in predicting future species coexistence and shifts in the Himalayan range. Warming temperatures on ridge tops may impact species with low and non-recruiting regeneration status and scarce distribution, whereas dominating species with excellent regeneration capability may adapt and relocate in opinionated microclimate. In the current scenario, species with low regeneration status must be identified so that suitable conservation measures may be taken, as they are vulnerable to changing climatic circumstances, which could lead to their extinction and, as a result, a change in the future composition of the ridge tops.Many studies have shown that stratification improves germination speed and uniformity, both of which are critical factors in creating a uniform seedling crop. Certain criteria must be satisfied for stratification and GA3 to be effective in overcoming seed dormancy: an optimum moisture level, temperature, time, and access to oxygen. Although there is limited information on population dynamics, regeneration, physiology, and seed germination from various sections of the country, no comprehensive study on multipurpose timberline tree species of the Indian Himalayan region has been conducted so far. As a result, it is critical to monitor their vulnerable areas and keystone species for future changes owing to climatic or anthropogenic impact, especially in locations where baseline data is scarce.

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