Natural regeneration status and associates of *Ulmus villosa* Brandis from four valley areas of its natural distribution in Himachal Pradesh

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ABSTRACT

The present investigations on natural regeneration status and associates of *Ulmus villosa* Brandis from four valley areas of its natural distribution in Himachal Pradesh were carried out with the objective to study natural regeneration status and associates of *U villosa* in its natural areas of distribution. The study was conducted throughout natural range of distribution of *U villosa* viz Jadh and Jugahan in Balh valley, Jhiri in Kullu valley, Andhra and Jagoti in Pabbar valley and Nichar in Kinnaur valley. To carry out this study quadrates of 10 m x 100 m at each site were laid down of tree and shrub species growing in association with *U villosa*, whereas, twenty quadrates of 2 m x 2 m were laid out per main plot to study the regeneration parameters. There were 19 tree and shrub species growing in association with *U villosa* in the study area. The recruits, unestablished and established plants of *U villosa* showed that maximum number of recruits 625.00/ha (26.55%) were recorded in Jhiri site of Kullu valley. Similarly, the maximum number of unestablished plants were found 375.00/ha (27.52%) in Jhiri site of Kullu valley. However, there were no established plants recorded from the studied sites in all the four valleys. The regeneration establishment and stocking data revealed that the maximum height of unestablished regeneration for *U villosa* was in Jadh site (1.28 m) from Balh valley while the minimum height was for Jagoti site (0.22 m) from Pabbar valley. The establishment index and establishment stocking percentages were recorded to be zero per cent in the studied sites from all the four valleys. The regeneration success percentage was recorded maximum in Jhiri site (3.75) of Kullu valley and minimum in Jugahan site (1.22) of Balh valley.

Keywords: *Ulmus villosa*; natural regeneration; stocking index; regeneration success

INTRODUCTION

Nature has endowed Earth with life and diversity but human dominance markedly reduced the diversity within habitats worldwide, thereby, accelerating extinction (Tilman 2000). The International Union for Conservation of Nature and Natural Resources (IUCN) has estimated about 10 per cent of the vascular plants of the globe to be under threat. In response, IUCN red listed species under different threat categories for their conservation and management. It provides a quantitative measure of extinction risk and is one of the most effective sources of information for conservation and planning (Lamoreux et al 2003). Changes on the red list often reflect the changes in the actual status of species (Cuaron 1993). Changes in evaluation of taxa came through improved knowledge of habitat (Samways and Grant 2007) distribution, population status and particularly information on regeneration status. While there is much discussion about the threat and conservation of biodiversity, there has been almost no attention given to species other than economically important (eg timber) species. The importance of all other species which help in maintaining ecosystem structure and functions has been neglected (Shankar et al 1998).

Ulmus villosa Brandis, belonging to family Ulmaceae, is commonly known as Marinoo in Balh valley, Marn in Kullu and Pabar valleys and Moldung

in Sutlej valley of Himachal Pradesh. It is a tree species up to 25 m of height with a girth up to 13.7 m and the branches somewhat pendulous, bark of young trees and branches pale grey, smooth with transversely elongated lenticels, on old trees coarsely longitudinally furrowed sometimes with interweaving ridges and the base of the trunk strongly buttressed, suckers and epicormic shoots rarely produced (Melville and Heybroek 1971). It is one of the most distinctive Asiatic elms and a species of remarkable longevity (Singh 1991).

The species is highly valued for its multiple uses of timber, fuel and cattle fodder (Lone et al 2018) for which it is a preferred species (Samant et al 2007). It is considered one of most important agroforestry tree species and has great potential outside its natural range for use on degraded land (Bhardwaj and Mishra 2005). It is considered one of most important agroforestry tree species for the valleys and the mid-hill agro-ecosystems.

The species is found in 5B/C2 North mixed deciduous forest with major group – dry tropical forest type, Group-5 Tropical dry deciduous forest, Sub-Group-5B-North tropical dry deciduous forest (Bhardwaj and Mishra 2005). The main area of distribution of *U villosa* is somewhat restricted. In Himachal Pradesh on the route from the Beas to the Sutlej valley, it was common from Mandi to Bilaspur and extended up to the divide at Sundernagar where it has been abruptly stopped. The reasons for sudden cut out are obscure. It was not seen wild in the parts of the Sutlej valley visited between Rampur and Wangtoo, although there are collections in herbaria from the valley. Some of these records can be accounted for by human introduction and protection as at Nichar, where the trees in front of the temple are clearly planted and close to a sacred *Cedrus deodara*. Outside the central distribution area the southernmost record is from the Pabar valley (Melville and Heybroek 1971).

Deforestation is occurring across the species range at an alarming rate with habitat being lost as a result of road construction and urbanization. The species is also overused as cattle fodder with the species on the verge of extinction as a consequence (Anon 2020). *U villosa* has most recently been assessed for the IUCN red list of threatened species and is listed as vulnerable (Crowley and Rivers 2021). Hence, the present study was carried out with the objectives to study natural regeneration status and associates of *U villosa* in its natural areas of distribution in Himachal Pradesh.

MATERIAL and METHODS

The selection of the site was carried out on the basis of presence of *U villosa* stands for the study purpose. The study sites selected for the present study included six sites from four different valleys viz Balh, Kullu, Pabbar and Kinnaur of Himachal Pradesh (Table 1).

Quadrates of 10 m x 100 m at each site were laid down for the study of tree and shrub species growing in association with *U villosa*. The regeneration

Table 1. Geographical details of sites of *Ulmus villosa* Brandis in its natural areas of occurrence from four valleys of Himachal Pradesh

Valley	Site	Altitude (m)	Latitude/longitude
Balh	Jadh	800	N 31°.43'.353"
			E 77°.59'.020"
	Jugahan	1,080	N 31°.42'.975"
			E 77°.59'.240"
Kullu	Jhiri	1,289	N 31°.43'.075"
			E 77°.58'.140"
Pabbar	Andhra	2,200	N 31°.41'.725"
			E 78°.51'.910"
	Jagoti	1,824	N 31°.44'.125"
			E 78°.71'.210"
Kinnaur	Nichar	2,400	N 31°.35'.425"
			E 78°.09'.610"

survey was carried out in all the sample plots in all the selected sites. In each major sample plot (10 m x100 m), twenty quadrates of the size 2 m x 2 m were laid out. Total 2,500 established plants per hectare were considered to express satisfactory regeneration. Similarly, the quadrate was considered fully stocked when it contained at least one established plant (Chacko 1965).

The survey was conducted for recruits (defined as current years seedlings), unestablished regeneration (seedlings other than recruits which were not yet established and the height was less than 2 m). Here, four unestablished plants were taken equivalent to one established plant and established regeneration having height of more than 2 m.

The regeneration data for *U villosa* and associated species were collected on the basis of number of individuals occurring at seedling, sapling and pole stages in each quadrate. The height of unestablished plants was also measured for the assessment of regeneration (Champion 1935).

Regeneration assessment

The collected data were analyzed by using the formulae given by Chacko (1965) as follows:

$$\text{Recruits (r)/ha} = 2500 \sum_{i=1}^{n} \frac{ri}{m}$$

$$\text{Unestablished regeneration (u)/ha} = 2500 \sum_{i=1}^{n} \frac{ui}{m}$$

$$\text{Established regeneration (e)/ha} = 2500 \sum_{i=1}^{n} \frac{ei}{m}$$

where n = Number of sampling units, m = Total number of recording units in survey, ri = Total number of recruits in each sampling unit, ui = Total number of unestablished plants in each sampling unit, ei = Total number of established plants in each sampling unit

$$\text{Weighted average height (m)} = \frac{\text{Total height of unestablished regeneration} + \text{Number of established plants} \times \text{Established plants}}{\text{Total unestablished plants} + \text{Total established plants}}$$

On the basis of above estimates following indices were calculated:

$$\text{Establishment index } (I_1) = \frac{\text{Weighted average height}}{\text{Established height}}$$

$$\text{Stocking index } (I_2) = 1/2500 \times \frac{\text{Unestablished regeneration/ha}}{4} + \text{Established regeneration/ha}$$

$$\text{Established stocking (\%)} = 100\ (I_1 \times I_2)$$

$$\text{Regeneration success (\%)} = \text{Stocking index } (I_2) \times 100$$

RESULTS and DISCUSSION

Associates of *U villosa*

The list of trees and shrubs growing in association with *U villosa* is given in Table 2. The data show that there were 19 tree and shrub species presently growing in association with *U villosa* in the study area of which 12 species were present in each of Jadh, Jugahan and Jhiri sites and 11 species in Andhra and Jagoti sites whereas 7 species were present in Nichar site.

The results (Table 3) reveal that maximum number of recruits were recorded from Kullu valley in Jhiri site 625.00/ha (26.55%) followed by Jadh site 487.80/ha (20.73%) from Balh valley and Andhra site 375.00//ha (15.93%) from Pabbar valley. Minimum number was recorded with number of recruits 250.00/ ha (10.62%) from Nichar site of Kinnaur valley and Jagoti site of Pabbar valley each. However, Jugahan site of Balh valley was number of recruits with 365.85/ ha (15.54%). Similarly, the maximum number of unestablished plants was found 375.00/ha (27.52%) in case of Jhiri site of Kullu valley followed by unestablished plants with number 365.85/ha (26.85%) and 250.00/ha (18.34%) in case of Jadh site of Balh valley and Andhra site of Pabbar valley respectively. Minimum number of unestablished plants 121.95/ha (8.95%) was found in Jugahan site of Balh valley. Nichar site of Kinnaur valley and Jagoti site of Pabbar valley were number of unestablished plants with 125.00/ha (9.17%) each. However, there was no established plant recorded from the studied sites in all the four valleys.

Table 2. Associates of *Ulmus villosa* in different study sites from four valleys of Himachal Pradesh

Associate	Sites selected in valleys					
	Balh		Kullu Jhiri	Pabbar		Kinnaur Nichar
	Jadh	Jugahan		Andhra	Jagoti	
Alnus nitida	-	-	+	+	+	+
Sapindus sebiferum	+	+	-	-	-	+
Populus deltoids	-	-	+	+	+	+
Celtis australis	+	+	+	-	-	-
Melia azedarach	+	+	-	-	-	-
Toona ciliate	+	+	+	-	-	-
Salix alba	-	-	-	+	+	+
Bauhinia variagata	+	+	+	-	-	-
Dalbergia sissoo	+	+	+	-	-	-
Juglans regia	-	-	-	+	+	-
Morus alba	-	-	-	+	+	-
Pistacia integerrima	+	+	+	-	-	-
Ficus palmate	+	+	+	-	-	+
Pinus wallichiana	-	-	-	+	+	-
Pyrus pashia	+	+	-	+	+	-
Robinia pseudocacia	-	-	+	+	+	-
Prinsepia utilis	+	+	+	+	+	+
Berberis lycium	+	+	+	+	+	+
Rosa moschata	+	+	+	+	+	-
Total	12	12	12	11	11	7

(+) = Present, (-) = Absent

Table 3. Regeneration status of *Ulmus villosa* in different study sites from four valleys of Himachal Pradesh

Valley	Site	Recruits number (%)	Unestablished number (%)	Established number
Balh	Jadh	487.80 (20.73)	365.85 (26.85)	0.00
	Jugahan	365.85 (15.54)	121.95 (8.95)	0.00
Kullu	Jhiri	625.00 (26.55)	375.00 (27.52)	0.00
Pabbar	Andhra	375.00 (15.93)	250.00 (18.34)	0.00
	Jagoti	250.00 (10.62)	125.00 (9.17)	0.00
Kinnaur	Nichar	250.00 (10.62)	125.00 (9.17)	0.00
Total		2,353.66	1,362.8	0.00

Figures in parentheses are per cent values

Regeneration establishment and stocking

Persual of data given in Table 4 shows the regeneration establishment and stocking data for different sites. The data reveal that the maximum height of unestablished regeneration for *U villosa* was in Jadh site from Balh valley (1.28 m) followed by Jugahan site (0.96) from Balh valley. The minimum height of unestablished regeneration recorded was for Jagoti site (0.22 m) from Pabbar valley. The establisment index and establishment stocking percentages were recorded to be zero in the studied sites from all the four valleys. The regeneration success percentage was recorded maximum in Jhiri site (3.75) of Kullu valley and minimum in Jugahan site (1.22) of Balh valley.

Table 4. Establishment and stocking data of *Ulmus villosa* in different study sites from four valleys of Himachal Pradesh

Valley	Site	Height of unestablished regeneration (m)	Weighted average height (m)	Establishment index	Stocking index	Establishment stocking (%)	Regeneration success (%)
Balh	Jadh	1.28	0.21	0.00	3.66	0.00	3.66
	Jugahan	0.96	0.48	0.00	1.22	0.00	1.22
Kullu	Jhiri	0.84	0.28	0.00	3.75	0.00	3.75
Pabbar	Andhra	0.44	0.22	0.00	2.50	0.00	2.50
	Jagoti	0.22	0.22	0.00	1.25	0.00	1.25
Kinnaur	Nichar	0.32	0.32	0.00	1.25	0.00	1.25
Total		4.06	1.73	0.00	12.38	0.00	13.63

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