

DEMOGRAPHIC ANALYSIS OF UNDERGROWTH VEGETATION UNDER *POPULUS TREMULOIDES* MICHX., FORESTS IN NORTH AMERICA*

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Introduction

Populus tremuloides Michx. (Quaking aspen, Trembling aspen, Golden aspen, Mountain aspen, Poplar, Popple) is a small to medium-sized tree and is most widely distributed in North America (Sargent, 1890; Little, 1971). It is a deciduous tree which belongs to family Salicaceae and has a wide range (Weigle and Fronthingham, 1911). It grows on many soil types, especially sandy and gravelly slopes and it is quick to pioneer disturbed sites where there is bare soil. This fast growing tree is short lived and pure stands are gradually replaced by slower-growing species (Perala, 1990). It is one of the few plant species that can grow in all mountain vegetational zones from the alpine to the basal plain (Daubenmire, 1943). As a consequence, *P. tremuloides* dominated communities are found intermixed with such divergent vegetation as semi-arid shrublands and wet Spruce Fir forests. The broad latitudinal and environmental range of *P. tremuloides* brings it into association with a diversity of other plant species. Consequently, undergrowth composition varies from place

to place and reflects both regional floristics and adjacent vegetation type (Mueggler, 1985). Many attempts have been made to examine undergrowth demography (Saxena *et al.*, 1978; Tiwari and Singh, 1981; Pandey and Singh, 1981a; Saxena and Singh, 1982; Joshi *et al.*, 1999; Bankoti *et al.*, 1992; O'Connor, 1993; Lieberman *et al.*, 1996; Bahar and Jain, 1996). Undergrowth is an important component of forests which influences the microclimate at forest floor, affects tree seedling establishment and provides browsing to wildlife. It also plays a major role in the nutrient cycle, ecological, hydrological balance and improves the productivity of the site (Marston, 1952; Meeuwig, 1970; Gulloin, 1977b; Yarie, 1980; Mathur and Soni, 1983; Bahuguna, 1990; Joshi *et al.*, 1999).

The present study was carried out in the months of May, June and July, 1997 and deals with demography of undergrowth under *P. tremuloides* forest at Site I (Utah), Site II (Idaho) and Site III (South Dakota) in North America.

*This study was conducted during May-July 1997 under FREEP in North America.

Material and Methods

The study was carried out in three sites on the basis of stand density, topography, aspect and biotic pressure. Vegetation structure of the forest undergrowth was analysed by quadrat method (Misra, 1968). The sampling size of shrubs was taken as 5x5 m² and for herbs

1x1 m². The study of shrubs was conducted with the help of laying 25 quadrats on each site and 50 quadrats were laid randomly for herbaceous vegetation study in each site during the months of May, June and July, 1997. Vegetation structure was evaluated by analysing the frequency, density and Importance Value Index (IVI) according to Misra (1968). The

Table 1

Comparative distribution and Importance Value Index (IVI) of undergrowth vegetation under Populus tremuloides forest at three sites in North America

Species	Site I (Utah)	Site II (Idaho)	Site III (S. Dakota)
1	2	3	4
<i>Achillea millefolium</i>	+ (8.92)	+ (5.59)	-
<i>Agastache urticifolia</i>	+ (9.52)	-	-
<i>Agropyron subsecundum</i>	+ (14.31)	+ (23.81)	-
<i>A. trachycaulum</i>	+ (9.42)	-	-
<i>Amelanchier alnifolia</i>	+ (9.92)	-	-
<i>Aquilegia coerulea</i>	+ (8.12)	-	+ (49.53)
<i>Artemisia tridentata</i>	-	+ (34.30)	-
<i>Aster engelmannii</i>	+ (5.12)	-	-
<i>A. laevis</i>	-	-	+ (6.07)
<i>Berberis repens</i>	+ (30.87)	-	+ (45.53)
<i>Bromus anomalus</i>	+ (28.17)	-	-
<i>B. marginatus</i>	+ (19.20)	-	-
<i>Calamagrostis rubescens</i>	+ (8.55)	-	-
<i>Carex geyeri</i>	-	+ (17.87)	-
<i>Elymus glaucus</i>	+ (10.30)	-	-
<i>Festuca idahoensis</i>	-	+ (9.94)	-
<i>Fragaria ovaalis</i>	-	-	+ (28.78)
<i>F. virginiana</i>	-	+ (9.13)	-
<i>Galium boreale</i>	-	-	+ (6.28)

Contd...

1	2	3	4
<i>Geranium</i> spp.	+(8.37)	-	-
<i>G. viscosissimum</i>	-	+(14.70)	-
<i>Hydrophyllum capitatum</i>	-	+(6.13)	-
<i>Lathyrus ochroleucus</i>	-	-	+(14.94)
<i>Lathyrus</i> spp.	+(2.48)	-	-
<i>Lupinus</i> spp.	-	+(7.49)	-
<i>Monarda fistulosa</i>	-	-	+(12.07)
<i>Oryzopsis asperifolia</i>	-	-	+(17.92)
<i>Osmorhiza occidentalis</i>	-	+(12.33)	-
<i>Osmorhiza</i> spp.	+(2.23)	-	-
<i>Pachistima myrsinites</i>	+(23.50)	-	-
<i>Poa nervosa</i>	-	+(23.56)	-
<i>P. pratensis</i>	-	-	+(9.51)
<i>Potentilla glandulosa</i>	-	+(9.76)	-
<i>Prunus virginiana</i>	+(12.58)	-	-
<i>Rosa nutkana</i>	+(9.79)	-	-
<i>R. woodsii</i>	+(3.17)	-	+(35.44)
<i>Rudbeckia occidentalis</i>	+(4.36)	-	-
<i>Senecio serra</i>	+(2.39)	+(6.48)	-
<i>Shepherdia canadensis</i>	+(5.07)	-	-
<i>Smilacina stellata</i>	-	+(5.70)	+(2.55)
<i>Spiraea lucida</i>	-	-	+(31.64)
<i>Stipa columbiana</i>	-	+(19.71)	-
<i>Symphoricarpos albus</i>	+(26.39)		+(27.09)
<i>S. oreophilus</i>	+(22.34)	+(69.77)	-
<i>S. vacciniodes</i>	+(8.66)	-	-
<i>Thalictrum fendleri</i>	+(4.34)	-	-
<i>T. occidentale</i>	-	+(18.21)	-
<i>T. venuloum</i>	-	-	+(10.31)
<i>Valeriana occidentalis</i>	+(1.91)	-	-
<i>V. sitchensis</i>	-	+(5.52)	-
<i>Vicia americana</i>	-	-	+(2.34)

Figures in parenthesis are the value of Importance Value Index (IVI) of that species.

(+) Presence of the species, (-) Absence of the species

value of (IVI) was computed by the summation of the value of the relative frequency, relative density and relative dominance (Curtis and McIntosh, 1951). One hundred trees were measured for different morphological characteristics of *Populus tremuloides* in each study site (Table 3).

Results and Discussion

Site I (Utah) : A total of 27 plant species have been recorded from this site. The site

is characterised by *Berberis repens* as the dominant species having highest Importance Value Index (30.87), *Bromus anomalus* was co-dominant species with IVI (28.17). Other important species recorded in order of their IVI were *Symphoricarpos albus* (26.58), *Pachistisma myrsinites* (23.50), *Symphoricarpos oreophilus* (22.34), *Bromus marginatus* (19.20), *Agropyron subsecundum* (14.31), *Prunus virginiana* (12.58), *Elymus glaucus* (10.30), *Amelanchier alnifolia* (9.92), *Rosa nutkana* (9.79), *Agastache urticifolia*

Table 2

Comparative account of undergrowth recorded under P. tremuloides

Location	Type of undergrowth recorded			Total species
	Shrubs	Grasses	Forbes	
Site I (Utah)	10 (37.04)	6 (22.22)	11 (40.74)	27
Site II (Idaho)	2 (11.11)	5 (27.78)	11 (61.11)	18
Site III (S. Dakota)	5 (33.33)	2 (13.33)	8 (53.34)	15

Table 3

Morphological characteristics of P. tremuloides

Location	Stand (ha ⁻¹)	G.B.H. (cm)	Crown area (m ²)	Height (m)
Site I (Utah)	1135	96.37 ± 12.30 (22.90 - 144.72)	110.75 ± 21.27 (47.25 - 153.74)	21.65 ± 5.24 (6.68 - 28.21)
Site II (Idaho)	1477	79.22 ± 8.91 (9.13 - 112.54)	90.21 ± 5.43 (5.72 - 124.55)	19.92 ± 3.19 (3.42 - 26.50)
Site III (S. Dakota)	1862	59.94 ± 5.72 (7.22 - 103.92)	78.44 ± 4.76 (4.85 - 109.67)	26.71 ± 7.33 (6.21 - 34.53)

Figures in parenthesis are minimum and maximum values of that character.

± is the Standard Deviation

(9.52), *Agropyron trachycaulum* (9.42), *Achillea millefolium* (18.92), *Symphoricarpos vacciniodes* (8.66), *Calamagrostis rubescens* (8.55), *Geranium* spp (8.37), *Aquilegia coerulea* (8.12), *Aster engelamanii* (5.12), *Shepherdia canadensis* (5.07), *Rudbeckia occidentalis* (4.36), *Thalictrum fendleri* (4.34), *Rosa woodsii* (3.17), *Lathyrus* spp. (2.48), *Senecio serra* (2.39), *Osmorhiza* spp (2.23) and *Valeriana occidentalis* (1.91) had least contribution in formation of this community (Table 1).

Site II (Idaho) : In all 18 plant species have been recorded from this site. *Symphoricarpos oreophilus* was the dominant species having highest Importance Value Index (69.71). *Artemisia tridentata* was co-dominant species with IVI (34.30). Other species recorded in order of their IVI were *Agropyron subsecundum* (23.81), *Poa nervosa* (23.56), *Stipa columbiana* (19.21), *Thalictrum occidentale* (18.21), *Carex geyeri* (17.87), *Geranium viscosissimum* (14.70), *Osmorhiza occidentalis* (12.33), *Festuca idahoensis* (9.94), *Potentilla glandulosa* (9.76), *Fragaria virginiana* (9.13), *Lupinus* spp (7.49), *Senecio serra* (6.48), *Hydrophyllum capitatum* (6.13), *Smilacina stellata* (5.70), *Achillea millefolium* (5.59) and *Valeriana sitchensis* (5.52) was recorded least in contribution in formation of this community (Table 1).

Site III (South Dakota) : Vegetation of this site was represented by 15 plant species. *Amelanchier alnifolia* was found dominant plant species having maximum Importance Value Index (49.53) at this site. *Berberis repens* having IVI (45.53) was co-dominant species. Other important species recorded in order of their IVI were *Rosa woodsii* (35.44), *Spiraea lucida* (31.64), *Fragaria vallis* (28.78), *Symphoricarpos albus*

(27.09), *Oryzopsis asperifolia* (17.92), *Lathyrus ochroleucus* (14.94), *Monarda fistulosa* (12.07), *Thalictrum occidentale* (10.31), *Poa pratensis* (9.51), *Galium boreale* (6.28), *Aster laevis* (6.07), *Smilacina stellata* (2.55) and *Vicia americana* (2.34) was recorded least in contribution in formation of this community (Table 1).

The total number of species recorded was 27, 18 and 15 at Site I (Utah), Site II (Idaho) and Site III (South Dakota) respectively. The contribution of Forbs was recorded maximum (40.74%) followed by Shrubs (37.04%) and Grasses (22.22%) at Site I (Utah). However, at Site II (Idaho), the contribution of Forbs was recorded maximum (61.11%) followed by Grasses (27.78%) and Shrubs (11.11%). At Site III (S. Dakota), highest contribution was found by Forbs (53.34%) followed by Shrubs (33.33) and Grasses (13.33%). Site I (Utah) included 10 Shrubs species whereas two Shrub species only were recorded at Site II (Table 2). It is evident from the results that the undergrowth vegetation showed considerable variation at all three studied sites. Maximum number of species was recorded at Site I (Utah) followed by Site II (Idaho) and Site III (S. Dakota) respectively. It can be attributed to the relatively less stand density at Site I (Utah) as compared to Site II (Idaho) and Site III (S. Dakota). The higher stand density enables more light, radiation and rain to reach the ground floor which explains higher genetic diversity and plant population. Similar observations have been reported by Mathur and Soni (1983); Bahar and Jain (1996) under *Eucalyptus* plantation. Comparative account of undergrowth vegetation clearly indicates that *Populus tremuloides* forest supports more luxurious undergrowth at Site I (Utah).

as compared to Site II (Idaho) and Site III (S. Dakota) in North America. Availability of nutrients to plants which may affect the presence or absence of associated species in the system (Gargya *et al.*, 1998). Biotic interference is the most important determinant of variability in structure of vegetation (Joshi *et al.*, 1999). In forests undergrowth vegetation, canopy, soil moisture and sunlight are the important limiting factors. The herbaceous vegetation is sparse during rainy and winter season. This may be probably due to closed canopy of the forest with a minimum supply of sunlight and maximum supply of moisture (Joshi *et al.*, 1999). The present

investigations showed that highest number of herbaceous species (17) were recorded at Site I (Utah). However, Site III (S. Dakota) supports least number of herbaceous vegetation (10). The herbaceous undergrowth is thus the outcome of soil moisture conditions, sunlight, canopy, topography and various rates of grazing stresses on various sites (Singh and Misra, 1969). The present study indicates that under the influence of biotic, stand density and edaphic factors, the vegetation character tends to change considerably. On the other hand, unpalatable plant species would result under the influence of biotic factors in all study sites.

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SUMMARY

The present paper deals with the demographic analysis of undergrowth under *Populus tremuloides* Michx. forest at Site I (Utah), Site II (Idaho) and Site III (South Dakota) in North America. 51 plant species were recorded from three sites. Total number of plant species was recorded 27, 18 and 15 at Site I, Site II and Site III respectively. Maximum number of Shrubs (10) were recorded at Site I (Utah) and minimum number (2) was recorded at Site II (Idaho). The highest IVI recorded was of *Berberis repens* (30.87), *Symphoricarpos oreophilus* (69.77) and *Amelanchier alnifolia* (49.53) shrubs at Site I, Site II and Site III respectively. Higher stand density enables light, radiation and rain to reach ground floor, which affects demography of the undergrowth.

उत्तरी अमेरिका के पोपुलस ट्रेमुलायडिस मिश्र. वनों की अधोवृद्धि वनस्पतियों का गणनात्मक विश्लेषण

एन० बहार

सारांश

प्रस्तुत अभिपत्र में उत्तरी अमेरिका के स्थल I (ऊटाह), स्थल II (इडाहो) और स्थल III (दक्षिण डाकोटा) में लगे हुए पोपुलस ट्रेमुलायडिस मिश्र. वनों की अधोवृद्धि वनस्पतियों का गुणनात्मक विश्लेषण विवेचित किया गया है। तीनों स्थलों से मिला 51 जातियां उल्लिखित की गईं। स्थल I, स्थल II और स्थल III से क्रमशः 27, 18 व 15 पादप जातियां

उल्लिखित की गई। क्षुणों की अधिकतम (10) संख्या I (ऊटाह) से तथा न्यूनतम (2) संख्या स्थल II (इडाहों) से उल्लिखित हुई। सर्वाधिक आन्तरिक नाडीयन निर्देशांक स्थल I स्थल II व स्थल III से क्रमशः बर्बेरिस रेपेंस (30.87), सिम्फोरिकार्पोस ओरियोफिसल (69.77) तथा एमेलैनेशियर एल्टिफोलिया (49.33) का रहा। अधिक वृक्ष घनत्व होने से प्रकाश, विकिरण और वर्षा भूमितल तक पहुंच जाती है जो अधोवृद्धि की संख्या को प्रभावित करते हैं।

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