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TREE INVASION OF LIGHT GAPS IN REESE'S SWAMP

PLANT ECOLOGY - UMBS

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ABSTRACT: The purpose of my experiment was to test if there is a relationship between the density of tree species ≥ 1 m within light gaps and the density of tree species of potential seed-bearing age adjacent to the light gaps. Data (was) were collected for four light gaps > $25 m^2$ in a 2.5 ha section of Reese's Swamp, Cheboygan, County, Michigan. Balsam fir (Abies balsamea) and Red maple (Acer rubrum) are the principal tree species that invade the two size-classes of gaps; small($219\ m^2$) and large ($449\ m^2$), within my study area. Balsam fir was a dominant or codominant species within a 5 m belt around the periphery of only small gaps while Red maple was sampled as dominant or codominant in the periphery of small and large gaps. Balsam fir had a higher individual recruitment of trees ≥ 1m in small gaps than Red maple, while there was an even distribution of each species within large gaps. Conclusion

INTRODUCTION

The rate at which gaps occur and the tree species invading these gaps can have a decided effect on tree-species heterogeneity in a given stand over a given time.

The transient pulses of resources produced by natural disturbances represent a distinctly different pattern to which plant species can respond. Traits traditionally associated with the response of woody plants to disturbance (e.g. rapid growth rates, small size, and early reproduction) appear to facilitate the exploitation of such pulses of resources (Canham and Marks 1985).

I hypothesized that the density of Balsam fir and Red maple within the light gaps is related to the presence of potential Balsam fir and Red maple seed trees within a 5 m peripheral zone of undisturbed vegetation adjacent to the light gap.

MATERIALS AND METHODS

My study was conducted in the SE 1/4 of the NW 1/4, Sec 3, T37N, R3W, Cheboygan County.

The major soil within my study area is Rifle Peat. Rifle Peat consists of dark brown or brown rather coarse moderately decayed woody peat ranging from 1 to 2 feet in thickness. Rifle Peat is generally acid in reaction, very high in organic matter, and contains very little admixed mineral matter (Foster et al. 1939).

Principal tree species noted in my study area include Northern White Cedar (Thuja occidentalis), White Spruce (Picea glauca), Black Spruce (Picea mariana), Balsam fir (Abies balsamea), Red Maple (Acer rubrum), Quaking Aspen (Populus tremuloides), and White Pine (Pinus strobus). Mountain maple (Acer spicatum) is encountered as an understory shrub in many light gaps.

Three transects 50 m long were run perpendicular to a 100m north/south baseline. Transects were placed at 30 m intervals along the baseline.

Gaps $\geq$25 m^2 encountered on transects were sampled. Belt transects 2 m wide were run along the mid-line of the long axis of each gap with all individuals $\geq$ 1 m tallied. Because of the common occurrence of Mountain maple within gaps, individuals $\geq$ 1m were tallied.

Belt transects 5 m wide were run around the periphery of each gap. Each dominant or codominant Balsam fir and Red maple potential seed tree within the 5 m zone was tallied and other species noted.

The area of the gaps was determined using a closed traverse, which entails taking a series of compass bearings and distances around a gap starting and finishing at the same point. A generated map is divided into triangles whose summed areas equal the area of the gap.

Data (was) were collected for gaps 193 m^2, 245 m^2, 420 m^2 and 479 m^2. Because of insignificant density of potential seed trees in the peripheral zone inferential treatment of density tables replaced a contingency analysis.

Analysis of data was conducted on two gap size-classes. The average of combined small gaps was 219 m^2 (Table 1) while the average of combined large gaps was 449 m^2 (Table 2).

RESULTS

In gaps that averaged 219 m^2 Balsam fir comprised 71% of the gap individuals while Red maple totaled 7% (Table 1). All other species combined comprised 22% of the total, of which 47% were Mountain maple. Balsam fir and Red maple each comprised 7% of the peripheral zone trees, while all other species totaled 86%, of which 67% were Northern white cedar.

In gaps averaging 449 m^2, the composition inside the gap was Balsam fir 47%, Red maple 45%, and other species 8%. In the periphery zone of the gaps, Balsam fir was not present, Red maple comprised 7%, and all other species were 93%, of which 59% were Northern white cedar.

DISCUSSION

Dispersal ability of Balsam fir allows it to invade small and large gaps though it may be absent in the peripheral zone of large gaps.

Though Red maple has an even distribution with Balsam fir in the periphery of small gaps it represents only 7% of the $\geq$ 1m individuals while Balsam fir comprises 70%. In spite of Red maple's dominance in the periphery of large gaps it shares with Balsam fir a 1:1 ratio of $\geq$1 m individuals inside the gap. I feel there is no direct relationship between Balsam fir and Red maple invasion of gaps and the presence of Balsam fir and Red maple seed trees in the periphery of the gaps.

The natural history aspects of Balsam fir and Red maple aid in explaining their position as gap colonizers.

Balsam fir can set seed at 15 years but best production occurs after 30 years. It's seeds are dropped in late summer and fall and germinate immediately or lie (dominant) until spring (Fowells 1965). Balsam fir's shade tolerance gives it the ability to invade micro-gaps created by a leaning or fallen canopy tree.

It is a moderately short-lived tree, and as it reaches the age of 50 to 60 years, it becomes increasingly susceptible to a variety of stresses, particularly to pathogens (Sprugel 1948).

As mortality occurs, disturbance by wind creates or expands existing gaps. This single and multiple gap process influences the size of the gap and species invading the gaps.

"Species may be able to reach the canopy fairly often by using a series of small gaps rather than a single large one. Species specializing in this mode of reproduction should be able to take advantage of temporary openings in the canopy and then should suffer only slightly after the canopy closes, thereby increasing the chance that they will still be able to respond while awaiting a new gap in the vicinity. High rates of multiple gap occurrence can also imply that individuals of tolerant species will usually be exposed to one or more gaps at some stage before reaching the canopy." (Runkle 1985).

Red maple's ability to invade gaps quickly is influenced by the fact that it sets seed early in spring and the seeds germinate soon after falling. Its limited density in small gaps in my study area may be explained by the actual canopy coverage associated with small gaps. According to Canham and Marks (1985) plant canopies absorb much of the incident light in the red wavelengths, which reduces the red/far-red ratio at the soil surface and prevents germination beneath a (full ?) fall canopy. Thus, only the seeds that fall within the canopy openings germinate during the season of dispersal.

In my study area multiple gaps seem to be occurring at frequent rates. This process gives Red maple much potential for expanding its distribution within the Northern white cedar stand. It appears that my study area is becoming more xeric. This can be noted by the low occurrence of Northern white cedar seedlings and suitable cedar seed beds. Construction activities to the south of my study area could indeed be influencing drainage patterns in Reese's Swamp which in effect may increase mortality of cedar, white and black spruce and ultimately lead to more gaps and a succession towards Red maple and Balsam fir.

The predictability of light-gap tree-species recruitment may indeed have its basis in the seed sources adjacent to the gaps; however, more samples would have to be analyzed with particular attention given to age of individuals within the gap. It may in fact be that the actual internal gap dynamics (i.e., soil moisture, age of individuals, percent cover) hold the key to long term successional patterns within Reese's Swamp.

CONCLUSIONS

Balsam fir and Red maple occurred in all light gaps within the Reese's Swamp study area. Balsam fir invaded small and large gaps, though not present in the periphery zone of the large gaps. Red maple invaded small and large gaps; however, it occurred as a small number of individuals in the small gap inspite of a 1:1 ratio of Balsam firm and Red maple seed trees in the periphery. I feel there is no direct relationship between the number of individuals in the gaps and presence of potential seed trees in the periphery of the gap.

The opportunistic nature of Balsam fir and Red maple as colonizers of light gaps in Reese's Swamp can have a decided effect on successional trends.

Table 1 Number of individual tree species within a 5m periphery zone outside and a 2m belt transect inside a $193m^2$ and $245m^2$ light gap in Reese's Swamp

Species	Outside	Inside
Abies balsamea	6	48
Acer rubrum	6	5
Thuja occidentalis	48	0
Pinus strobus	4	0
Picea glauca	1	0
Picea mariana	4	0
Betula papyrifera	14	0
Fraxinus nigra	0	7
Populus tremuloides	1	1
Acer spicatum	0	7
Totals	84	68

Table 2 Number of individual tree species within a 5m periphery zone outside and a 2m belt transect inside a $420m^2$ and $479m^2$ light gap in Reese's Swamp.

Species	Outside	Inside
Abies balsamea	0	83
Acer rubrum	7	80
Thuja occidentalis	58	0
Pinus strobus	26	0
Picea glauca	2	0
Picea mariana	3	0
Betula papyrifera	3	1
Fraxinus nigra	0	1
Populus tremuloides	6	0
Acer spicatum	0	11
Totals	105	176

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