Edge effects on the regeneration of forest fragments in south Brazil

A thesis presented

by

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Abstract

Forested environments are being cleared all over the world. From 1981 to 1990, the loss of tropical forests was estimated at 154 million ha. As a result of that, the interface between forest and open environment has increased greatly. General patterns of species distribution and dynamics in these forest edges must be determined, if we are to recommend guidelines for the management of forest edges.

This work addresses three main questions: 1) Do different types of species occur at different distances from the edge in the tropics? 2) Are non-monotonic patterns of plant density common in edges? 3) If so, which mechanism is generating it, and how do fragment size and edge orientation affects non-monotonic patterns?

In order to answer these questions, I established 48 transects 4 m wide, 25-100m long. I identified 192 species, on a sample of 16,674 saplings higher than 1m, and smaller than 5 cm DBH. Transects were located in 19 forest fragments, ranging from 0.4 ha, up to 650 ha. Two additional data sets were used. Fourteen transects, 10 m wide, 45-100m long, were surveyed for density of trees (above 10cm DBH), and fifty-five transects 50m or 100m long were surveyed for light and temperature measurements. The study site is located in North Paraná, Brasil, at 50^{o}W lon 23^{o}S lat. The annual average temperature is 22.5^{o} C. Monthly averages vary from 16^{o} C up to 24^{o} C. The average annual rainfall in the region is 1615 mm.

A historical survey of the region showed that human impact on the forests of North Paraná was very small prior to the construction of the main transportation network linking the region to the coast in 1934. The rapid deforestation process that occurred in North Paraná soon after 1934, caused edges to be even aged. The elongated shape of farms caused fragments to have straight edges, and the interspersion of large and small farms, caused small and large fragments to be interspersed. These four landscape aspects conditioned by history, plus the fact that North Paraná is devoid of major altitudinal and soil gradients, indicates that at this study site, historical and environmental variation is low, making comparisons among edges possible.

The occurrence of pioneers and canopy species closer to edges than the average individual, indicates that the light enhancement at these sites, is selecting species adapted to this condition. Furthermore, where light penetrates further into the forest, (north edges), the species composition of sites deeper into the forest, resembles the species composition of sites closer to the edge of protected (south) edges.

Sapling density showed to have a non-monotonic pattern. It is associated with species composition when all transects are pooled, and when different transect subsets are considered. The association sapling density/species composition ceases to exist around 35 m from the edge, in all different groups considered.

Sapling density is related to (either controlling or being controlled by) lateral light on the edge, but trees control light deeper on. The point at which

one condition switches to the other, coincides with the point at which Vapor Pressure Deficit stabilizes (35m). Further evidence that the edge is 35 m wide, is that plant diversity peaks at 35 m. This probably indicates that two different communities meet at this point. Species composition on the seven subsets (large-small, north-south, and three sizes of saplings) confirm that species composition is related to distance from the edge up to around 35 meters. After that, no pattern is shown.

Species composition of whole transects in small fragments somewhat resemble the typical species composition found in edges in this region. Therefore, in addition to the fact that small fragments are more exposed to edge effects because of their higher perimeter/area relation, small fragments are, as a whole, more affected by edge effects. This fact is coupled with the enhanced amplitude of the crest and hollow pattern of density on small fragments, in relation to large fragments. The most likely mechanism enhancing edge effects in small fragments, is the additional effect of secondary edges over the one being considered. The diameter of small fragments is many times smaller than 200 m, so that entire transects in small fragments are closer than 100 m to a secondary edge. In those cases, a weak secondary edge effect is added to the entire transect, amplifying the magnitude of the edge effect.

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