

Forest Structure and Pattern: The Foundation of Forest Biodiversity

Forest species vary widely in their habitat requirements, reflecting diverse strategies for obtaining nutrition, avoiding predation, and meeting other requirements of life. Many have specialized needs reflecting physical and behavioral adaptations designed to minimize competition with other species. Because of such habitat specialization the overall diversity of forest species is dependent upon the diversity of habitat features, which is in turn a consequence of the combined actions of fire and forest regeneration, among other factors.

The Natural Disturbance Model of forest harvesting seeks to maintain forest biodiversity by ensuring that the full range of forest habitat types continue to be represented. For this to be accomplished, forest structures and patterns that arise through natural processes such as fire must be maintained. This fact sheet provides an overview of key structures and patterns that exist in Alberta's boreal forests.

Stand structure:

- Forest stands can be characterized by their structural features, including type and density of dominant tree species, type of understory (ground vegetation), and amount of standing and fallen dead trees. These attributes undergo a predictable pattern of change as stands age, and together they can be used to classify stands into young, mature, and old stages.
- The duration of each stage differs among stand types because of differences in the rate of tree maturation. For example, aspen stands begin to acquire old-growth characteristics by 100 years, whereas stands of white spruce are still in the mature stage at this time.
- Much of the structure of young stands is due to the legacy left by the pre-fire stand. In all but the most intense fires, large trees are killed but not consumed and in time these dead trees become broken snags and then downed logs on the forest floor, providing structural diversity to the stand for several decades. Diversity in young stands is also enhanced by the openness of the canopy (upper forest) which permits light and warmth to reach the forest floor, stimulating understory growth.
- The transition of stands to the mature stage is marked by closure of the canopy. Mature stands are typified by a dense growth of relatively even-aged trees, reduced understory development, and the onset of self-thinning. The legacy of pre-fire aspen trees has diminished, though large-diameter conifer logs may persist. Mature stands have the lowest levels of structural diversity.
- The transition from mature to old stands is gradual. The key changes include breakup of the canopy and release of understory plants, emergence of secondary canopy species, and accumulation of snags and downed logs. Relative to younger stages old stands have trees of many ages and have more large canopy trees, large snags and large downed logs. Overall, structural diversity is highest in old stands and this is reflected in the highest species richness in both plants and animals.

- Stand structure is also influenced by stand type. The differences between coniferous and deciduous stands are particularly significant. Mixedwood stands, because they combine the features of both coniferous and deciduous stands, have a unique structural composition that is important to many species.

Age distribution:

- Most burning occurs in large fires associated with so-called fire years. These large fires have a dominant long-term influence on the age distribution of stands in a given region because large fires produce many new stands that mature as a group.
- Fires generated by lightning are largely randomly distributed when observed over large areas. Therefore, through chance some stands escape burning for very long periods. For example, if fires randomly burned 1% of the forest every year, then on average 37% of the forest would be greater than 100 years of age. This proportion of old-growth will not be observed in all locations at all times because of the local influence of individual large fires.

Distribution of stand size:

- The distribution of stand size reflects an interplay between fire, site conditions, and forest regeneration. Large fires produce large uniform patches, albeit with many small unburned islands, and regeneration processes differentiate the forest into smaller units in response to differences in site characteristics and seed availability. The net result is that stand size is distributed in a pattern similar to forest fire size, but on average, stands are substantially smaller than fires.

Spatial arrangement:

- The spatial arrangement of forest stands reflects the legacy of fire and local and regional differences in site conditions. As a consequence of infrequent large fires, stands of the same age are typically aggregated together. Within the uniform landscape produced by these large fires lie patches of older forest, representing fire skips, and patches of newer forest arising from more recent small fires.
- Aggregation is also apparent from the perspective of vegetation type. This is largely a consequence of regional patterns in site conditions, especially the amount of soil moisture present. Fire also plays a role in aggregating stands in that it promotes the establishment of aspen and mixedwood stands at the expense of pure conifer stands.
- At the local level the spatial arrangement of stands is often highly complex. This complexity reflects local variations in site conditions, seed availability, stage of regeneration, and the irregular boundaries of past fires.
- Aquatic features such as rivers, lakes, and wetlands also have an important influence on landscape patterns. Because they often act as fire breaks there is a greater probability of finding older forest stands in the vicinity of these features than in the remaining landscape. Furthermore, the unique moisture regime, soils, and even local climate lead to distinct assemblages of vegetation in these areas.