The visual landscape as a resource and its integration in forestry activities. Reflections for boreal forests

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The visual landscape as a resource and its integration in forestry activities. Reflections for boreal forests

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Abstract. The visual landscape is a part of the total landscape related to the aesthetics of the observed environment and the personal preferences of the observer. The visual landscape must be considered in landscape management and planning processes, in impact assessments and other activities such as biodiversity conservation and implementation of best practices in forestry. There are criteria that can be applied to avoid impacts and contribute to the conservation at the landscape scale for a given forest type. Mature and virgin boreal forests have characteristics that make them very important for the landscape quality, and they are necessary elements to preserve biodiversity. These forests are the type of forest that is most often destroyed and even today, their area in the boreal biome is shrinking due to clear cuts and forest fires. Preserving and managing these forests in a sustainable way is urgent as they are key elements in the landscape of boreal areas. Fortunately, there is knowledge and previous experiences that make it possible to create and manage complex forest environments from simplified forest structures, and that are economically profitable and present attributes of old-growth forest.

1. The landscape: a concept and polymorphic approach

We perceive the environment around us in different ways depending on our intentions and interests. The landscape as an observed environment is highly complex and admits complementary approaches and descriptions. The visual aspects are fundamental for its apprehension. The total landscape is made up of a fenosystem, which is the external manifestation, an apparent perceived part, and a cryptosystem, a set of hidden relationships that make up the fenosystem [1].

Five fundamental or significant approaches can be considered: artistic, recreational, scientific, operational and humanistic [2].

The scientific approach that tries to describe and explain the observed environment, accompanied by a methodological rigor, based on different disciplines, is transversal and multidisciplinary [2]. However, the surrounding environment contains everything around us, and rendering a unique and universal characterization seems impossible. There are therefore multiple classifications and interpretations of the landscape. They may be complementary and incomplete but true, as soon as they fulfill the objectives for which they were created. They describe and classify the environment with established aims and with the choice of the most relevant and significant aspects.

The most relevant scientific approaches differ depending on the disciplines that study the landscape. One can consider an object characterized by its biophysical components, such as a social construction, or an aesthetic object [3]. The landscape as a whole must include everything at once, as man with his constructions, relationships and aspirations interrelates with the natural landscape.

The use of statistical methods in combination with geographic information systems has led to a multiplication of classifications and typologies throughout the world [4, 5].

The pretension of making intelligible classifications of the landscape as a whole, which are repeatable by different people using automatic and semi-automatic procedures, which are independent of the observer, is an impossible endeavor. As we include meaningful information, we arrive at an irreducible nucleus in which subjectivity and expert opinions are necessary [6]. Multiple studies have shown this when visual (aesthetics, visual perception), social or cultural aspects, which need qualitative models that express the complex relations between the environment and society are included [4, 7, 8].

The multiplicity of classifications is also the result of different traditions and approaches that differ in terms of concept, spatial resolution, complexity, degree of independence of the observer, or importance of the elements being taken into account [4, 8].

The objectification of the landscape with the use of quantitative methods, based on natural, geological or biophysical landscape concepts [4], such as the geosystem, makes it possible to quantify parameters and apply automatic or semi-automatic methods and unsupervised classifications [4, 7, 8].

The biophysical landscape concept excludes sociocultural phenomena. On the other hand, the holistic landscape character assessment may include sociocultural phenomena, but in this approach, expert opinion, interpretative and intuitive approach, human perception and cultural relations are relevant [4].

However, multi-level taxonomic and hierarchical classification frameworks can be developed for each specific case, assisting with policy implementation and decision-making. Work [6] consider five scales of detail (between 1:1,000,000 and 1:5,000), with two levels of information each, multivariable or expert information. Each spatial scale has an associated political or administrative scale (from national to municipal), and a territorial level (supra-regional to local).

The landscape planning and management is aimed at the cultural landscape, which is made up of a set of natural and human (cultural) relations. Landscape classifications must include both components or subsystems and classifications can be differentiated into nature-centric or culture-centric, if they give priority to natural or cultural components and processes [9].

In Europe, the landscapes have been deeply transformed and all manifest the human footprint. The cultural landscape is a necessary approach for any territorial planning or management. To a greater or lesser extent, this judgment can be extended to the entire earth, since places with virgin or primary landscapes are rapidly shrinking.

The European Landscape Convention 2000 [10] defines landscape as: "an area, as perceived by people, which character is the result of the action and interaction of natural and/or human factors"; "perceived by people" refers to a holistic experience with all the senses, very often it is reduced to visual aspects [11]. It is important to note that visual perception accounts for 87% of sensory perception.

2. The integration of visual landscape in forestry activities

2.1. Objectives

The main objective of this synthetic document is to demonstrate that the visual landscape is a resource and an objective for forest management and that it should be integrated into forestry activities.

The objectives derived from this main one, have been:

- To establish the importance of the visual landscape in land management as a part of the landscape as a whole.
- To highlight the relationships between visual landscape and ecological landscape, and the importance of spatial heterogeneity for both of them.
- To show applied examples of criteria for integrate visual and ecological landscapes into forest management activities.
- To relate natural disturbances and silvicultural systems with their effects in the landscape.
- To establish relationships between the aforementioned items and current trends observed in boreal forests and their implications for the future of these forests.

2.2. Material and methods: Similarities between visual and ecological landscape

2.2.1. The visual landscape. The visual landscape refers to the aesthetic and other aspects incorporated by people, which determine their preferences to assess the quality of the environment observed. This information is necessary for spatial planning tasks, especially in processes of change.

The visual landscape is a resource of the territory that must be taken into consideration for its conservation and management.

The preferences of the landscape are related to the attractiveness or beauty of the views, but it is also linked to historical and cultural aspects of knowledge or use of the territory by human groups, and to the experience and knowledge of individuals. The visual landscape is characterized by an aesthetic component and another component of meaning, but the two are also related.

Landscape preferences are explained by theories of innate or acquired appreciation, that is, evolutionary or cultural [12]. Consistent with evolutionary theories, empirical research has shown a high degree of universality in landscape preferences; however, these evolutionary based preferences are modified and shaped by cultural influences and experience, resulting in variations in preference ratings between groups and subcultures [12].

2.2.2. The ecological landscape and the visual landscape. From the ecological point of view, the landscape has certain basic elements whose distribution and form influence plant and animal populations and their dynamics, in order to maintain stability, regulate their expansion, and avoid the fragmentation and disappearance of their habitats [13]. The distribution of these elements defines the spatial configuration, structure or characteristic pattern.

Both, the visual and ecological characteristics are dependent on the landscape structure, and they can therefore also share the same theoretical basis for landscape assessment [14].

The recognition and understanding of the relationship between ecology and visual appearance (perception and aesthetics) at the conceptual level are of great importance for landscape planning and management [15].

Complex and heterogeneous landscape structures are recognized to be more biodiverse than homogeneous ones and are more effective in preserving species and communities [15].

2.2.3. Aesthetic in sustainable traditional landscapes. The existence of agricultural and historical landscapes, which remained largely unchanged for centuries and with a high ecological and visual landscape biodiversity and contributed to a high level of visual attractiveness, indicates an adaptation to natural processes and the concurrence of aesthetic and sustainable landscapes. These landscapes formed a lasting bond between current and future production and were seen as a heritage. Long-term survival depended on proper management of the land [15].

Agroforestry and silvopastoral systems combining the visual quality of the landscape and ecological function can be found all around the world [16]. Agroforestry and silvopastoral systems are integrated production systems with trees, croplands, and/or pastures and livestock, which maintain a high degree of diversity and a complementary spatial and temporal sequence of products that exploit the resources to their maximum advantage. These systems have been created by farmers through the method of trial and error and combine diversified production and biodiversity and have an ecological basis [e.g. 17]. There are currently several successful models that researchers are seeking to understand, improve, and replicate [18]. These systems with human intervention present a paradox, since the combined biodiversity of these transformed systems, balanced, heterogeneous and stable over time, can contain more biodiversity than a natural system without human intervention (García Abril et al. 2016).

2.2.4. Heterogeneity of the landscape and the importance of complex forests. Landscapes can be dominated by forest subject to different degrees of human transformation, or they can comprise multiple land uses. Today, landscape is considered a complex reality, which is home to both species and people; a reality shaped by processes and ecological relationships, activities, and interactions, resulting in a shifting mosaic that change over time and in space. The spatial-temporal landscape composed of patterns of different land uses and natural vegetation must contain a sufficient representation of the communities of species to ensure their conservation. This is a priority of landscape management, which contributes to sustainable development [15].

The forest landscape governed by the natural disturbances regime is composed of a mosaic of larger or smaller units, depending on the extent and intensity of natural disturbances.

Biodiversity at the landscape level contains species linked to all successional stages. In forest natural areas, if large-scale disturbance frequency is low, most of the area will be old growth at different successional stages. Gap dynamics from early stages and shade-intolerant species is followed by phases with shade-tolerant species. To preserve biodiversity, it is therefore necessary to maintain the different successional stages described.

Landscape simplification and elimination of complex forest stages occur in densely populated areas but are progressing rapidly around the world, spreading to places where disturbance was rare until the twentieth century, such as the primary tropical forests and boreal forests. All over the world, biodiversity is being threatened by human activities and by the disappearance of complex and unchanged ecosystems [15].

"A diversity of silvicultural systems and strategies across the landscape/region is needed to increase diversity in structures, functions, and biota and consequently support a broad range of ecosystem goods and services (ESS)" [19].

*2.2.5. Coincidence of landscape preferences and ecological functions of forests (visual and ecological landscape).*In order to determine how the public perceives the visual effects of forest actions, their preferences have been evaluated with respect to what they can perceive directly, rather than the practices themselves [13]. Studies have shown that the landscape preferences of users are linked to ecological functions relevant to biodiversity conservation. Thus, preferring chromatic contrast in a forest means preferring mixed forests, or disdaining alignments, sharp geometric shapes and contrasts between vegetation and bare soil, which means avoiding systematic and intensive actions, such as clear cutting or aligned plantations. An attractive landscape can have the properties that are necessary to fully conserve biodiversity.

Close to nature. This is an aspect that visitors consider of great importance. It is, therefore, desirable to conceal all evidence of management as much as possible, to avoid straight-lined afforestation and geometric shapes in the design of edges, and it is also advisable to keep timber harvesting and forest roads out of sight of visitors [e.g. 20, 21].

Mix of young and adult trees, high proportion of old trees, and retention of old trees. There is a preference for stands resulting from selective cutting, with a stratified or irregular structure, which contain groups of trees from different generations. Visitors consider this structure more similar to the natural state of the forest and more harmonious on the whole.

The larger and older trees are the most attractive and noticeable to the public. Young stands may be more pleasing if some of the larger specimens are retained. Tree size appears to be the quality with the most important and common link to recreational value, with larger trees preferred [20, 22, 23].

Mix of conifers and broadleaves. Tree species is of relatively little importance, and, on balance, broadleaves are marginally preferred over conifers, while mixed stands are marginally preferred over monocultures [23]. Of the factors mentioned earlier, proximity to nature and proportion of very old trees are given the greatest importance. Another aspect that is being increasingly identified as important is the health of the forest, which means that the value for recreation and landscape decreases in woods where there is a noticeable decline in the forest's health [23].

Presence of water. Water is seen as a key element in shaping human preferences [e.g. 24, 25].

Presence of dead trees either standing or on the ground. In terms of the presence of coarse woody debris, the common ground between ecological and aesthetic values is not directly evident, at least if aesthetics are considered from the point of view of public preference [13]. The presence of dead or decaying trees is perceived as negative by the public and considered a symptom of disease and lack of care and management or is said to be responsible for hindering movement or creating a sense of lack of stewardship in the forest. However, from both the aesthetic and the ecological points of view, it appears that the presence of a few large logs is preferable to numerous small ones. This divergence can also be removed by the appreciation of the ecological integrity and health of the forest, considering that knowledge, experience, and education play an important role in the assessment [22, 26].

2.2.6. Management of complex forests and close-to-nature silviculture. In Europe there are successful experiences of profitable management of complex forests for wood production, maintaining a high structural diversity and proportion of large trees. This close-to-nature silviculture management responds to a long tradition stretching back to the nineteenth century and is today supported by research. This management can maintain structures close to mature forests and with characteristics of old growth forests, and carries out the conversion of homogeneous stands to mixed and irregular stands. It does not use clear cuttings [27-30].

2.2.7. Incorporation of visual landscape into forest management. Forests and forest stands are essential parts of the landscape. Forestry activities on them can change the character and quality of the landscape. The knowledge of the foreseeable effects of forestry activities in the short and medium term is a necessity for rational management of the territory and forestry itself. Past experiences and research are essential.

The formal incorporation of the landscape into forest management in developed countries has been driven mainly by the negative effects of certain forestry activities, which have resulted in social protests, triggered primarily by the loss of scenic landscapes, the visual effects of clear-cutting, disturbing afforestation, and the destruction of old-growth forests [15].

Different standards and criteria have been applied in Europe [e.g. 21, 31] and the United States [32]

The visual landscape has also been incorporated into impact legislation, as an element and attribute that can be affected by different activities, including some forestry, and which must be assessed, prevented and corrected [e.g. 33].

The ecological landscape has also been included as a means of conserving biodiversity in some actions [e.g. 34] and in sustainable management indicators [35, 36] and forest certification standards [37], which include the visual and ecological landscape.

2.3. Results and discussion

2.3.1. Landscape Design Criteria linking Visual Preferences and Biodiversity. Research on visual preferences, elements, and patterns of landscape characteristics has found links between visual and ecological landscapes, highlighting a common ground for both approaches [13].

The following criteria have been selected for forest management that satisfies both visual preferences and biodiversity conservation of two landscape dimensions [15]:

1. *Landscape criteria for the exterior landscape: broad-scale approach to forest management* (figure 1)

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A. Avoiding fragmentation by connecting relevant ecosystems
B. Increasing biodiversity
   a. Of species and ecosystems
   b. Of landscape elements
C. Softening margins of forests, cuts and new plantations
D. Adapting infrastructures, equipment, and other artificial elements to the forest environment
E. Working at the landscape scale in order to foster integration of management activities

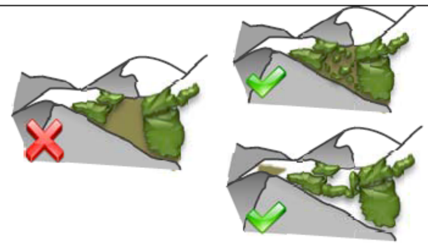
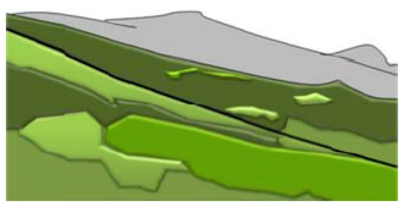
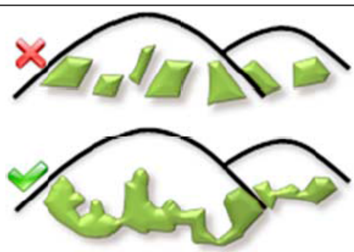
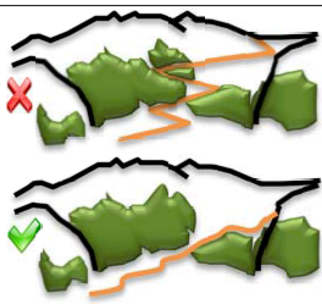
A. Avoid fragmentation looking for connection among relevant ecosystem		This criterion indicates that connectivity is not only important for ecological reasons but promotes landscapes preferred by the public
B. Increase biodiversity a. of species and ecosystems b. of landscape elements		Stands of mixed species tend to be more stable against biotic and abiotic damages than monospecific ones. Also multilayered stands offer high level of diversity. Besides, forest landscapes with aesthetic complexity are preferred.
C. Soften margins of forest and new plantations		Create or maintain wavy edges with indentations improve visual diversity and introduce irregularity to straight forest edges. This also regards the importance of edges for the connectivity
D. Adapt infrastructures, equipment and other artificial elements to forest environment		This criterion involves visual fragility and aesthetic values as well as the effects of anthropogenic disturbances affecting biodiversity conservation
E. Work at a landscape scale in order to foster integration of management activities		Match interventions to landscape scale refers to give importance to the perception of relative and absolute sizes. Furthermore, management areas are intended to have independent structure and functioning.

Figure 1. Landscape visual criteria for exterior landscape: broad-scale approach (from [13] and [15]).

2. *Landscape criteria for the interior landscape: small-scale approach to forest management*

A. Protecting river banks and shores
B. Paying attention to the unique function of forest edges
C. Increasing ecosystem and species diversity
D. Preserving large old trees, large fallen trees, and trees of different species
E. Integrating structures and equipment into the forest landscape
F. Not disturbing the genius loci (spirit of the place)

2.3.2. Natural dynamics in temperate and boreal forests. The natural disturbance regimes and associated dynamics we present here are taken from the findings in boreal and temperate forests by [38] and [39], adapted by [15]:

Severe stand-replacing disturbance, with succession dynamics: Crown fire perturbation triggers the regeneration process for the whole forest. Even-aged forests evolve composed of trees with an age range of less than 40 years. The diameter and age distributions are unimodal and near normal: The succession advances depending on fire recurrence. Thus, after internal processes encourage irregularity, gap dynamics may occur before the next crown fire, hundreds of years later.

Partial disturbances with cohort dynamics: The partial death of adult trees determines different structural subtypes to a varying extent: two canopy layers comprising adult trees and regenerated trees. The tree diameter and age distributions are bimodal or plurimodal. This is a temporary situation that develops into a regime of gap dynamics and even-aged structure if there are no more partial or severe disturbances. It is caused by partial disturbances such as windstorms, snowstorms, surface fires, pests, and diseases.

Endogenous disturbances with gap dynamics: All ages and diameter distributions are represented in small areas or through individual trees. These distributions are "negative exponential" or "reverse J-shaped." Gaps may come from the death of individual trees or groups of trees due to senescence, wind, or diseases.

"All-aged stands are gradually formed over several hundreds of years of endogenous succession with gap dynamics. This endogenous succession can be interrupted by stand-replacing or partial disturbances leading to successions with even-aged or cohort-structured stands." [39].

Old-growth forests were predominant among boreal forests before the advent of significant human activities, especially in Eurasia where they evolved through small-scale disturbances. In addition to gap dynamics, disturbances other than fire may promote conditions for even-aged stands of extensive areas due to drought, plagues, or large blowdowns [39, 40].

2.3.3. Forestry systems as disturbances. The Consequences on the Landscape. Silvicultural systems mimic natural disturbances, but all commercial wood is removed, and there is an evolution in the regeneration and rejuvenation of stands. Three main forestry systems can be considered and one modality included in all three [15], each of them creates a structure with different visual and ecological properties.

a. Clear-cuttings (figure 2a) are the widespread cuttings that give rise to even-aged forests. All trees are removed from the stand (usually from monospecific stands). They are similar to *severe stand-replacing disturbance.* Differences with fire perturbations can be summarized as follows: removal of nearly all structural elements that could serve as refuge and propagules capable for regeneration.

b. Shelterwood systems (figure 2b) gradually remove trees over a period of time greater or equal to the duration of an artificial age class (normally 20-40 years) or longer. The disturbance is partial and the remaining trees are maintained until death in natural process. However, in the managed stand, trees from the upper canopy remain until regeneration develops, then trees are cut. Forest structure is regular, with a bi or plurimodal diameter and age distribution, while crop trees remain. The main difference with clear-cuttings is the continuous covering of soil by crop trees and regenerated trees. Regeneration and crop trees coincide in space and time over more than half of the surface area.

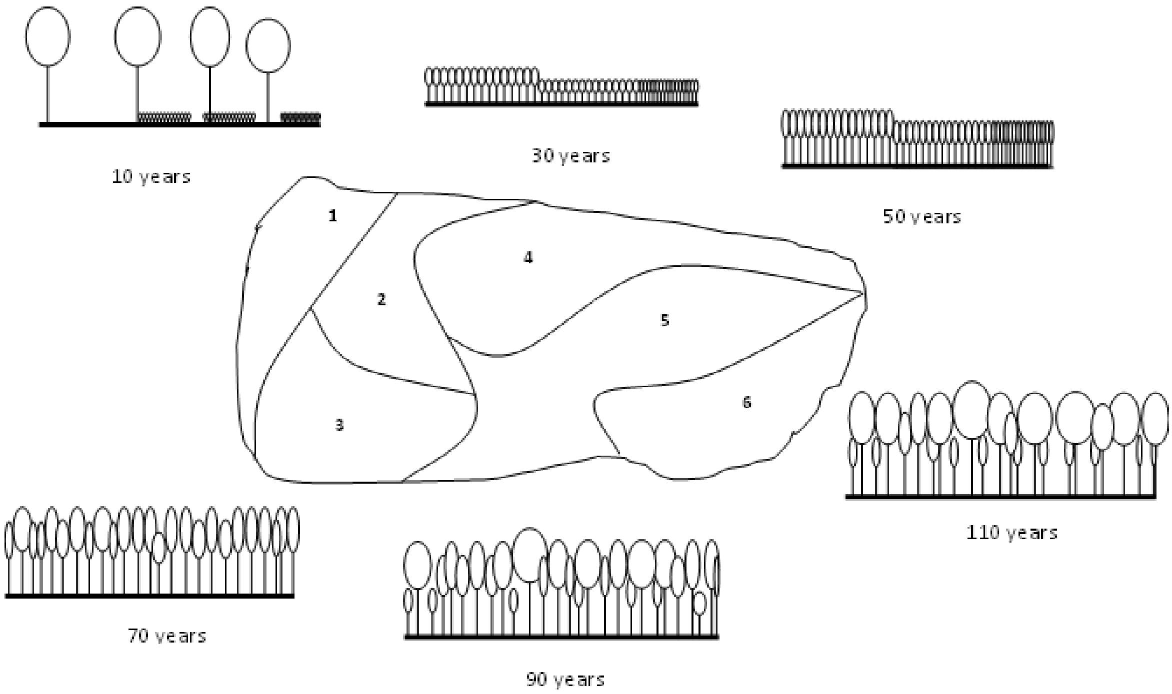


Figure 2a. Working circle even-aged forest with clear cutting system. Patterns repeat themselves during the period at the different stand´s location. Rotation-Period: 120 years, Regeneration period: 20 years. Seed- tree clear cutting system (from [13] and [15]).

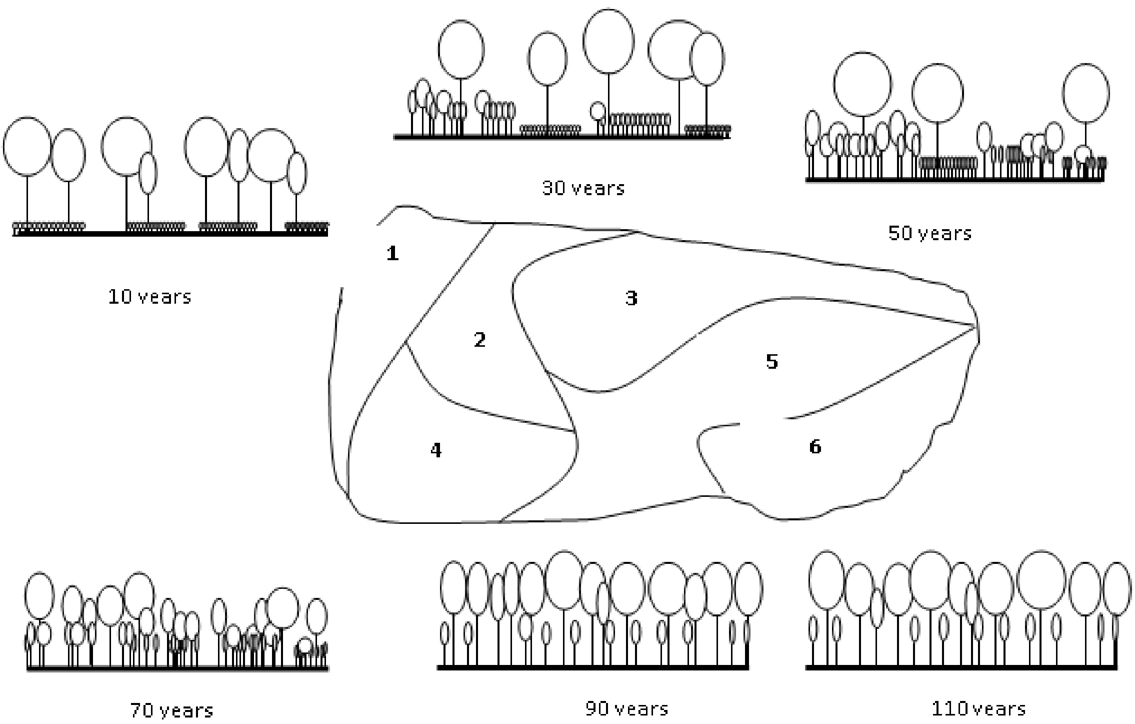


Figure 2b. Working circle, even-aged forest with shelterwood system.

Patterns repeat themselves during the period at the different stand´s location. Rotation-Period: 120 years, Regeneration period: 60 years. Systems of successive regeneration felling (uniform and group shelterwood systems) are applied (from [13] and [15]).

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c. Tree selection systems (figure 2c) are selective cuttings that generate and conserve uneven-aged stands. All management units are constantly in the process of regeneration. The soil is always protected by trees. This is equivalent to endogenous disturbances with gap dynamics in small areas caused by the death of one or more trees or small groups of trees far episodes of wind, snow, disease, or plague.

From the point of view of promoting structural diversity, clear-cutting, the shelterwood system, and selective cuttings inevitably involve the management unit.

Each of the cutting systems improves high or low structural diversity depending on the size of the management unit. The smaller the regeneration areas, the more similar to minor disturbance dynamics and complex structures of the final succession stages [15].

To achieve high structural diversity, it is advisable to replace clear-cuttings with a shelterwood system and the shelterwood system with a selection system [41]. The knowledge exists to perform both uneven-aged management stands and for the conversion of regular to irregular masses [e.g. 47].

Each structure type can be recognized by a vertical profile (crown line) that can serve as a surrogate for heterogeneity and visual attractiveness [15].

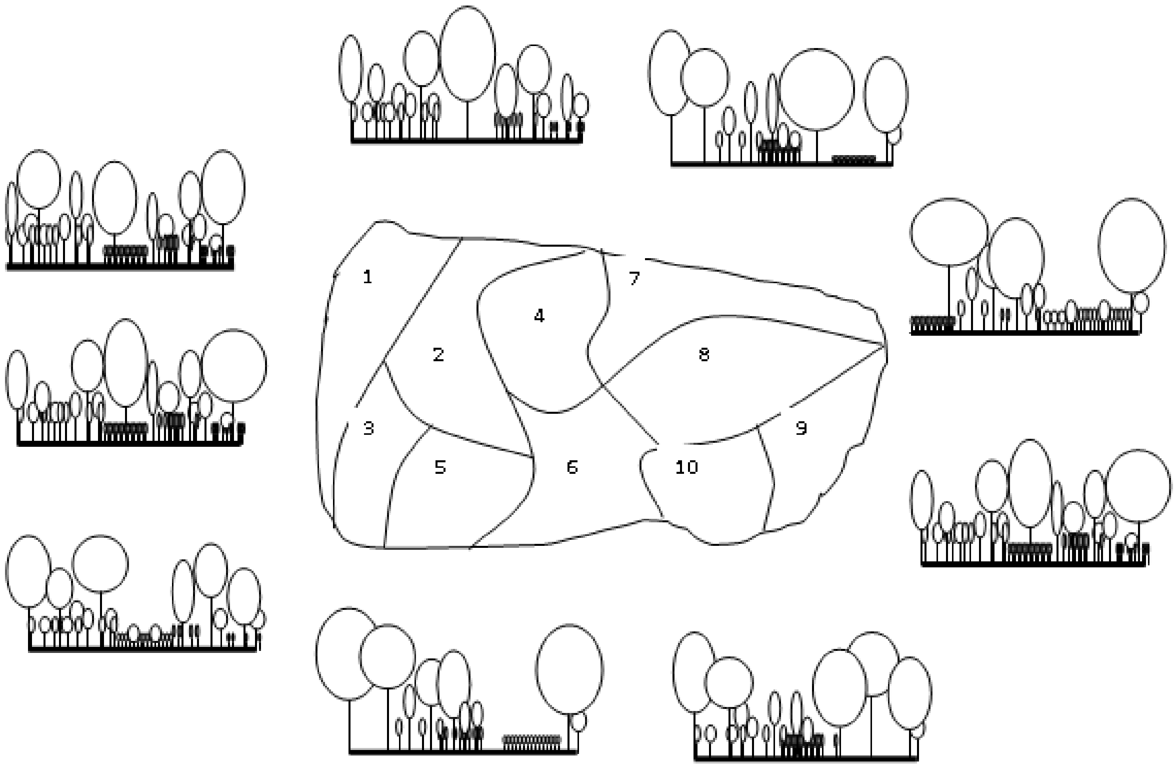

Figure 2c. Working circle uneven-aged forest with selection system. Each stand presents a mosaic of uneven-aged structures, which develops into different structures through cuts. There is no temporal sequence of structures within the stand. Management system is selective cuttings of individual trees or group of trees, or irregular shelterwood system. Rotation-period is usually 5- 15 years. Age of adult trees may well differ among them (from [13] and [15]).

Retention forestry is "an approach to forest management based on the long-term retention of structures and organisms, such as live and dead trees and small areas of intact forest, at the time of harvest. The aim is to achieve a level of continuity in forest structure, composition, and complexity that promotes biodiversity and sustains ecological functions at different spatial scales" [42].

This concept and its application emerged to reduce the impact of clear-cutting in natural forests. In its initial application, its purpose was the "Lifeboating" species and processes [43]. But the remaining structural elements are "legacies" from the previous forest and function similar to fire "legacies" in contrast with traditional clear-cuttings [43-45].

Retention Forestry is a treatment modality that can be included in each of the main forestry systems, and that can be used to diversify the structure and also incorporate characteristics of old growth forests [15, 42, 46].

2.3.4. *Natural and artificial disturbances in forest landscapes in the boreal zone.* Global tree area measurements over the last 35 years (1982 to 2016) have shown that there has been a net loss of forested areas of tropical forests; -95,000 km2 (8%) of tree cover in tropical dry forest biome and -84,000 km2 (2%) of tropical moist deciduous forests [47]. While in the temperate and boreal zones, there has been a net increase [47] or a slight loss in the Russian boreal zone between 1990 and 2013 [48]. In the period 1982 to 2016 temperate continental forests have gained +726,000 km2 (33%); boreal coniferous forests +436,000 km2 (12%) and subtropical humid forests gained +280,000 km2 (18%). The changes studied by [47] are carried out between three ground cover, tree canopy (TC) cover, short vegetation (SV) cover and bare ground (BG) cover. An estimated 60% of all changes were associated with direct human land-use activities and 40% with indirect drivers such as climate change [47].

This data that inform about the creation of new tree cover area does, not properly inform what is happening. The study by [47] classifies tree canopy when the height is greater than or equal to 5 meters. This means that the forest figures include new regenerated areas after felling or fires, or new occupied areas from short vegetation cover or bare ground cover. The forest gains and losses counts determine the final balance. The presence of nearby areas of loss and gain of wooded stands (trees> 5 m.) indicate precisely clear cuttings or fires [49].

Fires are the main cause of forest area losses in the boreal forest [49]. The increase in the number of fires in boreal forests is due to human influence, reinforced by changes in climate and is accelerating in Eurasia [50]. Increased fires destroy forests in the short term but also change succession patterns and the proportion of different forest types and dominant species [50].

On the other hand, clear cuts produce significant visual and ecological impacts in relation to other systems. These effects are especially negative when mature, old-growth, or virgin forests are destroyed, because the destruction of these structures is permanent. A succession of homogeneous and much younger forest stands is created in space and time.

In natural forests, clear-cuts followed by short rotation period (RTP) cuttings reduce the populations of many species and completely remove shade-tolerant species. Exclusion due to dense phases entirely suppresses species that may appear during the regeneration or establishment phase [51].

In Fennoscandia, the structural homogeneity caused by clear-cutting as the dominant method of harvesting, and the growing of even-aged stands, entails another dramatic landscape change: the sharp decrease in old forest, old trees, and deadwood [52]. "If forest management practices continue to drastically change ecosystem structures from those that occur naturally, the continued decline in diversity and local species extinctions also seems inevitable in the future" [52].

In the boreal and temperate forest landscapes of North America, many natural forests were transformed into plantations and commercial forests and managed as even-aged forests with rotations of less than 100 years and clear-cut system. The regeneration system was often seedling or plantation. These forests have very dense young phases-the thinning phase and also the phase known as the stem exclusion phase [52], which is particularly vulnerable to crown fires.

The justification that the clear cuttings simulate a natural disturbance such as fire is often used, but various studies have shown that they can be more damaging. On the other hand, clear cutting is the treatment that most closely resembles a crown fire.

Work [53] state that, in the boreal forests of North America and Eurasia there are more dynamics than just major forest fires. In central Siberia and North America, where there are long dry periods and continental conditions, major fires are more frequent than in the coastal regions on both continents with shade-tolerant species. In Eurasia, surface fires are more frequent than crown fires. In North America, large-scale disturbances include spruce budworms in the eastern forests, in addition to crown fires. For example, in Fennoscandia, natural fire frequency is lower than was supposed [53, 54].

The clear-cutting system differs from natural fires, even in the case of crown fires. Traditional clear-cutting removes all valuable commercial wood while destroying the undergrowth during logging. Natural fires conserve structural and functional features, which increase the spatial heterogeneity of nutrients and humidity; they can also preserve propagules and seed sources to reforest the burned area. Some structural features remain: unburned areas, partially burned areas, live trees, snags, and logs. These legacies are capable of recovering the stages prior to perturbation in the long run [e.g. 43, 44, 52]. These are the main reasons why clear-cuts are not the ecological equivalent of natural disturbance [45].

Moreover, higher frequency of fires due to human activities is well documented, and major fires have come to the attention of the public. In certain types of forest, wide patches of mature and healthy forest with a complex structure act as barriers against crown fires and preserve forest structure [45]. In this pattern, mature phases of succession represented by complex forests are of paramount importance. Their preservation and creation have also become a fundamental objective of landscape management in the future [e.g. 52].

There are experiences, knowledge and research that provide criteria and tools for productive forest management while preserving the characteristics of heterogeneous and mature temperate and boreal forests [e.g. 30, 55-59].

Forestry actions have different impacts on forests and their resources, and not all of these have the same value and meaning, but this should not be interpreted as limiting management freedom, or assuming that any forestry action that achieves management objectives is correct. Management objectives may be mono- or multi-functional, economic, social or ecological. Merely maintaining trees continuously does not validate the statement: "it is time to recognize that the role of forestry is to be better than nature" [60].

3. Conclusion

The visual landscape should be considered in landscape planning and management processes as another resource to be conserved and improved.

The visual quality of the landscape depends on the preferences of the observers, but these have a common background for many people and a correspondence with ecological landscape characteristics, that are important for the conservation and functioning of biodiversity. Landscape criteria can be developed for actions that avoid impacts on the scenic landscape and contribute to biodiversity.

Mature and complex forests are the forests that have been destroyed the most on a global scale throughout history, and today their conservation and creation is a goal to keep all living beings associated with them in the structure of the landscape. These forests have some attributes that also correspond to visual preferences. There are numerous forest management experiences to maintain a complex structure and incorporate criteria of mature and virgin forests.

In the boreal forest, felling and fires have resulted in the net loss of mature forests and impacts on the landscape. It is a growing process.

The natural boreal forests, due to their enormous extension, gave the impression that they were an infinite, perennial and endless resource. The simplified forest stands that replace them represent a clear and evident loss of quality of the ecological and visual landscape in comparison with the original forests.

It is urgent and necessary to integrate visual and ecological landscapes into forest management so that it fulfills its function for society instead of merely generating economic returns in the short term; the price of loss of environmental resources and economic costs in the long term that are not taken into account will be paid by future generations. We must leave a world at least equal to the one we were given and with at least the same capacity to decide that has been enjoyed by our generations. Failure to conserve and improve forest ecosystem services could truly make the forest use and operation unsustainable.

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