INDICATORS OF HETEROGENEITY for ecosystem management

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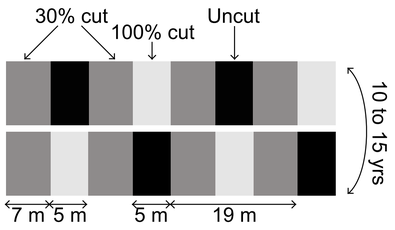
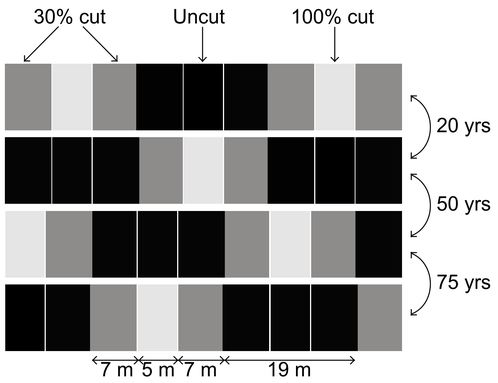
Studied treatments

Shelterwood regeneration cut (CPE)



Multicohort cut

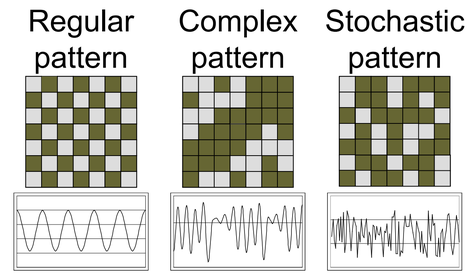


These cuts are intended to enhance the recruitment of coniferous species that are usually outcompeted in clearcuts. They are designed to emulate natural disturbances that partially open the canopy and let penetrate sufficient light for conifer seedling growth but not that of shade-intolerant hardwoods.

Objectives

Introduce complexity into forest management

Forests are neither regular nor stochastic systems. The complexity of the patterns emerging from interacting elements ought to be integrated into the decision making processes.

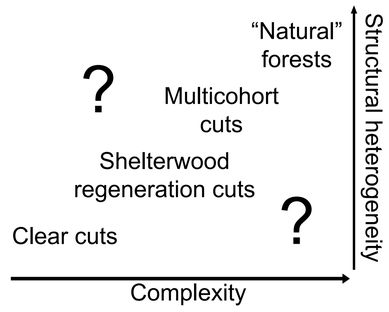


Complexity?

Complex behaviours in natural systems are created by the large number of the interacting components of these systems. Interactions result in emerging properties and feedback loops which create patterns at bigger scales than that of the individual elements, and which cannot be predicted by the study of individual elements.

Study the relationship between structural heterogeneity and complexity

Does structural heterogeneity reflect stand complexity and does it compare with naturality?
At which scale(s) can descriptive features be compared?
Which elements are the most modified by management?



Evaluate ecosystem management impacts on structural heterogeneity and define a framework for the use of structural indicators

Improve from a simple inventory of elements to an integration of the inner-variability and distribution of elements.

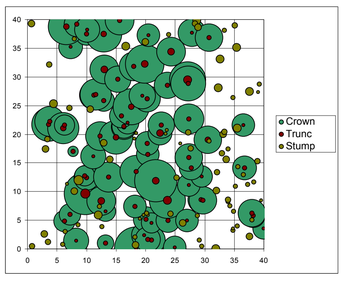
Inventory of elements — Frequency of elements — Distribution of elements — Integration of variability into the distribution of elements

Sampling

Inventory of understorey vegetation

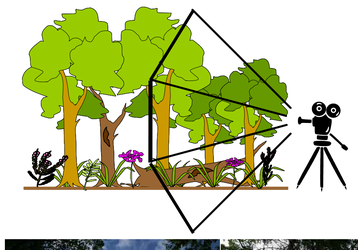
% Cover per species and size class was evaluated in 1m² sub-plots and sapling DBH and stump basal diameter in a 20m² plot.

Forest elements mapping



A 40x40m plot was sampled in each stand where each living tree was mapped and measured (DBH, height of the lowest branch, crown dimensions) as well as snags and woody debris (diameter, height and stage of degradation).

Systematic photographs of plots



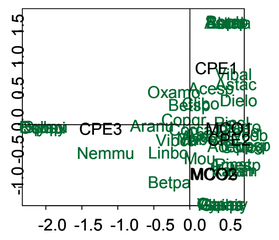
Vertical stratification of stands was photographed every 10m
3 pictures were taken at each location:
- 45° to the canopy
- Parallel with the horizon
- 30° to the ground

Systematic photographs in a shelterwood regeneration cut

Statistical approach

Multivariate analysis of composition

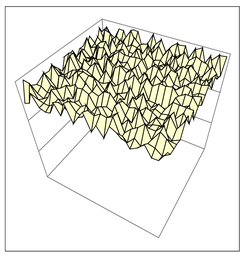
Factorial Correspondence Analysis (FCA) will be applied to specific and structural composition and compared between treatments.



Distribution study per type, species and size classes

A 2-dimensional distribution study will compare data to regular distributions, in order to define stands structure.
Variations of the test results at different scales will bring information on the pattern of association between similar elements and thus on the dynamics of the system (recruitment, competition, senescence, degradation).

Structural topography study (SCI) (Zenner, 2000)



This 3-dimensional index integrates the coordinates (x, y) of the elements and one caracteristic (height, diameter, length...) as a third dimension in space (z). The surface area of the resulting landscape is then compared to the horizontal projection of the coordinates (x, y) and thus compared to an even-aged stand of the same spatial distribution.
This test returns a measurement of stand heterogeneity.

Assembly diversity study (MIG) (Proulx & Parrott, 2008)

MIG measures the diversity of associations between elements.
It integrates structure and heterogeneity effects and allows us to distinguish regular, stochastic or complex patterns.

$$MIG = \frac{\left[-\sum_{i=1}^{M^k} p(\chi_i)\log p(\chi_i)\right] - \left[-\sum_{i=1}^{M} p(\gamma_i)\log p(\gamma_i)\right]}{\log(M^k / M)}$$

Vertical assembly: Photograph study (MIG)

The MIG index applied to the vertical structure photographs to study the distribution of pixels of different grey levels and hence the results of layer distribution and light profile.