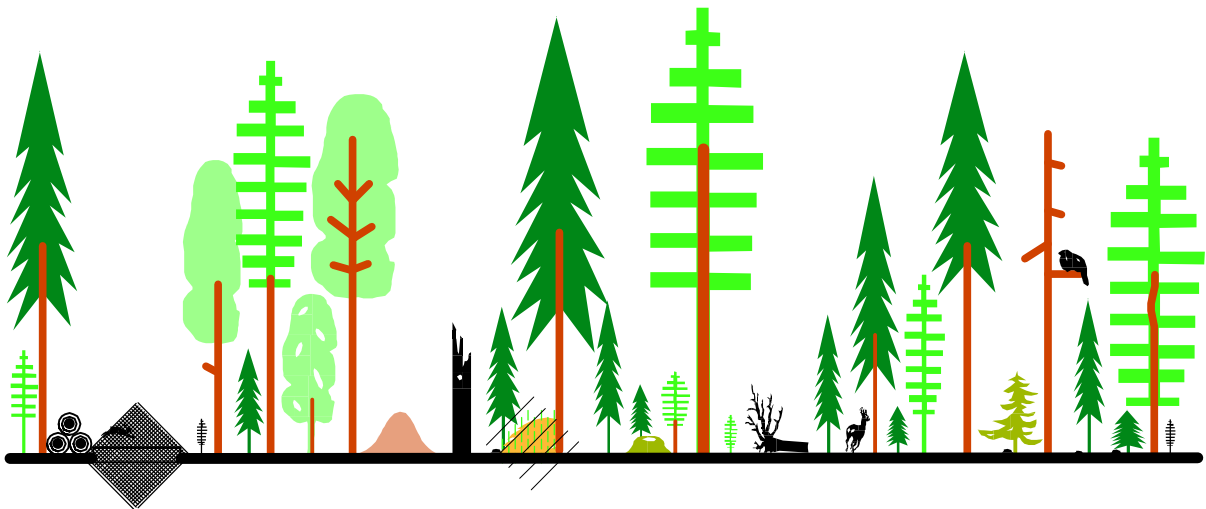


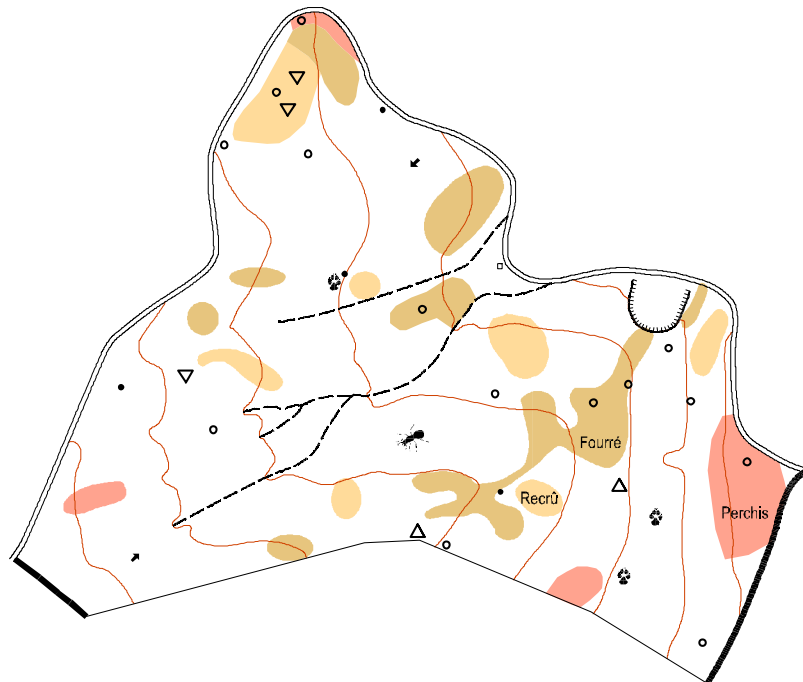
REPUBLIC AND CANTON NEUCHÂTEL
DEPARTEMENT ENVIRONNEMENT
FOREST SERVICE

Forest Master Plan Chapter 5

Sylvicultural principles



Transect through a single stem plenter forest



Map of an irregular mosaic forest

1. Introduction

Short historical overview :

After a longstanding period of uncontrolled and excessive felling in most of our forests %People went to mountain cutting timber as they went to pour water from a river+[after Chambrier, historian] after 1850 numerous measures to re-establish the squandered forest heritage are committed. Cattle pasture into forest was forbidden. Cuttings area went greatly reduced. Plantations of uncovered areas undertaken.

Since end of the 19th century after Henry Biolley developed the cultural plentering the Canton advocate a respectful naturalistic sylviculture on small scale aiming to promote well structured and mixed forests %to a matter of the best possible care, to consider as well what has to be removed as what remains+[Biolley 1927].

After the mid of the 20th century the cultural plentering showed limits on the south slopes at lower elevation. Between 1943 up to 1950 repeated drought revealed the vulnerability of fir-stands at low elevation. This lead to set the primacy of respecting local site conditions for sylvicultural decision. A new strategy based on the phytosociological classification has been developed by Jâmes Péter-Contesse and Jean-Louis Richard.

In the sixties, phytosociological mapping allowed a better understanding of the vegetal entities. This support is still used as indicator of the ecologic and productive significance for sylvicultural decision, so as to adapt treatment forms and intervention intensities to a natural potential of the considered sites.

The sylvicultural act in our Canton is repeated well balanced and differentiated since a century and thus elevate the forest owners as privileged heirs of the inestimable richness of the forest heritage. Conscious of these values the cantonal legislator included some sylvicultural principles by the last revision of the forest law (1996).

Legislative foundation:

The Cantonal forest law from February 6th 1996 (LCFo) sets the general goals. Two of them consider directly the sylvicultural practice (§2, litt. b and c). *This law aims particularly to b) steer and maintain forests as natural habitat, in such a situation which allows the sustainable realisation of protective, economic social functions as well as maintain biodiversity c) ensure productive capacity in term of quality, quantity and diversity through a nature respectful sylviculture considering the characteristics of the sites.*

Article 5 LCFo [principles] express two main tenet of forest management:

- 1 Forest area has to be maintained*
- 2 pastured forests have to be maintained, their forest cover grade should allow a well balance between forest and pasture; as a matter of principle, grazing prairies parts should not diminish.*

Regarding forest management: Art. 40 LCFo [Main orientation] makes clear

- 1 Forest of the Canton should be managed and treated in appliance to specific main uses, as*
 - a) a natural habitat and landscape to be protected*
 - b) a heritage to be improved economically*
 - c) a natural renewable resource which utilisation favours environmental quality*
 - d) a protective vegetal cover*

Art 46 LCFo [sylviculture] is specifically dedicated to sylvicultural skills:

A nature respectful silviculture aims to ensure a sustainable yield in term of quality quantity and protective effects

It aims to constitute diversely structured stands adapted to site conditions by way principally of natural regeneration

It ensures a sufficient number of trees accomplishing a complete biological life cycle

Art. 51 LCFo [marking the trees] addresses the way of marking the trees for cuttings:

1 High forest trees before harvesting should be marked by a forest service official

Art 58 LCFo [clear cutting]

1 Clear cutting is forbidden.

2 Final cuttings similar in effect to clear cutting are only allowed for regeneration of light demanding species or for transformation of un-adapted stands to site conditions

3 Such cuttings should be foreseen in the management plan.

Aims and stance of the present document :

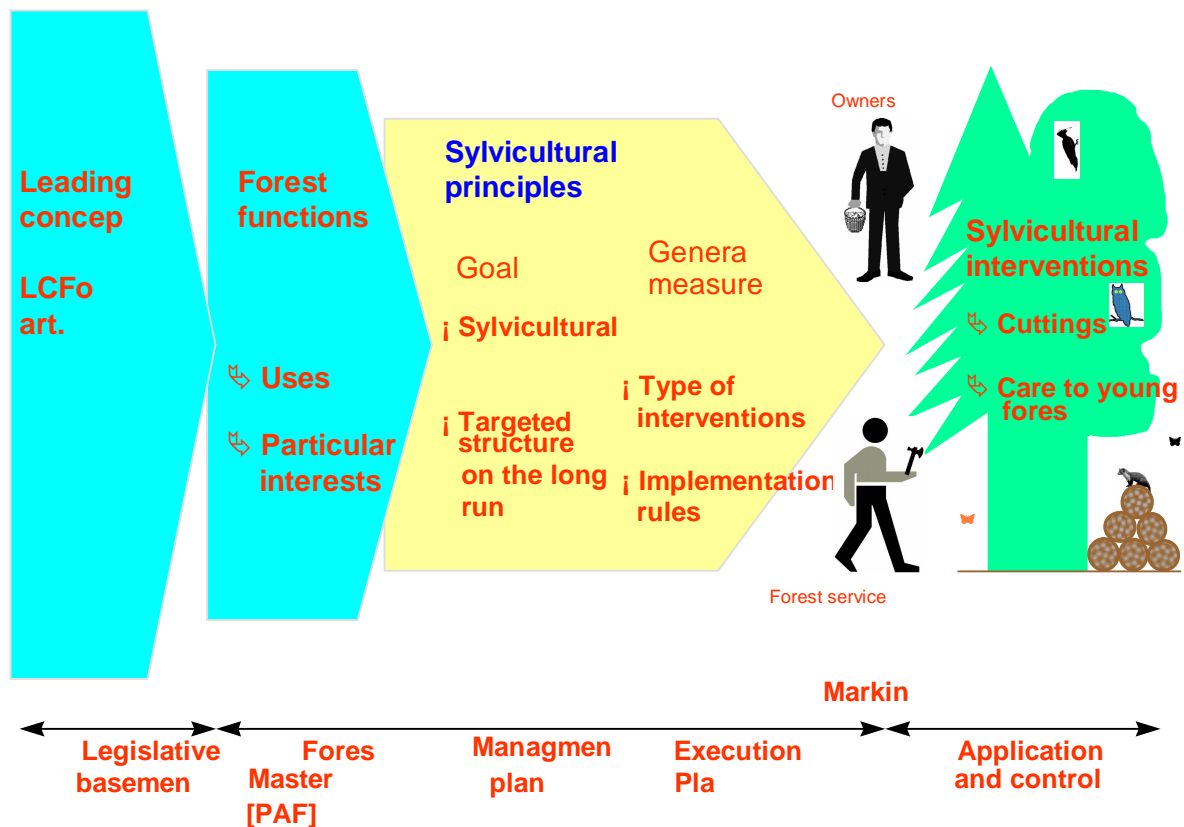
Multifunctional use and silvicultural skills stand in the nub of the new forest law. Aim of this document, addressed to every person interested in forestry is, over the strict legislative context, to define rules of application in order to fulfil numerous expectations to the forest from owners and collectivity, and to characterise treatment methods aiming at respectful polyvalent and economic management of the whole common heritage.

Our forest is certainly as precious as an oilfield or a goldfield because it renews constantly. Furthermore forest is a very complex living organism to which balance contributes numerous plants, animals, fungi, bacteria.

Our silviculture considers simultaneously four partners: forest owner, user, citizen and the forest itself; the silvicultural skills in this Canton allow at the same time the owner to manage his property, to sell the products, to produce services and to support an ecosystem.

In this spirit, objective of these silvicultural principles is simultaneously to

- improve the value of the heritage
- enrich the biodiversity
- to support common dialogue and contribute to good understanding of the silvicultural skills



2. Rules of implementation

2. 1. General rules

- “ Associating the different forest uses rather than dissociate. The conjunction of ever numerous needs expressed by the society renders unavoidable the principle of multiple uses. This principle of combination apply by the way for nature itself, because habitats are seldom used only from a unique species
- “ Maintain as large as possible ecosystem diversity leading to a variety of landscape
- “ Determining precisely the target structure on the long run for each compartment (eventually part of compartment) or parcel (for private ownership) from which depend the kind of treatment to apply.

<i>Targeted final structure</i>	<i>Kind of treatment to maintain structure</i>	<i>Kind of treatment to obtain structure</i>	Characteristics see annex
W single tree plenter forest	plenterring stem by stem	conversion cut	A1
2 groups plenter forest	plenterring by groups	conversion cut	A2
& irregular mosaic	cutting in irregulars mosaic		A3
e regular forest	cutting in extended groups		A4
W forested pasture	cutting for pastured forests		A6
G other structures	

Before realising any intervention in a forest it is necessary to know the targeted structure in the long run. It depends from former treatment, from site conditions, topographic conditions, from road network, main use. It is determinant by marking operations for the regeneration process and otherwise to steer harvesting operations on the different executive level.

~ Maintain continuity in the choice of different target structures. Once the targeted structured determined it's necessary to transmit it to every concerned actors in order to implement the treatment consequently. In forestry changes of treatment course during a stand development is not profitable, other than for cogently reasons.

~ Aim to vary treatment such to obtain a harmonic mix of as different structures as possible rather than foisting the same treatment everywhere (principle of treatment concomitance) [Schütz 1997]. Only multifunctional forests are able do adapt to continuous changes of expected uses. Emergence of new interests for patrimonial uses, particularly for biodiversity need to seek more for the complementarities of the systems rather than opposing them [Schütz]

~ Tree marking in the sense of free choice of cutting interventions [Hans Leibundgut 1949]. The silviculturist decides in appliance with the forest owner, the silvicultural techniques to be applied depending on the local and actual conditions, rather than only according to the management plan. Biolley formulated it as following: *Harvest should not be decreed* (1901) or in his work on management by the check method *Management is the observer and treatment the experimenter* (1920)

~ Favour natural regeneration and take heed of the real chances of succeeding when determining the goals. Intervention only when nature doesn't lead itself to the goals. Economic as well as ecologic necessities let prefer moderate interventions, which consider self-evolutive processes of forest development.

~ Apply differentiate treatment within the same stand. In the sense of a multifunctional and polyvalent silviculture, only a subset of the tree population is susceptible to produce high added value, others have potential for other uses like diversity, aesthetic, complexity or simply entourage.

~ Let realise tree species mixtures with respect to adaptation to the site conditions of the tree species (according to phytosociology) and the sociability of tree species. By silvicultural cares in young forest stages it's important to maintain a proportion of pioneer tree species. Only in a structured forest and mixing tree species canopy architecture and thus complexity of habitats increases sufficiently and permanently to create necessary conditions for enhancing the biodiversity [Schütz 1997]

~ Conservation of interesting local races (spruce, oak, Scots pine) by regenerating them naturally, as well as rare tree species like white beam, wild service-tree, service-tree, rowan, chestnut, European white elm, mountain pine, wild apple, wild pear, yew, linden, Italian maple and native black poplar should be reintroduced by seedlings or plantation. Tree species choice is one of the most determinant cores of silviculture. Depending on diverse site conditions in the Canton it is possible to constitute a great diversity of forest stands on a relative small scale.

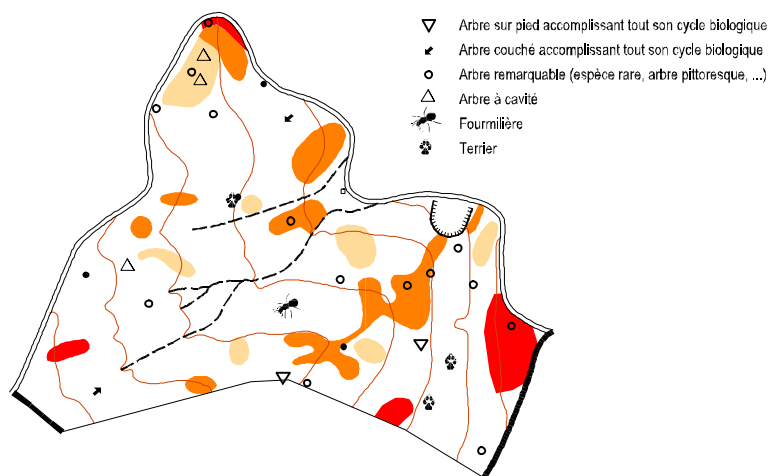
~ Promote structure in forest edges, shores and riparian forest even creating stand openings. Interfaces between different habitats are transition zones very important for fauna and flora. It is important to seek to structure them, enrich them, create sinuosity, promote microstructures with well-directed measures. Improving such transition zones needs continuous moderate repeated interventions aiming at by-pass regularity.

~ Maintain enough old trees accomplishing the whole biologic life cycle. Such protected trees far over the usual economic production time; old trees and dead trees, dispersedly or by small groups belongs to the forest biocenosis. Too much care for cleanness in forest reduces not only the soil productivity on the long run but the biodiversity as well. Old trees, dead trees as well as branch huddles belong to the biologic cycle and constitute important habitats and forage, particularly for birds, insects and fungi.

~ Timber harvesting should be careful for soil and stands including incorporated inhabiting fauna and flora. Thus respect habitats (or ecologic niches) like warren, pond, wallow, anthill, cavity trees, dry prairie etc. Soil is determinant for the ecosystem development and quality. Its care during harvesting work is essential. Forest machines shouldn't leave the hauling tracks and forest road which network should be particularly well organised and respected.

~ Sylvicultural interventions have to be moderate and repeated rather than concentrated. Unrespectful harvesting or interventions aiming at solving every problem in one operation are not appropriate. Sylvicultural achievement is never ended; a stable diversified well balanced forest once established continues to evolve. Its necessary to ensure its continuity through well balanced regeneration. *Regarding harmonious development of the trees, moderate and often repeated operations apply well to tree physiology than un-frequent and concentrated ones* [Biolley 1897]

~ Avoid too much order in forest; consider it as a biological system in dynamical equilibrium with environment, self-sufficient, extremely complex and apt to autonomic development+ [Ciancio & Nocentini 1996]. Aim of our sylviculture is to fulfil societal needs considering the dynamism and complexity of the living system.



Example of some natural values to be considered by sylvicultural operations

2. 2. Rules for particular single cases

Where the protective function predominates :

~ Favour a wealthy, young and dense forest. Where forest has particular protective functions (against rock fall, landslides and erosion) its important to maintain a high number of trees and avoid cover interruption on the soil; to be regenerated in small surfaces.

~ Regenerate by coppicing in broad-leaved stands. Coppice produce a high amount of sprouts which offer a good protection (slow down and stop) the stone falls and rocks of small dimensions

~ Favour tree species adapted to wounds by the rocks like sycamore and fir which good healing of the wounds. Avoid too large timber, particularly on moving soils, and at proximity of communication routes

~ If necessary let timber laying on the floor, almost partly, biaswise to the slope

Where the economic function predominates :

~ Favour species appropriate to the site conditions, able to produce a good financial return. If possible favour native species (spruce, fir, oak) without excluding introduced high productive species (Douglas fir, Larch) which are not enhancing particular risks to environment as well as for genetic conservation. If in not too excessive amount, such species get on well with native species, but bring supplementary touch to species diversity as well as good economic return to the owners.

~ Contribution to enrich the gamut of tree species. Tree species with high economic value (i.e. precious tree species) ensure a diversification of the yield, and constitute an important element of the biodiversity. It favours humus diversity, flora and fauna. With changing seasons the crown diversity and colours give an aesthetic compound to the whole landscape.

Where the social function predominates :

~ Avoid dangerous trees. Unhinged trees, rotten wounded trees with dead branches.

~ Favour particular beautiful tree with expressive shape, full forms, with character expressing power which merit respect; they represents landmark through time and contribute to poetry of the forest.

~ Clear view points with beautiful sight.

~ Use favourable light spots.

Where the biodiversity function predominates :

~ Adapt silvicultural treatment to improve biologic diversity according to particular goals (old growth patches) of habitats (health) or particular species protection (capercaille, butterflies, amphibians, orchids). Here is evidently an active and constructive collaboration with specialists necessary in order to set priorities and hierarchies for populations to be preserved (i.e. the choice between protecting white boar, fox or capercaille)

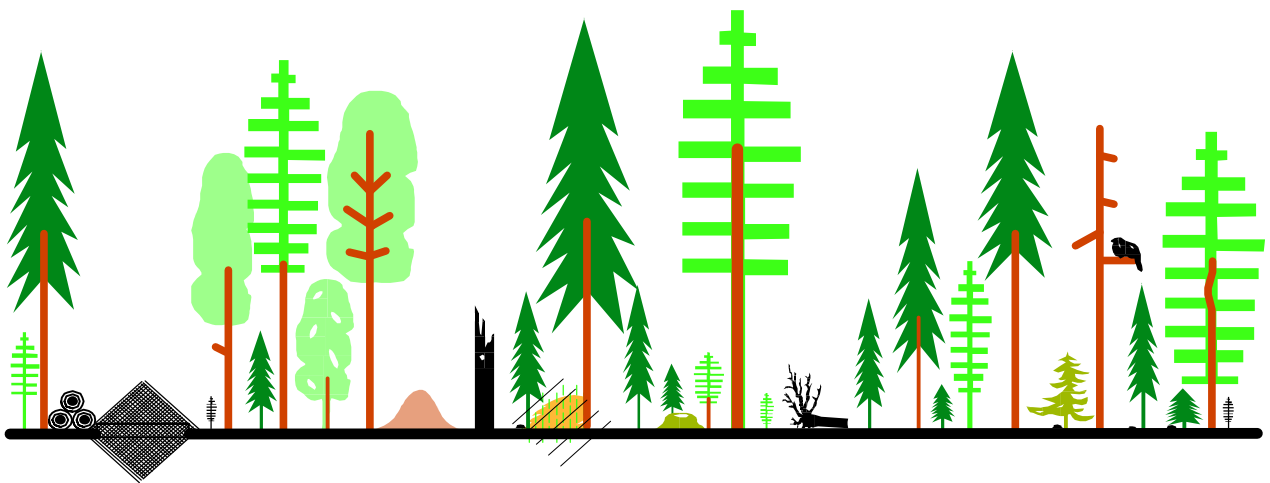
3. Sylvicultural systems

This chapter illustrates shortly the different stand structures issued from different treatments forms. See for more details annex 1 . 6

3. 1. Sylvicultural systems with general character

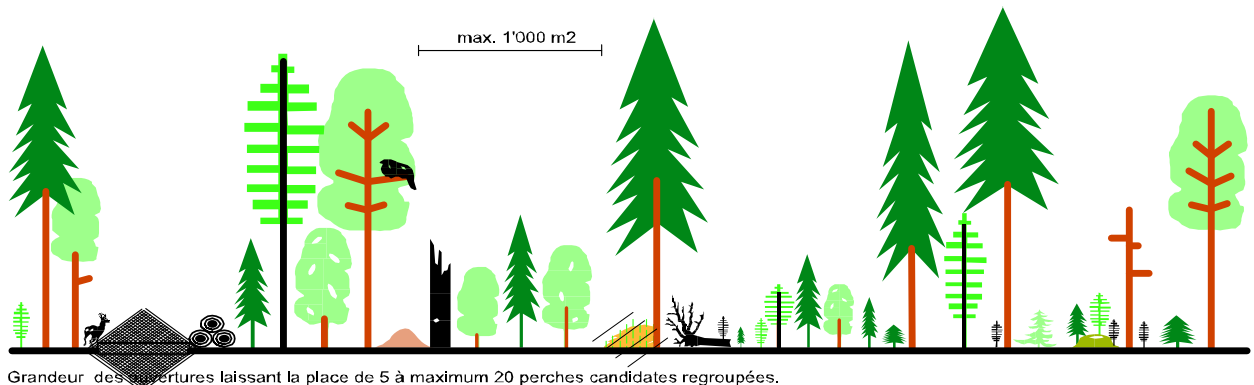
Stem by stem plenter forest

Structure resulting after a long run application of the plenter treatment. The definition of single stem plenter forest is a surface where all aged and all size trees live together permanently. Regeneration is continuous in space and time. General forest appearance doesn't change apparently



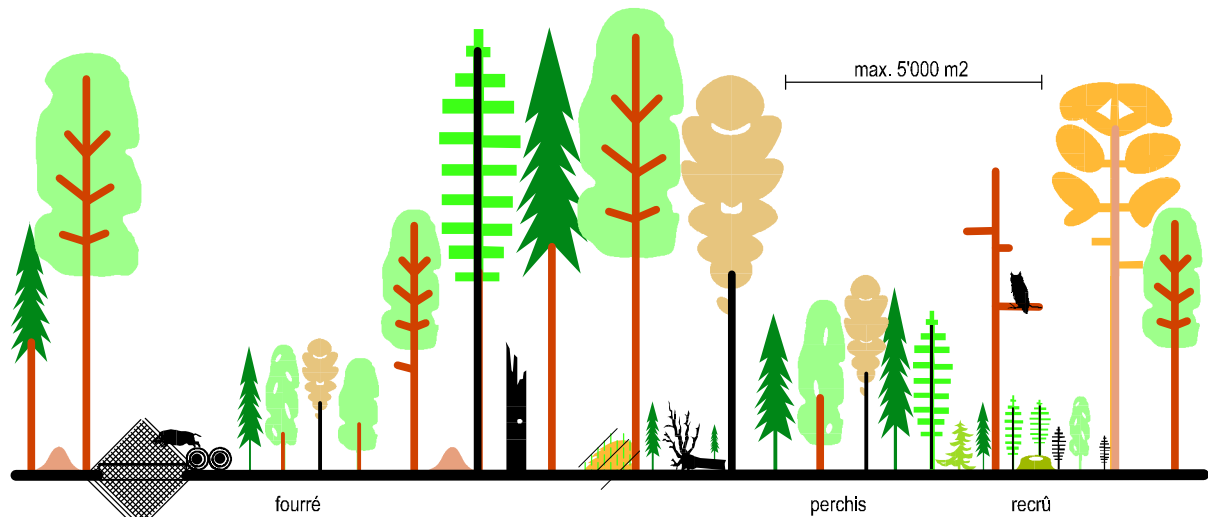
Group plenter forest

Structure resulting after a long run application of the group plenter treatment. The definition of group plenter forest; on the same space small trees collectives of all ages and size live together permanently. General forest appearance doesn't change apparently. No particular stands are perceptible.



Irregular mosaic forest

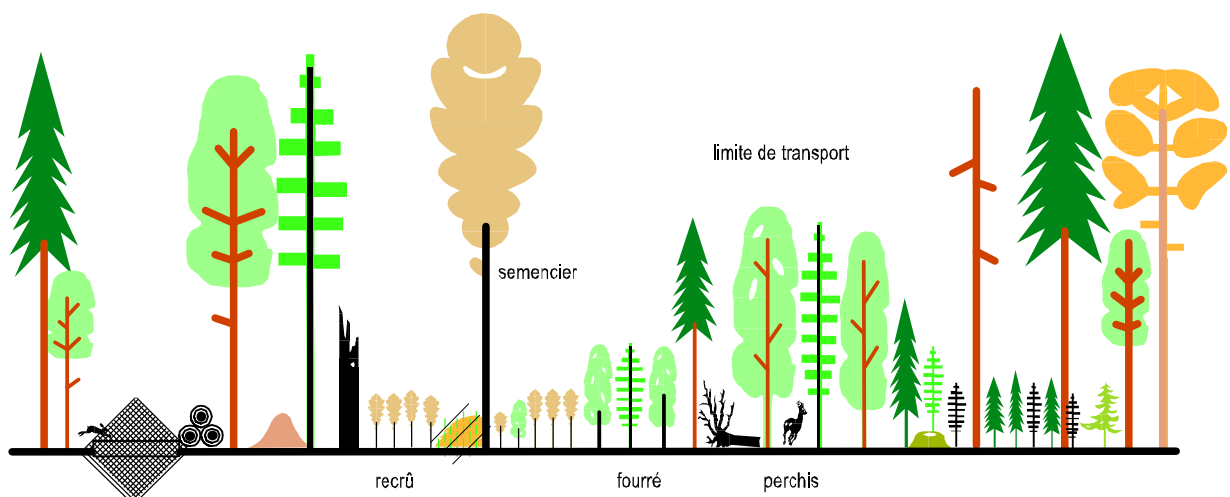
Structure resulting after a long run application of the irregular mosaic treatment. Here it is possible to distinguish small scale stand (not over 0.5 ha) not abutting and not ordered in space. On the same place appear the different developmental stages. General forest appearance is dynamic during time.



Grandeur des ouvertures laissant la place à maximum 100 perches candidates regroupées.

Irregular shelterwood with extendable groups

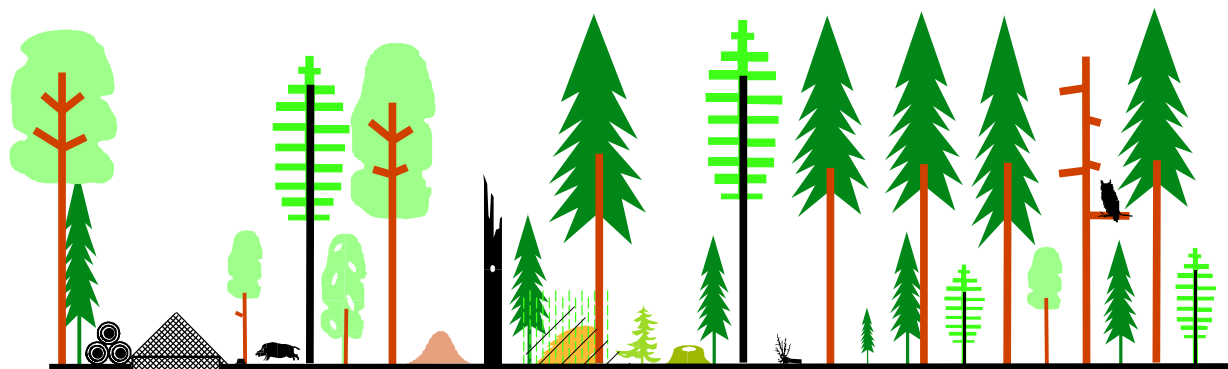
Structure resulting after a long run application of the irregular shelterwood with extendable groups. Forest with regular stands and horizontal closure. Here spatial order determines the operative behaviour. Stands are abutted corresponding to their age. Regeneration is initiated at the transportation limit. Forest is extremely dynamic during time.



Transition cutting

(synonyms: differentiation cutting)

Structure resulting after a long run application of the transition cutting: classical plenter forest. Intervention to change regular forest into irregular ones.

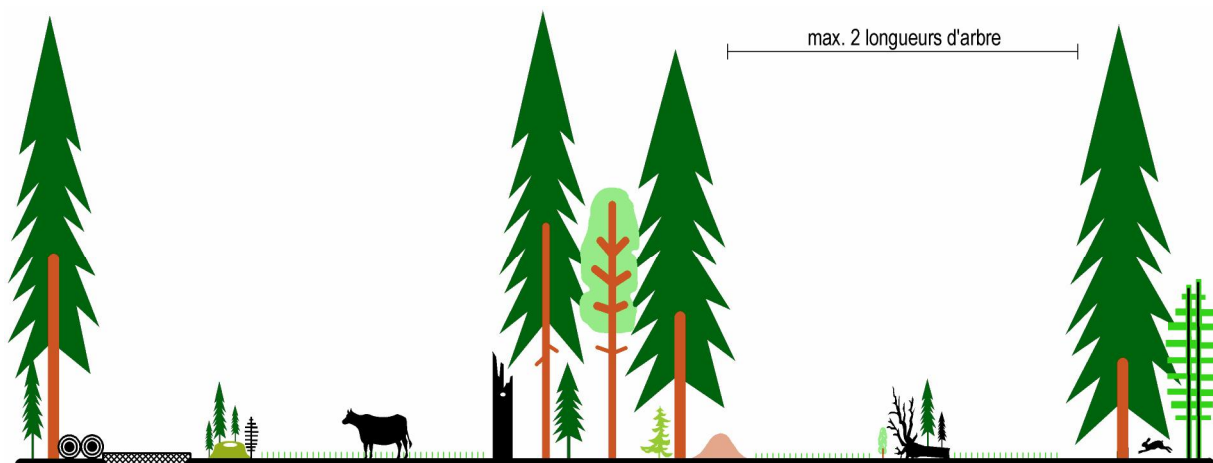


La coupe de conversion vise à déchirer la régularité. Le croquis ci-dessus représente une structure initiale à deux étages que la coupe de conversion répétée, telle qu'illustrée dans l'annexe 6, permet de transformer en forêt irrégulière.

3. 2. Silvicultural systems with particular character

Cutting on pastured forests

Structure resulting after a long run application of the treatment of pastured forests: Its comparable to group plenter forest with separated and dispersed collectives



4. Conclusion

The silviculture practice applied in our Canton aim generally to constitute and maintain forests at the same time which are

- Close to nature, apt to adapt to and prevent diseases.
- Stable, resistant against storm, ice or snow last and protecting water regime.
- Diverse, mixed, irregular containing enough ecologic niches.
- Of high quality producing continuously marketable high value timber.
- With different kind of structures; uneven sized stands with good regeneration and well developed undergrowth

In short: complex forest.

This aim need to apply a differentiate silviculture, free of reductionist schematism, coherent, which don't exclude any cutting form, but using a large panoply of silvicultural techniques leading to create a great variety of different ecosystems. In order to attain the goals such a silviculture requires evidently the proficiencies of qualified foresters and disposal of sufficient material and financial means.

Respect of these rules as well as knowledge and creativity of the foresters as their faculty of anticipating, varying and intuiting ensure the actual life framework and the patrimony to be transmitted to further generations. Furthermore it represents the appropriate way to fulfil the ever more numerous expectations of the collectivity to the forest. Implementing these rules signify imagine the forest of 2100.

La Chaux-de-Fonds 4th January 2001

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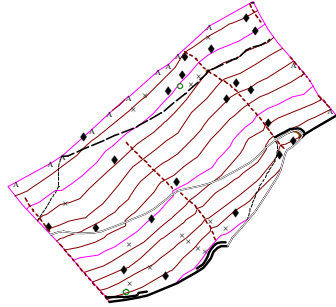
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Annex 1

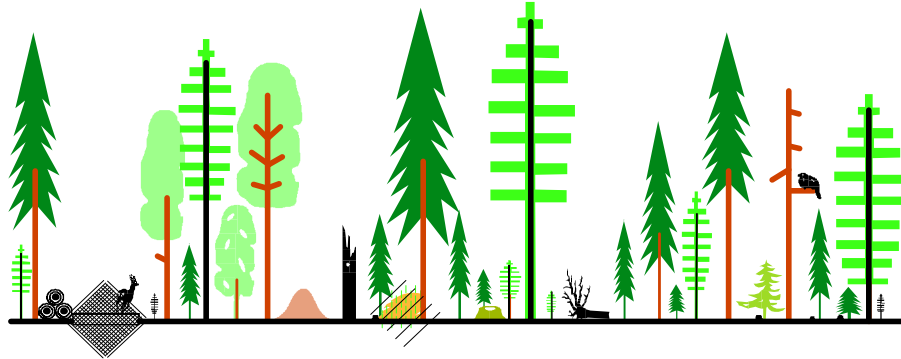
Characteristics of the stem by stem plenter system

Depiction of the obtained structure in the long run



- Standing volume distributed on the whole compartment.
- Regeneration in general individually or in small groups not over 250 m²
- No intentional interruption of the cover within compartment, great horizontal homogeneity
- No fences nor other artefacts to prevent game browsing.

● Vertical structure



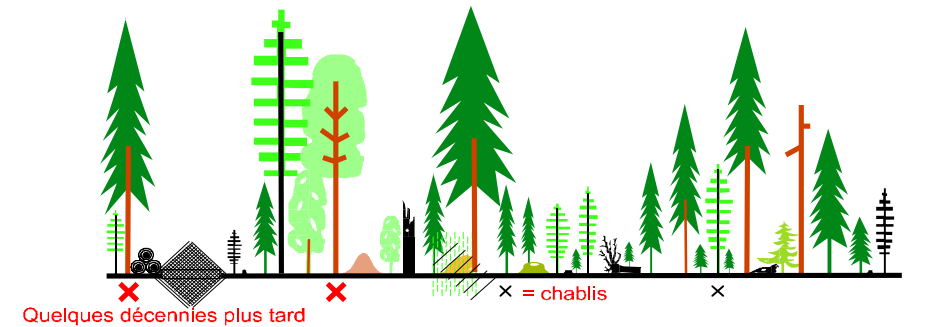
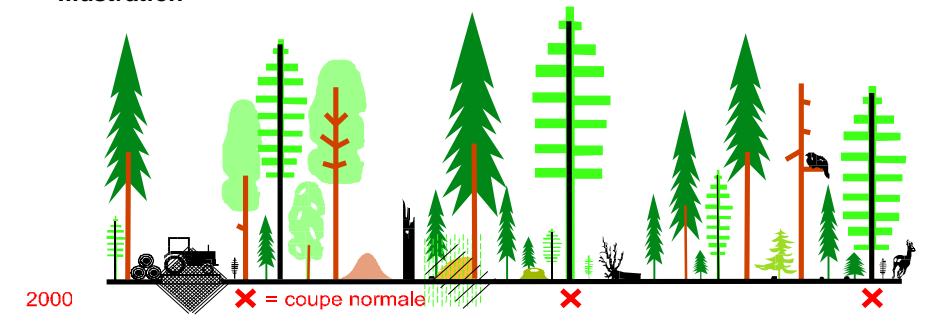
- Assimilation organs distributed over the whole space.
- Poles trees generally distributed over the whole compartment or in groups not exceeding 5 trees.
- Intermixing of all trees size, which crowns don't touch directly but are superposed. Long crown which give the tree a good resistance to storm damages. High vertical heterogeneity.

● Reference parcels

Essentially occurring in valleys and higher elevation of the Canton.

- Geneveys/Coffrane compartment. 7; Montalchez comp.10; Cernier comp. 11 (haut); Le Locle, Bois de Ville comp. 19; Couvet comp. 114

Illustration

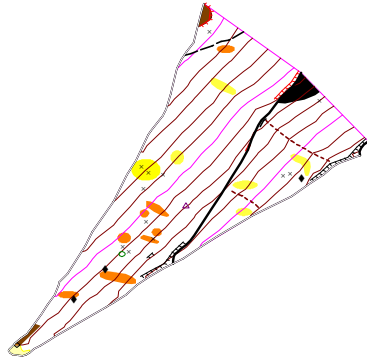


- Timber Harvest disseminated, need good extraction tracks, high qualified forest. Not appropriate on slopy conditions.
- Soil never bare, no canopy interruptions. Natural regeneration present on the whole floor so as to compensate removal for timber production. General appearance never changing.
- System limited to tolerant tree species, able to regenerate in shady conditions and to maintain long time in under shade (fir, spruce, beech, [sycamore, ash]). Broad leaved trees generally auxiliary.
- Only applicable in certain site conditions (fir-beech forests) and particularly on north slopes.
- Growth refrained in the first stages producing a narrow core in timber heart.
- Individual nurturing of the pole trees, free from lateral crown contact of same from the pole stage on
- Success thank to a well regulation of light up to the floor.

Annex 2

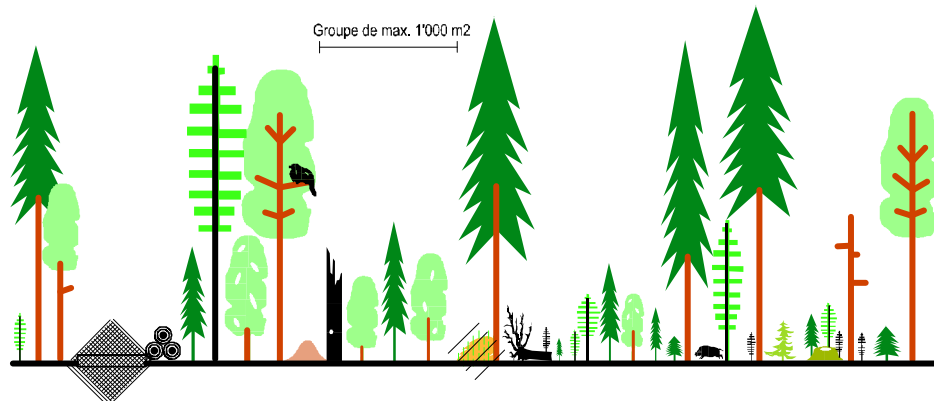
Characteristics of the group plenter forest :

- ☞ Depiction of the obtained structure in the long run
- ☞ Horizontal structure



- Standing volume distributed regularly on the whole area
- Regeneration mainly in small collectives, not over 1000 m².
- No grouping distinct, only small openings in the canopy, well distributed on the whole area.
- No fences nor other artefacts to prevent game browsing.

● Vertical structure

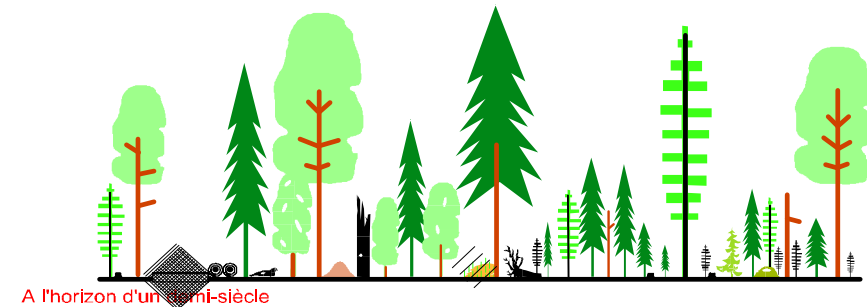
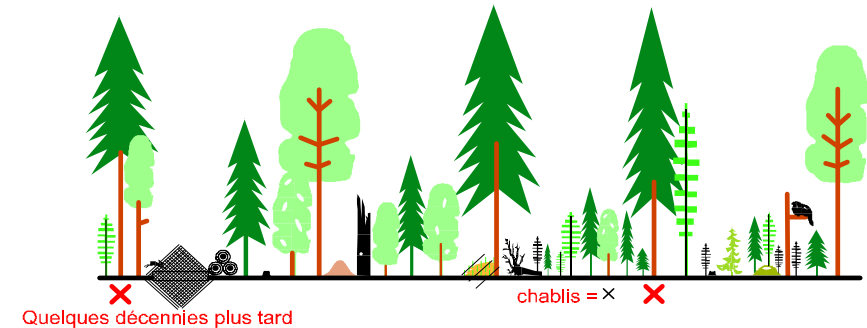
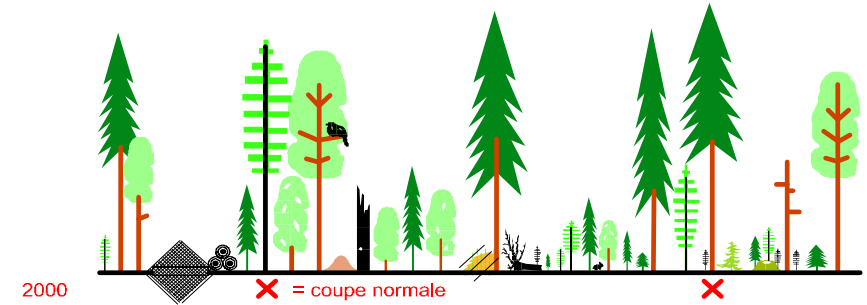


- Assimilation organs distributed practically over the whole space.
- Poles mainly in small groups not over 20 trees
- Long crown which give the tree a good resistance to storm damages. Great vertical heterogeneity.

● Reference parcels

- Ville de Neuchâtel, Les Joux comp. 30; Peseux comp. 22; Bevaix comp. 36; Dombresson comp. 8; Couvet comp. 111

☞ Illustration



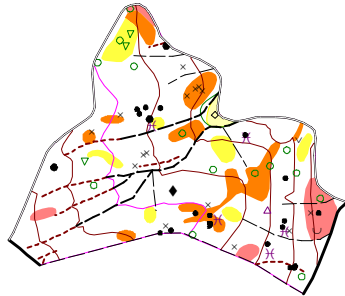
- Timber Harvest disseminated, need good extraction tracks, high qualified forest.
- Soil never bare, no canopy interruptions. Natural regeneration patchwise on the whole floor so as to compensate removal for timber production. General appearance never changing.
- System limited to tolerant tree species, able to regenerate in shady conditions and to maintain long time under shade (fir, spruce, beech, sycamore, ash). Support more broad leaved tree admixture than stem by stem plenter forest.
- Applicable on enlarged site conditions than the stem by stem plenter system and on south slopes.
- Growth refrained in the first stages producing a narrow core in timber heart
- Nurturing in small groups (see above) which are not enlarged
- Success thank to a well regulation of light spots up to the floor..

Annex 3

Characteristics of the irregular mosaic forest :

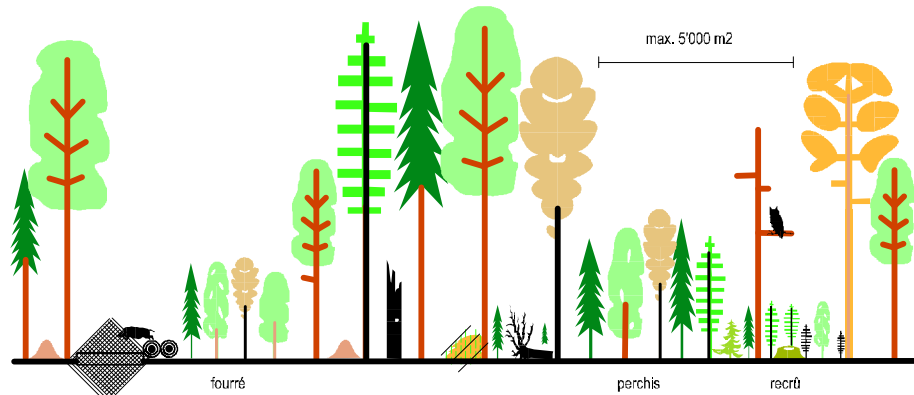
Depiction of the obtained structure in the long run

- **Horizontal structure**



- Standing volume irregularly distributed on the whole area. Presence of distinct small collectives un-abutting and distributed on the whole area, constituting a mosaic.
- Young stage patches on areas not exceeding 5000 m².
- Randomly distribution of the patches but not anarchic. The sylviculture process is not determined by the young collectives. Harmonisation of all stages Not young collectives determine the process It leads to a mixed structured and diversified forest with high horizontal heterogeneity.

- **Vertical structure**

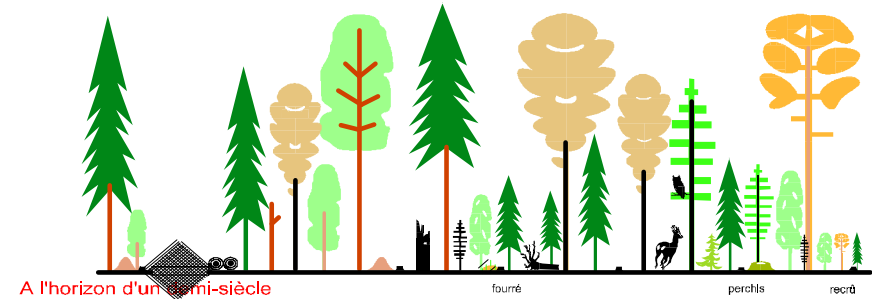
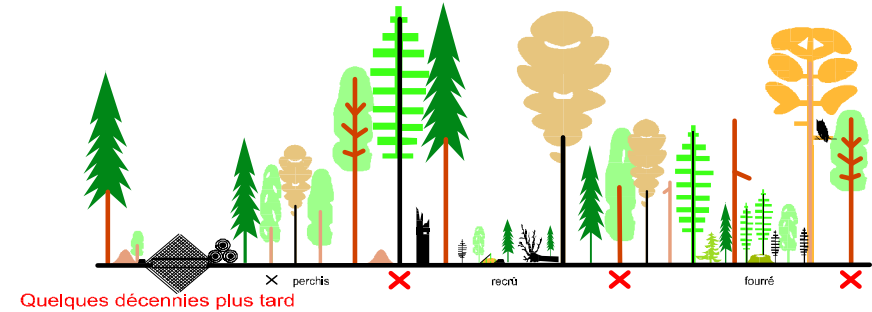
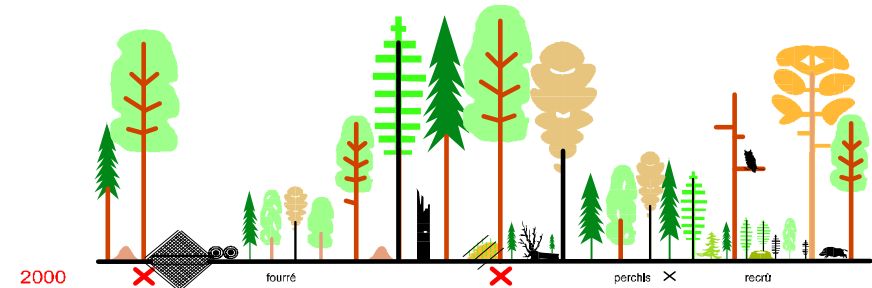


- Assimilation organs distributed over a great part of space
- Poles mainly in collectives not over 100 trees
- Shorter crowns than in plenter forest ; vertical heterogeneity in groups
- Control of sustainability by assessment of the different area of the collectives

- **Reference parcels**

- Ville de Neuchâtel, Chaumont comp. 46; Chanet de Colombier; Cortailod comp. 8; Savagnier comp. 25

Illustration



- Timber Harvest disseminated but more concentrated than in plenter forest, need good extraction tracks, high qualified forest work.
- Caring operations for the regeneration discontinuously in small patches. Enlarging the initial gaps not mandatory. Profile irregularity maintained by avoiding canopy closure in the upper storey.
- System allowing a large number of tree species, including precious tree species.
- Growth in the young stages faster than in the plenter forest.
- Nurturing cares collective. Particularly adapted for tree species demanding high lateral density to form good and straight boles (i.e. beech, linden) as well as for intolerant tree species (oak, cherry, pine, larch)
- Success through adequate repartition of the openings. It's important not to sacrifice yield potentials for enlarging too much the patches.

Annex 4

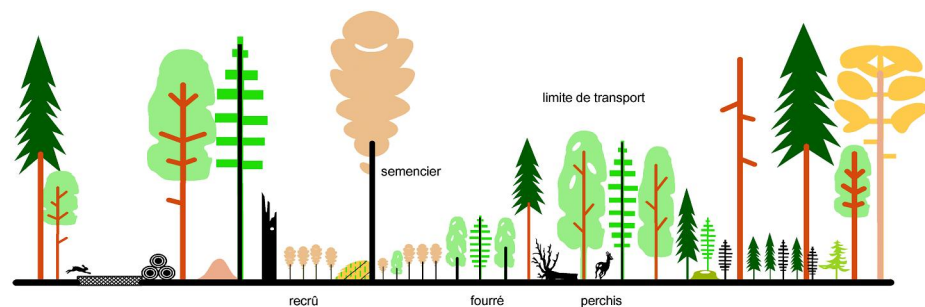
Characteristics of the irregular shelterwood with extendable groups : Depiction of the obtained structure in the long

● Horizontal structure



- Standing volume irregularly distributed on the whole area. Presence of distinct abutting collectives with relation to the transportation limit.
- Presence of canopy openings which are enlarged successively in order to ensure light regulation of the collectives. Area of the groups over 5000 m²
- Spatial order according to harvesting criterias and risks. Great horizontal heterogeneity.

● Vertical structure



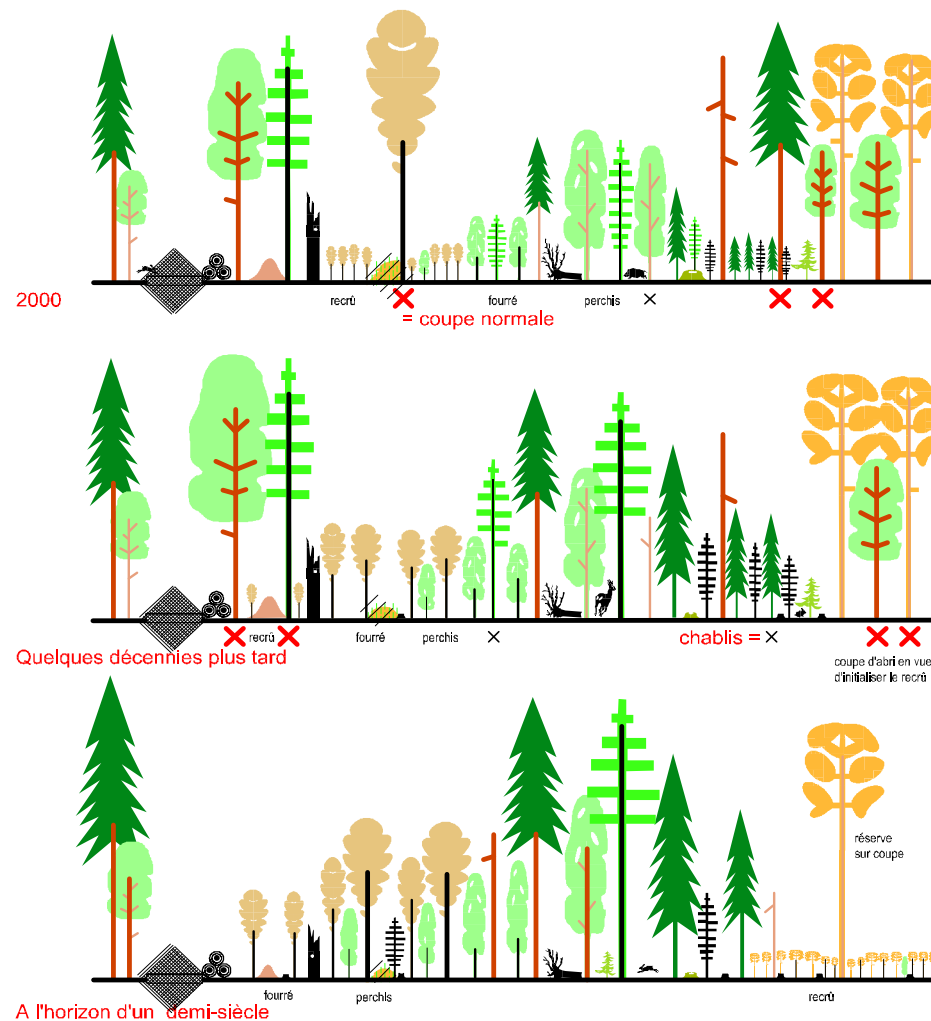
- Assimilation organs not distributed everywhere.
- Crown shorter than in the plenter forest resulting from a harsher competition in the crown layer.

● Reference parcels

Essentiellement dans le bas du canton afin de perpétuer nos espèces *héliophiles* ainsi que sur les pentes abruptes.

- Ville de Neuchâtel, Chaumont comp. 39; Corcelles comp. 18; Boudry comp. 2

Illustration



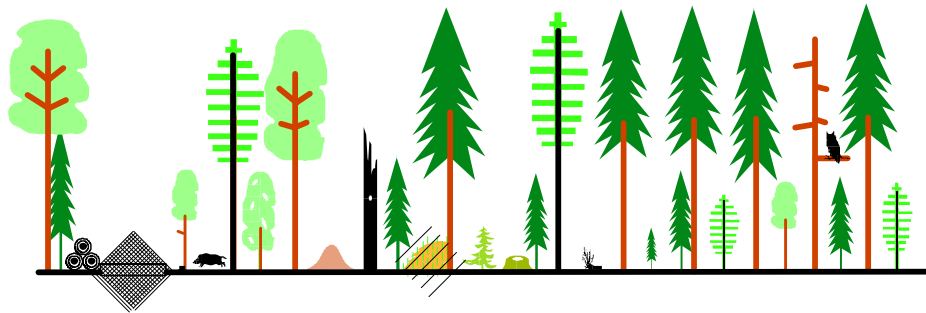
- Harvest concentrated, high qualified forest work needed.
- The collectives are enlarged according to a particular well established spatial order.
- System adequate for the most intolerant tree species (oak, pine, larch).
- Applicable even in not well served compartments or in slopy conditions
- Fast growth in the youth. Often two storeyed stands.
- Collective nurturing par collectifs. Particularly adapted for tree species demanding high lateral density to form good and straight boles (i.e. eech, basswood)
- Success thank good spatial order and light regulation in the canopy.

Annex 5

Transition cutting:

Depiction of initial structure

Vertical structure



– System for transforming regular to irregular and mixed forests

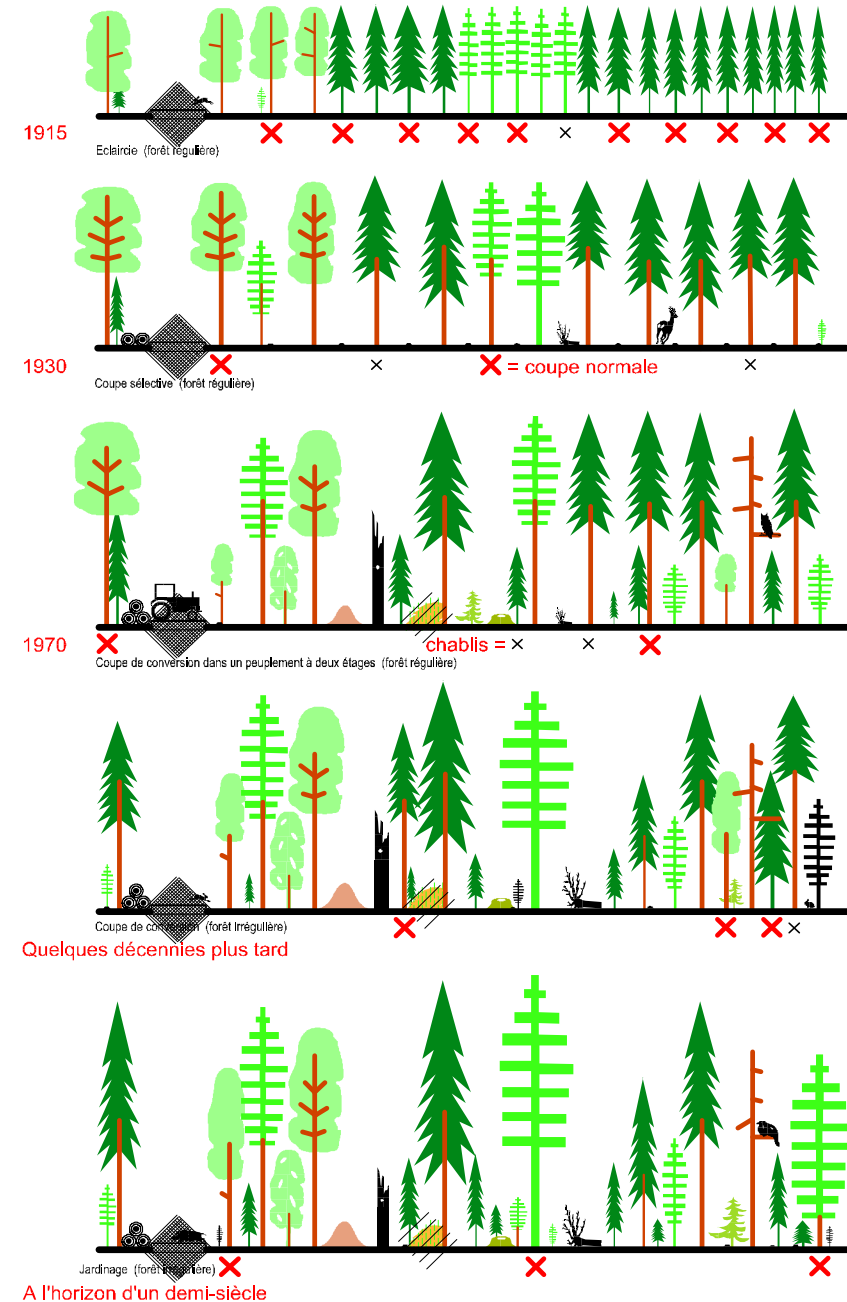
Depiction of the treatment (see on the right)

- Example of the forest in La Joux Pélichet, issued of plantation in 1900.
- Main effect is to interrupt horizontal closure through gaps or patches
- Irregular harvesting. Need good extraction road and tracks system and high qualified work.
- Success through dispersed opening the canopy and disrupting regularity.

References parcels

- Ville de Neuchâtel, Grand Vy comp. 8; Peseux comp. 11; Savagnier comp. 15; Le Locle, La Joux Pélichet; Couvet comp. 204

Illustration Here forest of la Joux Pélichet

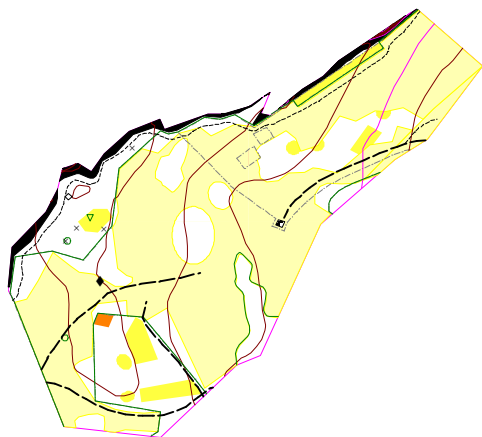


Annex 6

Characteristics of the cutting on pastured forests :

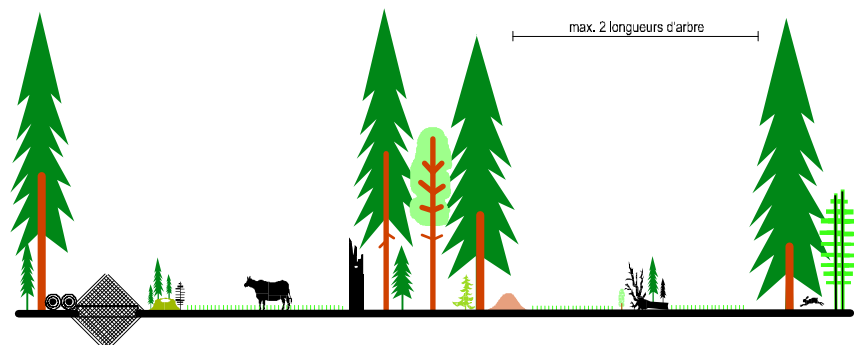
Depiction of final structure (forested pasture)

● Horizontal structure



- Very irregular distribution of the standing volume.
- Harmonious balance between pasture and tree groups
- Pasture is mandatory to maintain the system.

● Vertical structure

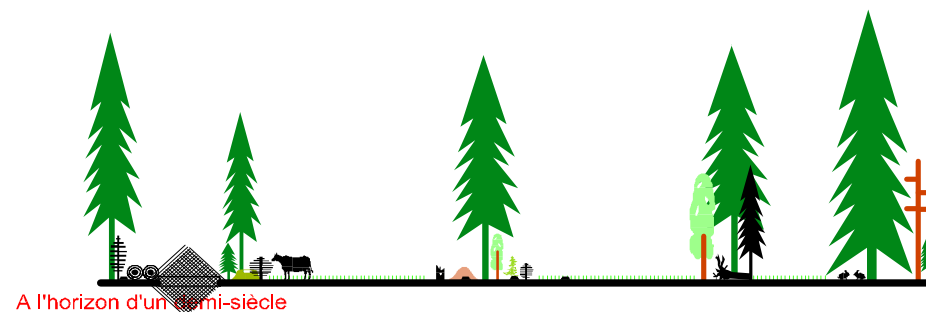
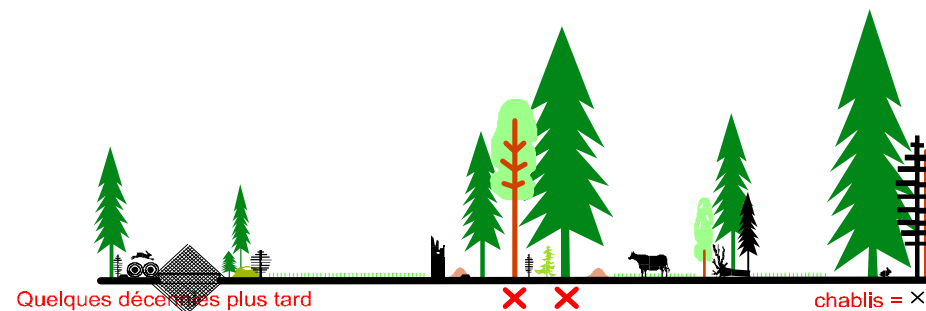
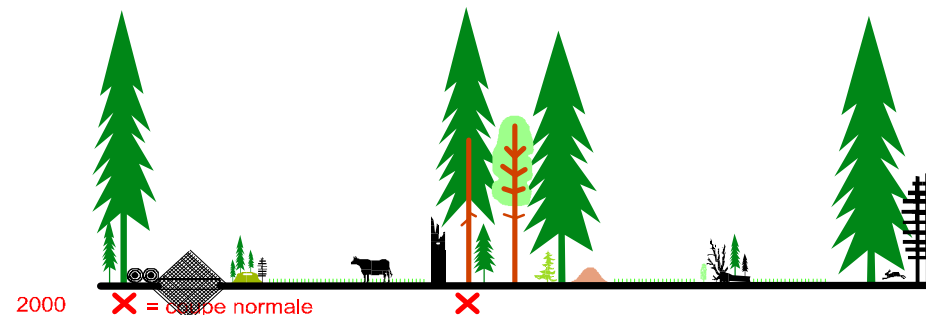


- Very long crowns, protecting against storm damages.
- Tree mostly in groups with branches all around; scarce timber quality.

● Reference parcels

- Lignières comp. 40a et 41a; Les Pradières comp. X; Bevaix comp. 40; Cernier comp. 29P; Communal de la Sagne

Illustration



- Very dispersed harvest.
- Natural regeneration in small collectives on favorable micro sites (stump, rock, thorn shrubs) Often need particular protection or even assistance.
- System applicable with following tree species : spruce, sycamore, beech, white beam, rowan
- The particular appearance is more important than timber yield.
- Comparable to group planter system
- Nurturing in small collectives.
- Enlarge good pastures prairies.
- Success through well balance between pasture and tree groups.

