A SYSTEM FOR THE CLASSIFICATION OF SERAL ECOSYSTEMS WITHIN THE BIOGEOCLIMATIC ECOSYSTEM CLASSIFICATION SYSTEM FIRST APPROXIMATION

by
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February 1988

Province of British Columbia
Ministry of Forests and Lands

This publication is RR87004-HQ

Copies of this report may be obtained, depending upon supply, from:

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Citation:

Hamilton, E. 1987. A system for the classification of seral ecosystems within the biogeoclimatic ecosystem classification system: First approximation. B.C. Min. For. Lands Research Report RR87004-HQ.

ACKNOWLEDGEMENT

Funding for this work was provided by the Research Branch of the B.C. Ministry of Forests and Lands. Thanks are extended to the many people who contributed to this study, and in particular to those who advised and/or reviewed the final draft: S. Arno, A. Banner, T. Braumandl, C. Clements, D. Demarchi, J. Foote, F. Hall, A. Harcombe, K. Klinka, T. Lea, T. Lester, D. Lloyd, D. Lousier, A. MacKinnon, D. Meidinger, B. Mitchell, F. Nuszdorfer, B. Nyberg, R. Page, J. Parminter, J. Pojar, D. Simmerman, O. Steen, and J.W. Thomas.

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INTRODUCTION

This report outlines the framework for encorporating seral ecosystems into the B.C. Ministry of Forests and Lands, Research Branch, Biogeoclimatic Ecosystem Classification (BEC) system. The seral framework is designed to be modular, so that general classifications of structural changes over time can be identified for large treatment units, as well as allowing for the development of more detailed site specific seral progressions. A 'central concept' for each stage is defined, recognizing that there is a great deal of variation in the patterns of vegetation development across the province, and in many cases succession will not follow the progression outlined.

The next step in the development of a classification system will be the actual identification of seral progressions. It is proposed that the seral development patterns expected after harvesting and site preparation treatments be outlined for the most widespread and important forest types. This will be done through linkage with the database available through the B.C. Ministry of Forests and Lands Inventory system, once the necessary cross links between Inventory map units -- defined largely on the basis of stand age and height -- and seral stages have been developed, and once the biogeoclimatic ecosystem classification system information is added to the database to facilitate ecosystem mapping.

EXISTING BIOGEOCLIMATIC ECOSYSTEM CLASSIFICATION (BEC) SYSTEM

The BEC classification system was designed to facilitate the development of management prescriptions for mature forest ecosystems. The existing BEC system includes hierarchical site, vegetation, and zonal (climatic) classifications (Figure 1) (Pojar et al. 1987). The site classification provides a framework for the identification of land units that support or

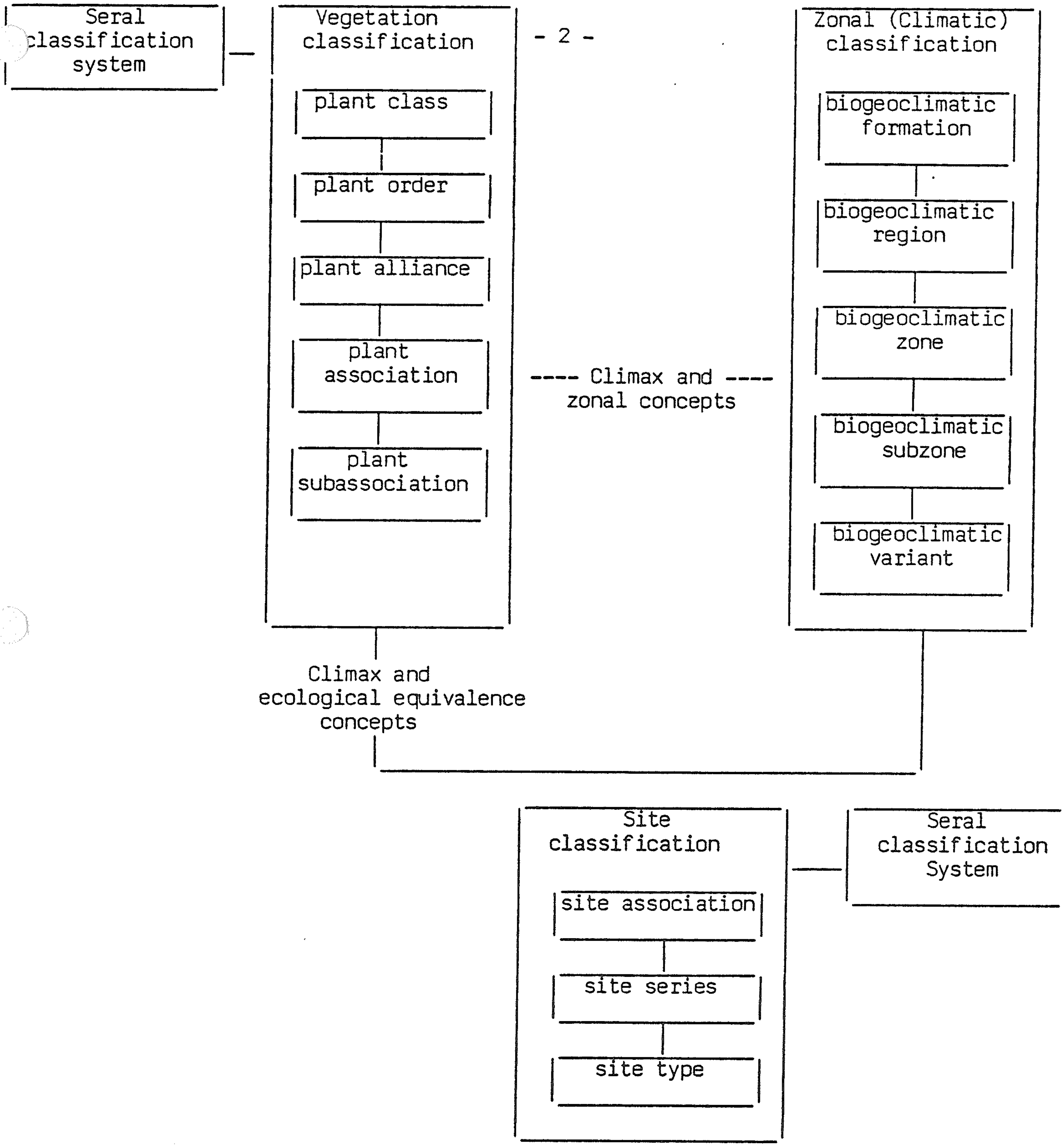


FIGURE 1. Categories and relationships of the three classifications integrated in the biogeoclimatic ecosystem classification, and the seral classification system. The seral classification system is linked directly to the site classification and vegetation classification (adapted from Pojar *et al.* 1987).

have the potential to support ecologically equivalent ecosystems that feature similar plant associations at climax. Plant communities are grouped on the basis of floristic similarity, providing the vegetation level classification of mature forested and non-forested communities. The zonal classification is used to identify geographic areas that have a similar climatic regime and which, therefore, would be expected to support similar ecosystems at maturity. This system is ideally suited to accommodate the classification of seral ecosystems at the site level. Since environmental properties used to identify a site are assumed to remain fairly constant through the seral sequence, seral pathways (which may differ in the mature plant association because of management practices) can be developed for one site.

The existing BEC system was developed largely through the sampling of stands that were considered to represent the "climax" state. However, in some cases where climax ecosystems are uncommon, earlier seral stages would be used. In these situations the sampling was done to develop a classification designed to characterize sites that differ in moisture and nutrient regime.

This type of classification should be distinguished from the classification approach proposed in this report, which is restricted to differentiating the seral sequence into floristically and functionally similar units that will change over time; and is separate from the type of classification of seral stands used to develop the basic BEC framework.

SERAL CLASSIFICATION SYSTEM

It is proposed that seral ecosystems be differentiated on the basis of both floristic and structural/developmental attributes. Integration of seral ecosystem classification into the existing BEC system would be done at the site classification level, through identification and prediction of the sequences of seral plant associations and structural/developmental stages that occur over time on a site.

Vegetation Level

Seral plant associations will be differentiated according to the criteria for the identification of mature plant associations outlined in Pojar et al. (1987). These criteria specify that each association must have a diagnostic combination of species (DCS) that may include character, differential, or companion species. Each association must include one differential or dominant differential species, with the exception that within a circumscribing alliance one association can be differentiated by the alliance DCS (i.e., by a lack of an association level DCS). The use of these criteria allows a change over time in the composition of the main canopy or in the presence of key species, to be used as a basis for the differentiation of seral plant associations. Table 1 gives an example of the DCS identified for the climax plant association -- which in this case is also characteristic of the whole seral sequence -- and the DCS that characterize each seral plant association. In some cases the climax DCS may not be present in very early seral stages.

Development of a hierarchy of seral plant associations, alliances, and orders will be done, with the seral plant association used as the basic unit in the vegetation classification.

The convention of using two species names to identify the seral plant association will be followed. Seral plant associations will be named using a scientific name, but a common name can be used where appropriate. A "$" will be used to signify that a plant association is seral.

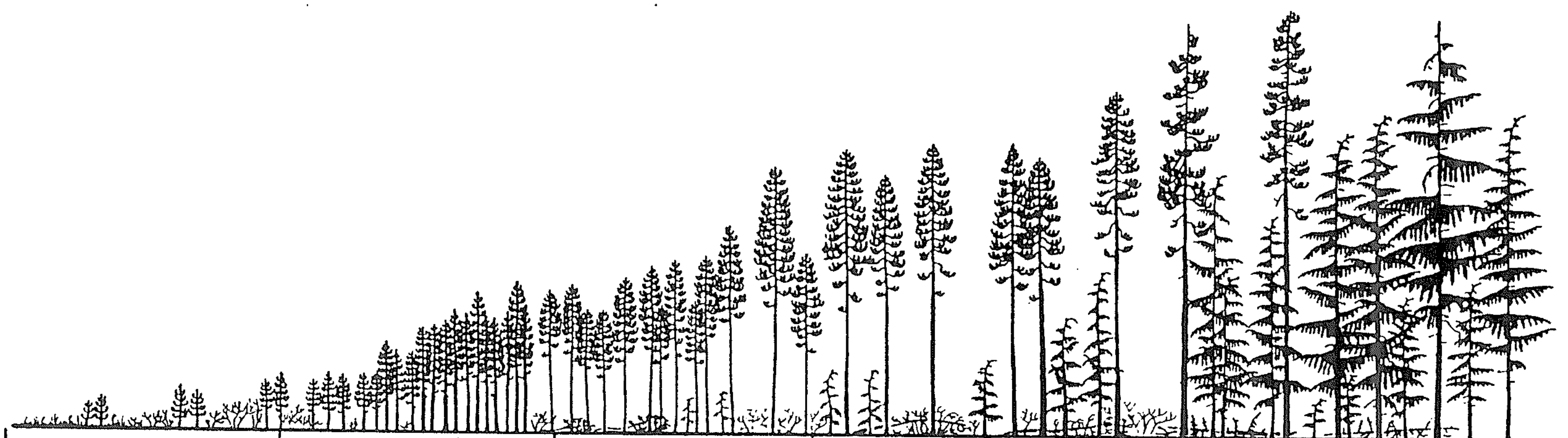
Structural/Developmental or Seral Stages

Stand structure will be used along with other attributes to identify seral stages. These stages are expected to differ in functioning and therefore in associated values. The proposed seral stage model (Figure 2) closely follows that used by the USDA Forest Service (Thomas et al. 1979; Hall 1980; Arno et al. 1986) and recommended by Harcombe (1984). Although these stages are most applicable to closed forest succession, the basic concepts can be adapted to open forests. Some of the features used to differentiate stages including evidence of self thinning, would not be evident in open forest succession.

TABLE 1. Classification of seral plant associations in the ICHal/01: *Vaccinium* - *Gymnocarpium* site series[a]

Seral Plant Association	$[b] Fireweed - red raspberry	$ Lodgepole pine - thimbleberry	$ Lodgepole pine - western hemlock	Western hemlock - oakfern	
Diagnostic species					
Epilobium angustifolium d	V 50				DCS for each seral plant association
Rubus idaeus d	V 20				
Rubus parviflorus dd	III 2	III 10			
Pinus contorta dd		IV 40	IV 10		
Tsuga heterophylla dd			V 20	50	
Gymnocarpium dryopteris dd	V 5	IV 10	V 15	40	DCS for the climax plant association and characteristic of the site series
Vaccinium membranaceum	V 10	IV 5	III 10	10	
Cornus canadensis	IV 3	IV 5	V 10	10	

[a]Key:
ICH - Interior Cedar-Hemlock Zone
ICHa - Moist Southern Interior subzone.
ICHal - Lower Columbia - Kootenay variant.
ICHal/01 - Zonal association in the ICHal, which supports the *Vaccinium* - *Gymnocarpium* plant association.
d - differential species (see Pojar *et al*. 1987).
dd - dominant differential species.
DCS - diagnostic combination of species.
[b]$ will be used to signify that a plant association is seral.



Seral stage	Shrub-herb (SH)	Pole-sapling (PS)	Young Forest (YF)	Mature Forest (MF)	Old-Growth (OG)
Seral plant association (common name)	$ Fireweed - red raspberry	$ Lodgepole pine - thimbleberry		$ Lodgepole pine - western hemlock	Western hemlock - oakfern
Site association	Vaccinium - Gymnocarpium				

FIGURE 2. Example of classification of seral stage and seral plant association in a site association.

Seral Stage Definitions

Seral stages were defined on the basis of several attributes that change over time including stand age, vegetation physiognomy, stand structure, mortality/replacement relationships and stand diversity. The following descriptions are intended only to assist in the recognition and classification of stages and are not proposed as rigid definitions.

Shrub-herb stage (SH)

This stage develops after a disturbance in which the forest canopy is completely or significantly removed (e.g. after clearcut logging or a severe fire) and typically lasts up to fifteen years, although it may persist much longer. The vegetation is characterized by the dominance of shrubs and herbs; young trees are also abundant although not dominant. Establishment is the primary process; biomass increases rapidly and floristic diversity is often high. This stage can be subdivided into three phases: a grass forb (GF) phase, a low shrub (LS) phase (< 2 m in height), and a tall shrub (TS) phase (> 2 m in height). Succession may proceed from the grass forb phase to the tall shrub stage or alternatively from the grass forb stage directly to the pole-sapling stage.

Pole-sapling stage (PS)

This stage typically begins about five to fifteen years after a disturbance, when the young trees overtop the shrubby or herbaceous vegetation. It usually lasts for up to thirty years, but may persist indefinitely -- as in the case of some lodgepole pine stands in the Interior. Trees at this stage are characterized by their vigorous growth and lack of dead lower branches. Stands are more or less even-aged, having been planted or established naturally within a relatively short time. Establishment remains the dominant process with stand biomass continuing to increase. Understory biomass declines as the tree canopy closes in.

Young Forest stage (YF)

This stage begins when self-thinning becomes evident. A second cycle of trees may begin to show a significant presence in the ground layer by the end of this stage. Differentiation of the initial tree species into dominant, codominant and suppressed layers, self-thinning, low stand diversity, and increasing biomass through rapid height growth are characteristic of this stage. Understory development is often limited by the dense forest canopy. This stage usually starts about 30 years after a succession initiating disturbance and lasts for up to fifty years. In open forests where self thinning may not be evident and a second cycle of trees is lacking, this stage will be characterized more by the vigorous growth of the trees.

Mature Forest stage (MF)

This stage extends until the initial trees mature, height growth slows and some of the initial trees begin to die. A second cycle of trees may show a significant presence in the lower tree layers. In some cases the first cycle of trees may begin to die from old age before significant development of a replacement layer begins; in other cases the next cycle of trees may be well developed before significant mortality of the initial trees occurs. Generally the even age distribution typical of early stages changes as new trees become established and older trees begin to die. Gap phase replacement may begin to be important at this stage. The understory redevelops as the canopy opens.

Old Growth stage (OG)

Old growth stands generally have an all-age class distribution. Growth slows and volume is lost through rot. Stands show structural heterogeneity as gaps develop in the canopy after dead trees fall. The understory biomass increases as more light becomes available. The presence of dead snags and rotting logs scattered on the forest floor enhances the value of forests at this seral stage for wildlife. This stage often begins about 250 years after a succession-initiating disturbance.

Integration

An example of a seral classification developed for a hypothetical site association in the Interior Cedar - Hemlock Zone is shown in Figure 2. The illustrated correlation between the seral plant associations and the seral stages may not always occur.

Nomenclature and Levels of Refinement

The nomenclature proposed for identifying seral plant associations and seral stages is outlined in Tables 2 and 3. Options exist for identifying seral plant associations, seral stages or both. This type of classification can be made at the site association or site series level. Different levels of refinement would be used for different purposes. In some cases the seral stage designation may be sufficient while in others identification of the seral plant association at the site series level may be needed.

Multiple Pathway Seral Sequences

An example of a simple sequence of seral ecosystems after different site treatments is illustrated in Figure 3. Similar sequences could be developed for pathways that do not converge because of different management activities.

Stand Attributes

Additional attributes may be used to further characterize a seral ecosystem. Any of the standard B.C. Ministry of Forests and Lands Inventory attributes available in the forest cover database, including stand age or age class, stand height, crown closure - as a percentage or a class (see Harcombe 1984) and stocking could be used. Other important attributes, not in the inventory database, might include key understory species (such as browse species), humus layer attributes, fuel loading, abundance of downed woody material, or lichen abundance (see Table 4). The attributes of interest will be determined by the interpretations to be made from the classification system.

TABLE 2. Nomenclature used to identify basic components of the existing BEC system and seral classification system

Basic Components	Nomenclature
Site association[1]	Vaccinium - Gymnocarpium
Site series[1]	ICHa1: Vaccinium - Gymnocarpium
Seral stage[2]	Shrub - herb or (SH)
Seral plant association[3]	$ Epilobium angustifolium[4] - Rubus idaeus

[1] Definitions provided in Pojar et al. 1987.
[2] See Figure 2 for abbreviations for seral stages.
[3] Seral plant associations may also be referred to by their common names.
[4] A abbreviated symbol for each species name can also be used, i.e., the conventional seven letter codes - Epil ang.

TABLE 3. Nomenclature used to identify seral plant associations and seral stages at the site association and site series level

Level	Nomenclature
Seral stage at the site association level	Vaccinium - Gymnocarpium - $ (SH)
Seral stage at the site series level	ICHa1: Vaccinium - Gymnocarpium - $ (SH)
Seral plant association at the site association level	Vaccinium - Gymnocarpium - $ Epilobium angustifolium - Rubus idaeus
Seral plant association at the site series level	ICHa1: Vaccinium - Gymnocarpium - $ Epilobium angustifolium - Rubus idaeus
Seral plant association and stage at the site association level	Vaccinium - Gymnocarpium - $ Epilobium angustifolium - Rubus idaeus (SH)
Seral plant association and stage at the site series level	ICHa1: Vaccinium - Gymnocarpium - $ Epilobium angustifolium - Rubus idaeus (SH)

Treatment	Seral Stage: Shrub Herb	Pole-Sapling	Young Forest	Mature	Old Growth
Burning and planting	$Pseu men[a] Epil ang →	$Pseu men Shep can →	$Pseu men Shep can →	$Pseu men Shep can →	Pseu men Shep can
No site preparation	$Pinu con Cala rub →	$Pinu con Shep can →	$Pinu con[c] Shep can →	Pinu con Shep can →	Pinu con Shep can

a The vegetation within one box belongs to the same plant association.

b Key:

Epil ang	*Epilobium angustifolium*
Cala rub	*Calamagrostis rubescens*
Pseu men	*Pseudotsuga menziesii*
Pinu con	*Pinus contorta*
Shep can	*Shepherdia canadensis*

c This unit within the dotted lines would be identified by the symbol IDFzl/01 — $Pinu con-Shep can (YF) and would be called the $ *Pinus contorta* - *Shepherdia canadensis* seral plant association, a young forest seral stage of the IDFzl: *Pseudotsuga* - *Shepherdia* site series.

FIGURE 3. An example of a seral sequence developed for the IDFzl: *Pseudotsuga* - *Shepherdia* site series.

Table 4. An example of a seral classification sequence for the IDFz/01 site series illustrating seral stage attributes of interest to silviculturalists

Treatment of disturbance	Stand[a] attributes	Seral stage: Shrub-herb	Pole-sapling	Young Forest	Mature Forest	Old Growth
No burning natural regeneration	Seral plant association	$Pseu men[b] Shep con				
	age (yrs)	0-5				
	height (m)	0-1				
	crown closure (%)					
	stocking (st/ha)	300-400				
	humus form[c]	0.HU				
Burning and planting DF at low stocking	Seral plant association	$Epil ang. Pseu men				
	age (yrs)	0-7				
	height (m)	0-1				
	crown closure (%)	1-10				
	stocking (st/ha)	800				
	humus form	0.VM				
Burning and planting DF at high stocking	Seral plant association	$Epil ang Pseu men	$Pseu men Pinu con	$Pseu men Pinu con	$Pseu men Cala rub	Pseu men Cala rub
	age (yrs)	0-5	5-25	25-90	90-120	120 +
	height (m)	0-1	1-5	5-10	10-15	15
	crown closure (%)	0-10	10-40	40	40	30
	stocking (st/ha)	1500	600-500	300-400	200-300	200
	humus form	0.VM	0.HU	0.HU	0.HU	0.HU
Burning and natural regeneration	Seral plant association	$Epil ang Pinu con	$Pinu con Pseu men			
	age (yrs)	0-15	15-30			
	height (m)	0-1	1-5			
	crown closure (%)	0-10	10-20			
	stocking (st/ha)	1000	500			
	humus form	0.VM	0.HU			

a Other important attributes may include key understory species and stand structure (i.e., multi-layered or simple).

b Key:

Pinu con	Pinus contorta
Pseu men	Pseudotsuga menziesii
Shep can	Shepherdia canadensis
Epil ang	Epilobium angustifolium
Cala rub	Calamagrostis rubescens

c Humus forms are described in Klinka et al. 1986.

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