NEWFOUNDLAND FORESTS. HEATHLANDS, AND SWAMPS

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NEWFOUNDLAND FORESTS, HEATHLANDS, AND SWAMPS

INTRODUCTION

The following document provides a detailed description of how the Newfoundland forest types previously described were incorporated into the CNVC forest associations. It also includes other upland forest and heathland types not previously included in the CNVC with some suggestions on the most appropriate application to the CNVC hierarchy at the Group, Alliance and Association levels. Rather than use the Meades and Moore (1994) publication for forests, I have chosen to go back to the original sources for the forest vegetation because this handbook does not include the vegetation data that is essential for comparisons with other classifications in Canada and the United States. However, a crosswalk between CNVC associations and the forest types in Meades and Moore(1994) is included in Appendix I.

Using this document with supplementary Excel and PDF documents that will be provided, it should be possible to track any CNVC association back to the original vegetation descriptions and reléves used to define the existing upland vegetation classifications in Newfoundland and Labrador. Unfortunately, there are very few attempts at formal vegetation classification in Labrador, but where appropriate, I have included references that do provide some good general descriptions of vegetation.

M495 Eastern North America Boreal Forest

General Comments on Macrogroups, Groups and Alliances

Macrogroup 495 Subdivisions a and b.

The question arises with this division of the Macrogroup is essentially why wouldn't the subdivisions constitute their own macrogroups i.e. why split ? I think the answer is that the recognition of a and b as two macrogroups would be difficult to justify with multiple sets of strong diagnostic species. Jack pine is probably the only species that could be a differential since its distribution coincides with the distinction of high fire frequency and lower frequency. Most of the tree species and many of the understory species have a range throughout eastern boreal Canada and differentiation is mainly through differences in frequency and cover (see Baldwin et al. 2020, Table 3). However, when it comes to the macrogroup criteria of climate, disturbance regimes and broad range of edaphic conditions as expressed by vegetation types the submacrogroup distinction between 495a and b is warranted. With respect to insular Newfoundland forest type nearly all the upland types occur in 495a. The only exception being the Kalmia-Birch forests (Damman 1967) that are included in M495b under Group 637 and the lichen woodland association in M179.

Groups

Groups 674 and 826 are both dominated by Balsam fir and are differentiated by very different edaphic and topographic conditions. G674 occurring on moist, nutrient rich sites usually in the lower slope position and G826 on dry to mesic, medium to poor mid to upper slope positions and lacking most of the strong differential species being mostly herb poor feather moss understories. Newfoundland forest types are well represented. These two Groups meet most of the group criteria.
Group 825 is a mixture of closed canopy black spruce-balsam fir forests and black spruce woodland. This is problematic because the group Growth Form criteria require "moderately uniform growth forms and canopy closure". Group 825 with CA00003 as the only alliance would meet group criteria representing the closed black spruce forests that are frequently a fire chronosequence of the balsam fir types in G674 and G826 dominated by black spruce on sites of medium moisture and fertility. However, there are also stable black spruce cover types on wet and dry moisture regimes within this group which cannot be floristically differentiated.
It would probably be more appropriate to combine the woodland alliances (CA00001 and CA00002) in Group 824 and broaden the concept to include dry to mesic black spruce woodlands in the boreal zone arising from fire disturbance. These alliances are all described from insular Newfoundland and lack species found in the subarctic woodland included in Macrogroup 179. Also, the associations comprising these alliances are dry not moist.

There is one forest association (CNVC00237)from insular Newfoundland that is included in Group 637 primarily because it has similarities to associations found in Quebec that are included in this group. If we are including birch chronosequences in the same alliance as the stable conifer type, to be consistent this association should be under G826/A00007/c222 representing the dry to moist fir forests.

Alliances

There appears to be some inconsistency in the alliance concept in both the USNVC and CNVC definitions. On the one hand alliances should have consistency in dominant species and growth form, and on the other, allowing for the grouping of successionally related types which do not always have the same dominants. The latter concept seems to be equivalent to the Ecosite unit in Ecological Land Classification which includes the chronosequence of vegetation types that occur on similar climate and topographic conditions.

In CA00007 and CA00008 balsam fir dominated associations are grouped with white and yellow birch dominated associations. If we are to be consistent in this approach then the black spruce dominated associations should be included in the same alliance as the balsam fir types they replace after fire. However, this would be problematic since it is almost impossible to floristically differentiate stable black spruce types from stands that orignate from fire.

CA00005 is a well defined alliance including the fir- feathermoss in Newfoundland but CA00004 is only differentiated by its coastal position and frequency of Vaccinium vitis-idaea and white spruce. It could be kept as an alliance representing coastal ecosystems in NS & NL or combined

with A00005. CA00003 is a strong alliance capturing the black spruce forest types of Newfoundland. The only criticism might be that it contains a wide breath of moisture regimes and does not differentiate associations which are succesionally stable from those that replace balsam fir types after fire. As mentioned above CA00001 and CA00002 should probably be combined under one Group representing dry to moist Boreal Woodlands.

Specific Comments on the Position of Newfoundland Forest Types within the CNVC Hierarchy

M495a GROUP G674 Atlantic Boreal Moist Balsam Fir-White Spruce

This group is characterized by Balsam fir, White birch and Yellow birch forest cover types that usually occur lower slopes with nutrient rich seepage. The alliances and associations have well defined differential species particularly in the well developed herb layer. Fire is infrequent in the eastern maritime climate but when it occurs fir dominated forests usually develop to birch cover types because of the lack of black spruce seed fall and the consumption of advance fir regeneration in the understory. This group is unique to the extremely wet climate of coastal Newfoundland.
As with the alliance level there is a significant difference in definitions with the USNVC requiring " *diagnostic plant species* (including dominants and co-dominants)". In the CNVC treatment softwood and hardwood cover types are included in G674. In the original treatment by Damman 1967 (pp.) the birch forests were treated as the association *Betuletum* with 4 subassociations, one on unstable scree slopes and 3 others (*rubetosum*, *dropterosum* and *kalmietosum*) representing chronosequences after fire of fir forests on similar edaphic conditions. The Betuletum rubetosum is included in G674 whereas the Betuletum dryoptertosum is placed in G826). In the CNVC analysis only the Kalmia-birch forests were found in Quebec (G637, CNVC00237). It is not known if the other hardwood types described for Newfoundland are truly unique to the island or this a sampling figment. An alternative could be to create a Group for mature Birch and Aspen Forests as fire or other disturbance types occurring within the Boreal Forest matrix.

ALLIANCE CA00008 *Abies balsamea-Betula papyrifera/Rubus pubescens*. This alliance is unique to Newfoundland being defined primarily by a strong group of diagnostic indicators and absence of floristic elements found in similar mainland sites. The alliance essentially represents a successional series in a common edaphic position under a moist maritime climate. However, the question arises as to whether associations with hardwood cover and softwood dominance should be in the same alliance. The CNVC definition of suggests that alliances can be defined by "consistency in dominant and/or diagnostic species" thus allowing for creating alliances with different dominants (i.e. fir and birch) whereas the USNVC requires "Diagnostic species, including some from the dominant growth form or layer". Thus the alliance is valid using the

CNVC definition because the associations share a strong diagnostic species group and a similar position in the edatope.

Association CNVC00348 *Abies balsamea / Taxus canadensis / Rubus pubescens / Dicranum majus.* Stable type under moist maritime climate, with somewhat wet to wet, nutrient rich soils, usually on lower slope position with seepage. Unique to the island of Newfoundland:

Alnus crispa-balsam fir (AA) Damman 1963 Northern (2)
Rubus-balsam fir Mitella variant (RAm) Damman 1963 Northern (6)
Rubus-balsam fir Athyrium variant (RAa) Damman 1963 Northern (1)
Rubus –balsam fir (Fr) Damman (1967) Western (6)
Rubus –balsam fir wet variant (Frw) Damman (1967) Western (4)
Rubus-balsam fir (bFr) Meades (1986) Eastern (5)

The Rubus-balsam fir type for central Newfoundland (Damman 1964) is included in CNVC00351 because of its higher black spruce cover probably a consequence of increased fire frequency in the more continental region of the province.

Association CNVC00349 *Betula papyrifera (Populus tremuloides) / Dryopteris carthusiana - Rubus pubescens.* This association is dominated by birch or aspen and occupies essentially the same soil and landscape position as c348. After natural or anthropogenic fire disturbance that kills balsam fir advance regeneration, hardwoods take over the site until balsam fir re-establishes. This association was described from Terra Nova National Park in east-central Newfoundland, western Newfoundland and one site in coastal southeast Labrador:

Birch-trembling aspen Forest(TNPBtA) Meades (1975) east-central (5)
Lycopodium- Birch Forest (Lab B_Lyc) unpublished site description SE Labrador (1)
Rubus-birch type (Br) Damman (1967) Western (4)

Association CNVC00316 *Betula papyrifera / Alnus viridis / Solidago macrophylla.* This association represents pioneer succession on steep mountainous talus slopes. Over time if conditions stabilize this association could develop to a species composition similar to c348 or c349. Unique to NL. The type is only described from western Newfoundland but is probably more widespread in mountainous areas with unstable soils:

Birch forests on unstable soils(Bu) Damman(1967) Western (3)

M495a GROUP 826 Atlantic Boreal Mesic Balsam Fir-Paper Birch Forest.

This group is defined by common balsam fir/birch dominance in the tree layer and a per humid climate that dictates a low fire frequency. It is differentiated from G674 by being in the dry to medium moisture regime and poor to medium nutrient status. The constituent alliances reflect this wide variation CA00007 moist forest with fern dominated understory and CA00006 being dryer and dominated by feather mosses. As with G674 there are alliances that include hardwood and softwood associations.

ALLIANCE CA00007 Abies balsamea (Betula papyrifera - B. alleghaniensis) / Dryopteris carthusiana Alliance. The associations within CA0007 have common diagnostic species, particularly the dominance of Dryopteris ferns, a common edatophic position and share a common chronosequence after fire disturbance. They lack most of the diagnostic herbaceous species that define CA00005. As with CA0008 the only question is whether hardwood and softwood forest cover types should be placed in the same alliance. With the exception of the *Oxalis montana* subassociation in c310, it has only been described from insular Newfoundland.

CNVC00311 Abies balsamea (Betula alleghaniensis) / Dryopteris carthusiana. This association is a stable forest type, that occurs on moist slopes that are rarely disturbed by fire because of frequent precipitation. This association is distinguished fro c310 by the higher cover of yellow birch which is indicative of its temperate range throughout eastern and southern Newfoundland. Some releves with a high cover of yellow birch in Damman forest types listed under c310 were moved to c311. This facilitated the creation of one association with yellow birch co-dominant (c311) and the other (c310) with white birch co-dominant. This association has only been described from insular Newfoundland:

Balsam fir-Dryopteris (bFd) Meades 1986 Eastern (4)
Balsam fir-Dryopteris –Bazzania trilobata (bFbd) Meades 1986 Eastern (3)
Balsam fir-Dryopteris (Fd) Damman 1967 Western (6)

CNVC00310 Abies balsamea / Dryopteris spp. / Hylocomiastrum umbratum. This association occupies very similar site conditions but yellow birch is absent in the tree layer. The *Oxalis montana* subassociation of c310 occurs in New Brunswick and Nova Scotia. In some of the forest types listed below, some releves with high cover of yellow birch were moved to CNVC00311:

Dryopteris-Lycopodium- Balsam fir (Dry-LbF) Damman 1964 Central (3)
Dryopteris Balsam fir (DA) Damman 1963 Northern (3)
Dryopteris-Hylocomium- Balsam fir (Fdh) Damman 1967 Western (10)
Dryopteris-Rhytidiadelphus –Balsam Fir (Fdr) Damman 1967 Western (5)

CNVC00315 Betula papyrifera - B. alleghaniensis / Dryopteris carthusiana. This association is dominated by a mixture of White birch and Yellow birch with sporadic balsam fir. It occurs on similar sites to c310 and c311 after fire disturbance. It is only described from Newfoundland but further sampling might reveal similar associations in the Gulf of St. Lawrence:

Dryopteris-Birch typical variant Damman1967 Western (3)

Dryopteris-Clintonia-Birch Damman 1967 Western (3)

ALLIANCE CA00005 Abies balsamea (Betula papyrifera)/Pleurozium schreberi Alliance. This alliance is widespread in eastern Canada because of the relatively low fire frequency that promotes balsam fir rather than black spruce as the dominant forest cover type. It is somewhat dryer and less nutrient rich compared to CA00007 and CA00008 and consequently does not have hardwood chronosequences after fire disturbance but rather Black spruce forests or woodlands dominated with black spruce and ericaceous shrubs. CNVC00222 is by far the dominant association in the landscape with CNVC00278 generally occurring on peatland margins.

CNVC00222. Abies balsamea/Pleurozium schreberi. This association represents Balsam fir dominated forest types with a continuous feathermoss understory with scattered shrubs and herbs that occurs throughout eastern Canada in regions with low fire frequency. The sites tend to range from somewhat dry to moist and poor to medium nutrient status. In Damman and Meades treatments the dryer sites were represented by the Pleurozium-balsam fir types and the moist the Hylocomium –Balsam fir sites. While this distinction could easily recognized looking at the soil profile, the floristic indicators were not always well developed due to the deep organic duff layer. The Taxus- Balsam fir types occur in western and northern Newfoundland usually on shallow limestone soils somewhat resembling an alvar habitat. Succession in this association is mainly insect driven gap replacement although when fires do occur the stands usually replaced by black spruce cover or open Kalmia-Conifer stands if black spruce seed supply is inadequate. Newfoundland forest types in this association include:

Hylocomium-Balsam fir (Hyl-bF) Damman 1964 Central (14)
Pleurozium-Balsam fir (Pl-bF) Damman 1963 Central (4)
Pleurozium-Balsam fir (bFp) Meades 1986 Eastern (5)
Clintonia-Balsam fir (bFc) Meades 1986 Eastern (6)
Hylocomium-Balsam fir (bFh) Meades 1986 Eastern (7)
Dicranum-Balsam fir (bF) Meades 1986 Eastern (5)
Clintonia-Balsam fir (CA) Damman1963 Northern (7)
Taxus-Balsam fir (TA) Damman1963 Northern (4)
Pleurozium-Balsam fir (Fp) Damman 1967 Western (11)
Hylocomium-Balsam fir (Fp) Damman 1967 Western (3)
Taxus-Balsam fir (Ft) Damman 1967 Western (5)
Taxus-Balsam fir/Epigaea variant (Fte) Damman 1967 Western (5)

CNVC00278 Abies balsamea/Pleurozium schreberi-Sphagnum spp. This Balsam fir dominated association is characterized by ericaceous shrubs and a richer herbaceous layer with patches of Sphagnum spp. in the feathermoss carpet. In Newfoundland it commonly occurs in bog borders and small islands influenced by peat bog water. This association has been described from Quebec and Newfoundland. This forest type has only been described from western Newfoundland:

Gaultheria-Balsam fir (Fg) Damman 1967 Western (9)

ALLIANCE CA00004 Abies balsamea/Vaccinium vitis-idea/Pleurozium schreberi-Bazzania trlobata. This alliance represents coastal balsam fir forest that are within the salt spray zone. The sites are dry and poor, usually on shallow soils over bedrock. The alliance has been described from Nova Scotia and insular Newfoundland. The alliance is distinguished from other alliances in Group 826 being dryer and nutrient poor with ericaceous shrub. Other than its coastal position exposed to strong winds this alliance is not strongly differentiated from CA00005.

CNVC00309 Abies balsamea / Taxus canadensis / Rubus pubescens / Dicranum majus. This association occurs in Newfoundland and Nova Scotia It has only been described from eastern Newfoundland but is probably more widespread in coastal areas. The Newfoundland plots are recognized as a distinct subassociation with a greater abundance of *Vaccinium vitis idaea* and other ericaceous shrubs. These sites usually form Empetrum Heaths after disturbance by fire or cutting because of the extreme wind exposure in coastal areas. There is only one forest type described from Newfoundland:

Vaccinium-Balsam fir (EbFv) Meades 1986 Eastern (5)

M495a GROUP 825 Atlantic Boreal Mesic-Moist Black spruce-Balsam fir Forest.

This group in contrast to G826 is dominated by black spruce forests or mixtures of black spruce and balsam fir where black spruce is dominant. Although fires are generally of low frequency within this macrogroup, when they occur the zonal forests dominated by balsam fir are replaced by black spruce. Balsam fir sheds its seeds annually and is not fire adapted. Black spruce can also form stable forests on wet and dry sites where it can outcompete balsam fir.

ALLIANCE CA00003 This alliance is characterized by the dominance of black spruce alone or in mixtures with balsam fir codominant. These are floristically poor sites with an understory dominated by feather mosses and sporadic shrubs and herbs. the association c351 occurs on sites that are at the wet or dry end of the moisture spectrum and are probably stable types The association c350 is dominated by medium moisture and nutrient regimes and will be replaced by balsam fir types in the absence of fire disturbance.

CNVC00351 Picea mariana - Abies balsamea / Pleurozium schreberi (Hylocomium splendens). This association occurs in Quebec and Newfoundland as a black spruce fir mixture on sites that vary from dry to moist. The Newfoundland forest types in this association occur on extremely wet and dry sites and probably do not require fire for stand replacement. Damman did not recognize mixtures and in his classification these forest types were classified as balsam fir types. The following forest types from Newfoundland are included in this association:

Carex-Balsam fir (C-bF) Damman 1964 Central (4)
Rubus-Balsam fir (Ru-bF) Damman 1964 Central (7)
Pleurozium-Balsam fir/ lithosolic podzol type (PA/1p & PA/1Pca) Damman 1963 Northern (6)

CNVC00350 Picea mariana / Pleurozium schreberi - Hylocomium splendens. This association covers most of the black spruce types that occur throughout Newfoundland on a wide range of site conditions from dry to wet. Most of the stands in the moist to mesic range occur following fire disturbance in the balsam

fir forests. However, they can also occur on very dry and very wet sites where black spruce can outcompete and form stable forest types not needing fire for stand replacement. This association is described from Newfoundland and Quebec. On the island of Newfoundland it is most extensive in the central region where sites are generally poor and fire frequencies are higher due to a more continental climate. This association includes the following forest types from Newfoundland:

Black spruce-moss (bS I-V) Damman 1964 Central (13)
Black spruce-moss (bSm l & bSm-lll) Meades 1986 Eastern (8)
Pleurozium-black spruce on lithosols (LP) Damman1963 Northern (3)
Pleurozium-black spruce on calcareous lithosols (LPca) Damman1963 Northern (2)
Black spruce-moss on sand (Ps) Damman 1967 Western (4)
Black spruce-moss on lithosol (Ps) Damman 1967 Western (1)

ALIANCE CA00002 Picea mariana/kalmia angustifolia/Pleurozium schreberi. This alliance is an open woodland with black spruce growing in patches surrounded by ericaceous shrubs underlain by feather moss. Sites tend to be nutrient poor and mesic to moist. In the absence of further fire disturbance these woodland are stable over long periods. This alliance is unique to Newfoundland.

CNVC00307 Picea mariana (Abies balsamea) / Kalmia angustifolia / Pleurozium schreberi . This association . This association is dominated by poorly growing open grow black spruce forests with scattered balsam fir and rarely white birch. Ericaceous shrubs underlain by feathermosses and lichens dominate the openings between trees. These woodlands can be found throughout Newfoundland but are most common in the central region due to more frequent fires. The acidic podzols are overlain by a deep ericaceous mor humus. The following forest types are described from Newfoundland:

Kalmia –Black spruce (Kal-bS) Damman 1964 Central (10)
Kalmia-Black Spruce (KP) Meades 1986 Eastern (5)
Kalmia-Black Spruce (KP) Damman 1967 Western (4)
Kalmia-Black spruce (KPt) Damman 1963 Northern (1)

CNVC00338 Picea mariana / Rhododendron canadense - Taxus canadensis / Pleurozium schreberi. This a unique association because it occurs on mucky limestone lithosols and has a mixture of species that usually occur on acid or near basic soil conditions. The ericaceous shrubs tend to grow in patches rather than a continuous layer as in c310. Because the soils are shallow they tend to dry out. This vegetation closely resembles a mainland alvar except for the absence of eastern cedar.

Kalmia-Black spruce (KPt) Damman 1967 Western (4)

M495a GROUP 824 Atlantic Boreal Dry Black Spruce Woodland.

This woodland group occurs well within the altitudinal and latitudinal treeline and owes disturbance rather than climate to the reason for its origin. These forest types develop following fire and/or cutting in balsam fir and black spruce forest when there is inadequate stocking due to poor seed supply or poor seedbed conditions for germination. Because these sites are generally dry to moist and nutrient poor, ericaceous shrubs quickly dominate the site and further deteriorate conditions for successful tree establishment and maintain the woodland in a semi-permanent state. Black spruce is the dominant tree with open spaces dominated by ericaceous shrubs, primarily *Kalmia angustifolia.*

ALLIANCE CA00001 Picea mariana / Kalmia angustifolia - Rhododendron canadense / Cladina spp. Alliance. This alliance only has a single association described on extremely dry soil conditions in central Newfoundland. Red pine is considered a rare species in Newfoundland(13 sites) and is most commonly associated with this woodland type.

CNVC00205 Picea mariana / Kalmia angustifolia - Rhododendron canadense / Cladina spp. This association occurs on very dry nutrient poor sites where even the ericaceous shrubs have low cover and reduced vitality. Cladina spp. rather than feather mosses dominate the ground layer giving the association of northern woodland near the continental treeline. This association is only defined by a single forest type in Newfoundland:

Cladonia-Kalmia-Black spruce (Clad_Kal_bS) Damman 1964 Central (11)

The "Black Spruce Highland Heath" described by Porter et al. (2020) in Cape Breton may also fit this alliance but it is definitely a more scrubby version from the Cape Breton Highlands of NS.

CM495b GROUP 637 Ontario-Québec Boreal Mesic-Moist Black Spruce Forest

ALLIANCE CA00011 Betula papyrifera / Vaccinium angustifolium / Pleurozium schreberi Alliance

CNVC00237 Betula papyrifera / Vaccinium angustifolium - Kalmia angustifolia / Pleurozium schreberi This association is dominated by White birch with an understory of ericaceous shrubs on nutrient poor, dry to mesic sites originating after fire disturbance. This association occurs in Quebec and

Newfoundland. It is a relatively rare condition in Newfoundland only being described from east-central region even though it was first described in Damman's work from western Newfoundland where it was included with other White birch forests in his Betuletum association. This is the only Newfoundland forest type included in the submacrogroup CM495b.

Kalmia-White Birch (Bk) Damman 1967 Central (2)

M179 North American Northern Boreal Woodland

G635 Eastern Canadian Subarctic Woodland

A2117 Picea mariana Eastern Subarctic Woodland Alliance
CNVC00206 Picea mariana/Betula glandulosa/Cladina spp. This is a Labrador association that was created from 5 releves I described along the Labrador highway between Esker and Churchill falls in 1980. These are very dry open woodland on eskers with black spruce the dominant tree and Cladina macrophylla the dominant lichen. These woodlands have developed following fire since there are closed canopy black spruce stands in the surrounding landscape. At the time CNVC created this association there were no subarctic reléves from Quebec. Closer scrutiny would probably show that there is an equivalent association in Quebec since the locations are within a few kilometers of the Quebec border.

M299 North American Boreal Conifer Poor Swamp

G807 Atlantic Boreal Black Spruce - Balsam Fir Poor Swamp In Newfoundland this group represents what Damman 1967 referred to as forested bogs. In general, Newfoundland peatlands do not support forests because of the annual moisture surplus. This group usually occurs on shallow oligotrophic to mesotrophic peat soils in the transition between forest and open peatlands. The group does meet the criteria for Swamp using the criteria of the Canadian Wetland Classification

CA00041 Abies balsamea - Picea mariana / Osmundastrum cinnamomeum - Carex trisperma / Sphagnum spp. Alliance. This alliance has both Black spruce and Balsam fir dominated swamps but the abundance of Sphagnum spp. in the understory and the lack of species associated with nutrient rich fen conditions clearly differentiate it from forested fen habitats. The abundance of ericaceous shrubs differentiates it from CA000040. This alliance can occur as a narrow margin or be quite extensive in rolling terrain where the transition from upland soils to peatlands is more gradual. The following associations were described from Newfoundland.

CNVC00334 Abies balsamea / Osmundastrum cinnamomeum - Carex trisperma / Sphagnum spp. This association is only described from northern and eastern Newfoundland. Balsam fir is the dominant tree which is somewhat unusual considering these are wet sites with a continuous carpet of Sphagnum mosses forming a mesotrophic peat 15-20 cm in depth. Only 2 forest types have been described:

Sphagnum-Balsam fir (bFs) Meades 1986 Eastern (5)
Sphagnum Balsam fir (SA) Damman 1963 Northern (3)

CNVC00312 Picea mariana - Abies balsamea / Osmundastrum cinnamomeum - Carex trisperma / Sphagnum spp. This association is dominated by Black spruce forming marginally productive stands on deep acidic peat around bog borders. Five types have been described in eastern western and northern Newfoundland:

Sphagnum robustum-Black spruce (SP) Damman1967 Western (4)
Sphagnum robustum-Black spruce, Nemopanthus subassociation (SPn) Damman 1967 Western (4)
Carex-Sphagnum-Black spruce (CSP) Damman 1963 Northern (3)
Osmunda-Black spruce (OP) Meades 1986 Eastern (6)
Sphagnum-Black spruce, Nemopanthus subassociation (SPn) Meades 1986 Eastern (5)

A CA00040 Picea mariana (Abies balsamea) / Kalmia angustifolia / Sphagnum capillifolium Alliance This alliance is differentiated from CA000041 by the occurrence of a dense ericaceous shrub layer. In the absence of data I have no way of telling how CA000041&40 are differentiated from A4102 and A4103 although the spreadsheet suggests both occur in Newfoundland.

CNVC00335 Picea mariana / Kalmia angustifolia / Pleurozium schreberi - Sphagnum capillifolium. This association is somewhat drier than those in CA000041 . Kalmia is dominant in the shrub layer and feathermosses are mixed with Sphanum spp. in the ground layer. The following four forest types have been described from Newfoundland:

Sphagnum - Kalmia - Black spruce forest (Sph_Kal_bS) Damman 1964 Central (5)
Nemopanthus - Kalmia - black spruce forest [Taxus variant] (KPnt) Meades 1986 Eastern (4)
Sphagnum - Kalmia - black spruce forest [wet variant] (SKPw) Damman 1963 Northern (1)
Nemopanthus - black spruce forest (KPn) Damman 1967 Western (2)

G806 Ontario-Québec Boreal-Subboreal Black Spruce Poor Swamp

Alliance 2124 Picea mariana - Larix laricina Eastern Boreal Poor Swamp Alliance

CNVC00320 Larix laricina / Alnus incana / Carex trisperma / Sphagnum spp. This association is a Larch dominated swamp with alder and sedges in the understory described from unpublished site descriptions on the Eagle River in eastern Labrador.

Sphagnum - Myrica - Tamarack forest Meades 1980 Labrador #80020
Sphagnum - Alder - Tamarack forest Meades 1980 Labrador #80019

M300 North American Boreal Flooded & Rich Swamp Forest
G810 Atlantic Boreal Flooded & Rich Swamp Forest

In Newfoundland this group represents what Damman 1967 referred to as Forested Fens consisting of open spruce with a luxuriant herb layer on wet, basic seepage soils usually influenced by calcium parent material.

CA00042 Picea mariana / Carex spp. / Rhytidiadelphus triquetrus Alliance. This alliance is formed from both closed canopy and open forest types. It is differentiated from the Poor Swamps by the dominnce of sedges and herbs in the understory and lower abundance of Sphagnum spp. in the ground layer.

CNVC00353 Picea mariana / Alnus incana / Carex vaginata / Rhytidiadelphus triquetrus. This association represents almost closed canopy black spruce forests with scattered alder and ericaceous shrubs in the shrub layer and a lush herbaceous understory dominated by numerous Carex spp.. The soils are a wet, mesotrophic muck 15-20cm over gleysol. This type is usually occurs in bog borders with abundant seepage. It includes a single forest type;

Alder - black spruce swamp (Ald_bS) Damman 1964 Central (4)

CNVC00293 Picea mariana / Sanguisorba canadensis / Rhytidiadelphus triquetrus. This association is comprised of the most floristically diverse forests in insular Newfoundland. These are open black spruce forests with luxuriant ground vegetation of sedges and low herbs. They occur in western and northern usually on mucky sedge peat influenced by nutrient rich seepage, often from calcareous soils with pH 6.5 to 7.0. They usually occur on lower slopes or wet opening in the forest. The association is formed from the following forest types:

Sanguisorba - Paludella - black spruce forest Carex vaginata
- Equisetum scirpoides - black spruce forest (SCP) Damman 1963 Northern (2)

Carex vaginata - Equisetum scirpoides - black spruce forest (CCP) Damman 1963 Northern (2)

Carex - black spruce forest (CP) Damman 1967 Western (5)

Osmunda - black spruce forest (OP) Damman 1967 Western (7)

Newfoundland Forest Types Classified but Not in CNVC

Alder Swamps

Damman (1967) described 7 alder swamp types from western Newfoundland and two from central Newfoundland (Damman, 1964). The alder swamps were treated as one association *Alnetum* with eight subassociations that were differentiated floristically and edaphiclly with respect soils and frequency of inundation in the floodplain landform. The types are defined using 2-8 reléves with complete floristic lists and soil and habitat descriptions. From a biodiversity perspective they are important because of their floristic diversity and the occurrence of species that are common in mainland hardwood forests but rare in Newfoundland. The best fit to the CNVC hierarchy that I can suggest in the absence of data for alder swamps in other regions would be G768 but would probably form a separate alliance since it lacks many of the southern species of A2238. It would not fit M300 because the tree cover falls below the 10% threshold for forest.

M894 North American Boreal Marsh, Wet Meadow & Shrubland

G768 Eastern North American Boreal Freshwater Marsh, Wet Meadow & Shrubland

A A2238 Alnus incana ssp. rugosa - Alnus viridis - Cornus sericea Eastern Boreal Shrub Swamp Alliance

A A2237 Typha latifolia - Schoenoplectus tabernaemontani Eastern Boreal Marsh Alliance

The following Newfoundland **Alder Swamps** have been described :

Carex –Alder swamp Damman 1963 Central (Alnetum-caricetosum pp.33) 3 Sites
Lycopodium-Alder swamp Damman 1963 Central (Alnetum-lycopodietosum pp.31) 3 Sites
Carex-Ader Swamp Damman 1967 Western (Alnetum-caricetosum pp.97) 5 Sites
Dryopteris –Alder swamp Damman 1967 Western (Alnetum-dryopteretosum pp.93) 3 Sites
Equisetum Alder Swamp Damman 1967 Western (Alnetum-equisetosum pp.99) 1 Site
Larix-Alder Swamp Damman 1967 Western (Alnetum-laricetosum pp.100) 2 Sites

Solidago-Alder Swamp Damman 1967 Western (Alnetum-solidagetosum pp.95) 8 Sites
Moist- Alder Swamp Damman 1967 Western (Alnetum-typicum pp. 94) 3 Sites

Hardwood Thickets

Thickets occur as a seral vegetation of varying longevity depending on the amount of coniferous regeneration after disturbance. Where fir or spruce regeneration is adequate (2500 stems/ha) these sites return to coniferous cover within 20-25 years. In the absence of adequate coniferous regeneration sites can develop to birch or aspen cover types for several rotations until fir and/or spruce seed in through a process of relay floristics. Hardwood Thickets usually develop on sites that are mesic to wet and medium to rich nutrient status. On nutrient poor, dry sites ericaceous shrubs rather than hardwood species tend to dominate the succession after disturbance forming semi-permanent woodlands or heaths where conifer regeneration is inadequate or lacking. The Hardwood Thickets would probably fit in M537 with a separate Group for Tall Seral Shrublands on upland sites.

2.B.3 Boreal Grassland & Shrubland
D025 2.B.3.Na North American Boreal Grassland & Shrubland
M537 North American Boreal Shrubland & Grassland

Two types of Hardwood Thickets have been described for Newfoundland: Mountain Maple Thickets and Pin Cherry Thickets.

Mountain Maple Thickets

The Mountain Maple Thickets are dominated by *Acer spicatum* and occur on wet mucky nutrient rich sites on lower slopes. These thickets usually develop after windthrow or cutting in forests included in alliance CA00008 but can also occur as a natural transition to forested fens (CA00042) Damman 1967 described two types:

Galium- Mountain maple Thickets Damman 1967 Western (Aceretum galietosum pp.88) 5 sites. This type was described as a disturbance type ocurring after windthrow or l ogging

Carex-Mountain maple Thickets Damman 1967 Western (Aceretum caricetosum pp.91) This t ype was described as a natural type in transition to black spruce fens but there are no releves for this type in the vegetation table for Mountain Maple thickets.

Pin Cherry Thickets

Pin Cherry Thickets were described for eastern Newfoundland (Meades 1986). They are dominated by tall shrubs (2-5m) primarily Pin cherry and White birch forming a seral vegetation following cutting and fire over a wide range of moisture an nutrient regimes. Three subassociations were described corresponding to dry, moist and wet soil moisture regimes.Although described in eastern Newfoundland this vegetation occurs throughout the island and there are more unpublished reléves available from central and western Newfoundland. As with the other thickets it would probably form an upland disturbance alliance within G862. The types described are as follows:

Pin Cherry-Birch Thickets Meades 1986 Eastern (Punetum typicum pp.82) 4 sites Dry
Heath Grass-Pin Cherry Thickets Meades 1986 Eastern (Prunetum deschampsietosum PP.82) 4 sites Moist
Sedge-Pin Cherry Thickets Meades 1986 Eastern (Prunetum caricietosum pp.84) 5 Sites Wet.

Central and Western Newfoundland Thickets on Clearcuts

In 1988 I initiated studies to investigate the development of seral vegetation over a range of forest types described by Damman 1964 & 1967 for central and western Newfoundland respectively. Reléves were stratified across 4 age classes: 0-5 years, 6-10 years, 11-15 years and 16-20 years. Managed stands where scarification and planting had occurred in the 6-10 year age class were also described. Braun-Blanquet scales were used for cover and abundance and growth of dominant trees was also measured. The Central Newfoundland study (Northlands, 1990) was contracted to Northland Associates Ltd. with Sylvie Dupuis as the lead investigator, unfortunately, the western Newfoundland work never published but the plot data is available in the CFS archives.

The Northlands study included 140 plots distributed across the 5 age classes in the following forest types described by Damman 1964:

1. Black Spruce-Moss Forest (bS-I) well drained = CNVC00350 26 sites
2. Black Spruce Moss Forest (bS-III) moist = CNVC00350 25 sites
3. Rubus-Balsam Fir (Fr) moist = CNVC00351 22 Sites
4 Dryopteris-Lycopodium-Balsam Fir (DLybF) moist = CNVC00311 22 Sites
5. Pleurozium-Balsam Fir (Fp) dry = CNVC00222 27 Sites
6 Hylocomium- Balsam Fir (HybF) moist = CNVC00222 16 Sites

The data was summarized using TWINSPAN but no formal names were given other than the age classes designation within each forest type.

Labrador Forests

Key References

Foster (1984) is the only published forest classification for Labrador that includes releve data with full floristic descriptions of vascular and nonvascular plants and there relative cover. He used the Braun-Blanquet method to record field descriptions and TWINSPAN to classify the 88 reléves into 5 communities as follows:

Birch Forest	G674 CA00008 CNVC00316
Fir spruce- feather moss forest	G826 CA00005 CNVC00222
Spruce-fir forest	G825 CA00003
Spruce-Pleurozium	G825 CA00003
Spruce-Sphagnum fuscum	G807 A4102 CNVC00335 ?

Although I have suggested the closest fit to the existing forest hierarchy there are a more rigorous comparison may be required since some species such as Kalmia angustifolia do not occur in Foster's reléves and species such as Vaccinium myrtilloides occur in Labrador but not on the island.

Mercer, W.E. 1979. The forest types of the Goose Bay area, Labrador. Report to Newfoundland Forestry Div., Department of Forestry and Agriculture and Newfoundland Forest Research Centre, Canada Department of the Environment

In the late 70's, working with CFS, I had contracted Gene Mercer to complete this report that had been initiated through The Candia Land Inventory. If the report can be located there was a large vegetation table with numerous reléves that could be used in the CNVC. I have written to Claudia Hanel who reviewed the report in 2004 to see if it can be located.

Forest Types described in the Goose Bay Area

Abietum Balsamae

- Hylocomietosum (G826/CA00007/CNVC00311) 7 Sites
- Spagnetosum (G807/A0041/CNVC00334) 7 Sites
  - Giergensohnii Variant
  - Hypnum Variant
- Clintonietsum (G826/CA00007/CNVC00311) 8 Sites

Betuletum papyriferae (G826/CA00008/CNVC00315) 2 Sites

Populetum Balsamiferae (Not described in report)

Piceetum marianae (G825/CA00003/CNVC00350) 25 Sites

- Hylocomietosum

Pleurozietosum
Clintonietsum

Ledo-piceetum (May relate to Quebec type) 11 Sites
Kalmia Variant
Ptilium Variant

This association does not have equivalents on the island due to the absence of *Kalmia angustifolia.* The Kalmia variant refers to *Kalmia polifolia* It may equate to some Quebec associations. This is a much wetter type than the Ptilium so these would probably be 2 CNVC associations.

Sphagmo-fuscae-Piceetum 3 Sites
This appears to be very similar to Foster's Spruce –Sphagnum fuscum and Wilton's Spruce/Sphagnum Very Wet types. The closest CNVC fit is to G807 A4102 CNVC00335 but the southern associations don't have Sphagnum fuscum as the dominant moss and the Labrador type lacks southern species such as Rhododendron canadense, Viburnum cassinoides and Nemopanthus mucronata.

Sphagno-robustae-Piceetum 7 Sites
Typicum variant
Vaccinium cespitosum Variant

As with the above association this type lacks some of the southern species and has Vaccinium sespitosum which does not occur in the southern CNVC types. The variants are not strongly differentiated. At least ecologically it is close to M299/G807/4103/CNVC00312

Cladonio-Piceetum 17 Sites
Typicum 11 Sites
Tyicum Variant
Stereocaulon paschale Variant
Cladonia mitis Variant

The 2 subassociations presented are significantly different and probably should be recognized as distinct CNVC associations. The typicum lacks Kalmia angustifolia and several other southern species and has Betula glandulosa and Vaccinium cespitosum. It is most closely related to `/G635/A2117/CNVC00206. This was a Labrador association created from my field notes (unpublished)

Kalmietosum 6 Sites
Typicum Variant

Cladonia sylvatica Variant

This subassociation is very similar to the Kalmia –conifer forests described from insular Newfoundland M495a/G825/CA00002/CNVC00307. These 2 subassociations probably represent a climatic transition from the boreal (Kalmia-Conifer) to the Subarctic (Betula glandulosa) climate zone.

Alnetum rugosae (not described)

Barren Ground Vegetation There is a table providing 13 site descriptions of essentially Alpine vegetation in the region but no detailed descriptions. These would generally fall into M131 Eastern North America Alpine Tundra G910 Eastern Boreal Alpine Tundra.

Wilton, W.C. 1965. The forests of Labrador. Department of Forestry Publication No. 1066. Incl. Map.

The primary objective of this publication is to report on the productivity of timber resources in Labrador and climatic and physiographic factors limiting their productivity. He gave a general description of the following 5 types but there is no relive data:

Fir-Spruce-Birch/Rich Herb Moist
Spruce/Lichen Very Dry
Spruce-Fir/Feathermoss Dry
Spruce-Fir Dwarf Shrub Wet
Spruce/Sphagnum Very Wet

Wilton also provides a map at 1:1 Million scale that illustrates the distribution of and relative productivity of forests in Labrador.

Hustich, I 1939 *Notes on the coniferous forest and the tree limit on the east coast of Newfoundland-Labrador*. (Acta Geographica 7(!): 76pp.)This publication does not have relive data but does provide some good general descriptions of the coastal vegetation from Cape Charles as far north as Hebron. He classifies the coastal forest into 3 regions: "Bush" with spruce and fir 0.5 to 1.0 m ; Brushwood with spruce and fir 2.0 to 8.0 m in height equivalent to the term krummholz in Europe; Timber Forest Region conifers > 10.0m. There is also a comparison of the forest limit of Labrador with northern Europe. There are a number of other papers by Hustich cited by Hanel 2003 that provide historical descriptions of Labrador vegetation but lack plot data.

M538 Northwest Atlantic Coastal Heath

The use of the term "coastal" may be somewhat misleading, since some interpret coastal to mean "on the coast", while a lot of the heath types described below can occur many kilometers

from the coast. Also most of the Empetrum Heaths are coastal and the Kalmia heaths are inland where there is more shelter. In the heath literature these would be referred to as "maritime" but this would also be confusing as Maritime is often used to distinguish mainland provinces from Newfoundland + Maritime provinces = Atlantic provinces. The literature also refers to the "North Atlantic Heath Formation" for the maritime heaths of Europe and Scandinavia. Perhaps we could distinguish the North American counterpart in M538 The Northwest Atlantic Heath. The CNVC map of Canada uses Atlantic Maritime Heath for the this area. Agreed to use Northwest Atlantic Heath for Macrogroup name.

Studies on the plant communities of heathlands, or "barrens" as they are called in Newfoundland are few and mainly related to wildlife habitat. Ahti (1959) did studies throughout insular Newfoundland on caribou range and Peters (1958) and Huxter (1964) on Willow Ptarmigan primarily on the Avalon peninsula. Meades (1973) classified heaths on the Avalon Peninsula using the Braun Blanquet approach. Meades (1986) completed a forest classification for eastern Newfoundland with some minor revisions to the heath classification and a study of the long-term successional status of the heaths in an attempt to differentiate those that are primary from those that are derived from forest after disturbance. Meades (1983) provided an overview of the previous work in eastern Newfoundland on acidic heaths and added a classification of the limestone and serpentine basic heaths in western and northern Newfoundland. Unless otherwise cited the following descriptions follow the 1983 publication although the complete collection of relévés is in the 1973 thesis. It must be noted that with the exception of some descriptions by Ahti (1959), heaths and alpine vegetation throughout central, western and southern Newfoundland have not been described.
Below I have developed a provisional hierarchy placing the Atlantic Heaths of Newfoundland into 2 Groups reflecting the primary ecological driver responsible for their development i.e. acidic parent materials versus basic or near-basic parent materials. The Alpine Heaths are in M131 Group 162. Disturbance by natural and anthropogenic fires and cutting as well as relative wind exposure is also a factor in the origin and differentiation of the Acidic Heaths. The Basic Heath group is for the most part stable beyond the limits of tree growth due to extreme wind exposure and soil toxicity. The number sites (releves) given for the Acidophytic Dwarf Shrub Heaths follows Meades (1973) except for the Empetrum-Shagnum nemoreum association which was later recognized in Meades (1983). The number of sites given for the Dwarf Shrub-Herb Rich Heaths on Basic Soils follows Meades(1983).

The tentative hierarchy is as follows:

G970 Acidophytic Dwarf Shrub Heaths

A1.Moss Heaths.

This provisional alliance represents the moss heaths dominated by *Racomitrium lanuginosum* that occur in the sub oceanic barrens of southeastern Newfoundland and have affinities to similar heath vegetation described throughout the north Atlantic region. Meades(1973) described one association Empetrum nigrum-Rhocomitrium lanuginosum Barren *(Empetro-Rhacomitrietum languginosae*). Although these heaths are considered to represent primary succession having no evidence of previous forest, they lack the arctic alpine species element characteristic of arctic and alpine tundra. Six floristic variants are described that represent gradients in relative exposure and disturbance by wind erosion. Ahti (1959) included this concept in his *Kalmia-Rhacomitrium-Cladonia* association which is very similar but probably includes some of what I differentiated as Empetrum Heath. All his descriptions for this type are from the southern Avalon and Burin peninsulas and he comments that these are the most maritime of the heaths he observed. Similar communities have been described in Greenland (Sieg et al., 2006), Iceland (McVean,1955), Jan Mayen Island (Warren-Wilson,1952), Scotland (McVean,1964), and the Faeroe Islands (Bocher 1940, 1943). National and Continental ecoregion maps have recognized the occurrence of these heaths as a unique zone where the vegetation reflects the occurrence of a sub oceanic climate. CNVC could recognize one association*: Empetrum- Rhacomitrium Heath* (48 sites)

A2 Empetrum Cushion Heaths

This alliance occurs outside the southern sub oceanic zone and is characterized by continuous cushions dominated by Black Crowberry (Empetrum nigrum) and absence or low abundance of Racomitrium moss. Extreme winds on coastal headlands and exposed hills inland reduces the protection of winter snow cover and compresses the shrub layer into cushions 10-15 cm in height. Soil frost action creates frost boils between the vegetation cushions where other herb and grass species. The mor humus is usually , 10cm in thickness. Some of these heaths areas have supported forest in the past as shown by macrofossil evidence (Meades, 1983). However, there are probably some subalpine and coastal areas where this heath is stable but can expand with disturbance by fire. Meades 1986 described one association for this alliance:

Empetrum Heath (*Empetretum association).* There are 3 significant subassociations; *Typicum, Myricetosum and Sphagnetosum* representing dry, moist and wet gradients in soil moisture regime often correlated with slope position. These could be recognized as 3 CNVC associations under A2:

1. *Empetrum nigrum Heath* (dry) Sites 23
2. *Empetrum nigrum-Myrica gale Heath* (moist) 18 Sites
3. *Empetrum nigrum–Sphagnum nemoreum* Heath (wet) 4 Sites

In addition the following types described by Porter et al. (2020) are a good fit for this alliance although they would probably warrant seperation at the association level due to the occurrence of some southern species that are lacking in Newfoundland:

4. *Black Crowberry / Reindeer Lichen Highland Barren*
5. *Black Crowberry Wet Coastal Barren*
6. *Black Crowberry Mesic Coastal Barren*

The Pink Crowberry – Alpine Bilberry Highland Barren type is more appropriately placed in the M131 Group G910 Eastern Boreal Alpine Tundra. The Bearberry–Lowbush Blueberry Inland Barren and the Broom Crowberry types would require a separate Alliance for coastal heaths from Nantucket to Nova Scotia.

A3 Kalmia Dwarf Shrub Heaths

Kalmia Heaths are in more sheltered inland sites with the dominant shrubs attaining a height of 30-50 cm on average often reflecting the protection of winter snow cover. The humus layer is continuous and consists of a deep ericaceous mor 20-30cm thick. Many of the dwarf shrubs forming this community occur in the Empetrum Heaths but are less abundant and are compressed into the Empetrum cushion. These heaths occupy previously forested habitats following fire and or cutting. However, succession back to forests appears to be problematic and should probably be thought of in centuries rather than decades (Damman 1964, Meades 1983,1986). Similar two the Empetrum Heaths the Kalmia Heaths are divided into 3 subassociations: *Kalmietum typicum, Kalmietum myricetosum and Kalmietum sphagnetosum* reflecting dry, moist and wet soil conditions. There is a fourth subassociation *Kalmietum alnetosum* representing the most sheltered micohabitats in valleys and the forest edge. Meades (1973) recognized two heath associations dominated by *Vaccinium angustifolium*. The Kalmia-Vaccinium Heath (*Luzulo Empetretum nigrae*) association represents heaths that are recovering from natural fires or prescribed fires and starting to recover shrub cover (i.e. *Kalmia,Ledum & Empetrum*) but *Vaccinum angustifolium* is still the dominant shrub. The Vaccinium Heath (*Luzulo- Polictichetum commune*) represents heaths that are actively managed for commercial blueberry production using prescribed fire. Blueberries, grasses and a wide variety of weeds are dominant. This can be treated as a cultural vegetation type. CNVC could recognize the following six associations:

1. Kalmia angustifolia Heath 55 Sites
2. Kalmia angustifolia-Myrica Heath 20 Sites
3 Kalmia angustifolia-Sphagnum Heath 30 Sites
4. Kalmia angustifolia-Alder Heath 12 Sites
5. Kalmia-Vaccinium Heath 15 Sites

6. Vaccinium Heath 15 Sites

The Subalpine Lichen Barrens described for the Newfoundland interior by Ahti (1959) would also fall in this alliance being very similar to the Kalmia Heath. Fahey (1976) has described Kalmia "heath balds" in the subalpine zone of Mahoosne Range in northern New Hampshire-Maine border. These heaths would also fit in this alliance. He contends that these are stable heaths that have not originated from fire. The Sheep Laurel Highland Heath, the Sheep Laurel Inland Heath and the Lowbush Blueberry Highland Heath described by Porter et al. (2020) for the barrens of Nova Scotia could also form associations within this alliance. Also, the Black Spruce Highland Heath type has more than 30% cover of black spruce but is less than 5m. height (mostly 50cm.) so it would probably fit this alliance.

G971 Dwarf Shrub-Herb Rich Heaths on Basic Soils

A4 Empetrum-Dryas Heaths on Limestone Soils

The Empetrum-Dryas Heaths were described by Meades (1983). These heaths occur on soils derived from calcareous parent materials with calciphilic species characterizing the vegetation. Wind exposure is also a critcal ecological driver limiting height growth and reducing snow cover leading to intense soil cryoturbation and the formation of sorted polygons. In combination these factors reduce competition from trees and shrubs allowing the limestone flora to persist. The heath matrix is comprised of Empetrum carpets alternating with exposed limestone gravels with sorted frost polygons. The Empetrum carpets form an acidic mor humus that facilitates the mixture plants requiring acidic and basic soil conditions. The majority of the limestone flora persists in the exposed gravels.The CNVC could recognize the following associations within this alliance:

1. Empetrum eamesii-Salix cordifolia Heath (Terrace Flats) 9 Sites
2. Empetrum eamesii-Salix reticulata Heath (Upper Terrace Slope) 6 Sites
3. Potentilla fruticosa-Dryas integrifolia Heath (Terrace Gravels) 6 Sites
4. Potentilla fruticosa-Juncus alpina Heath (Wet Turf Hummocks 6 Sites

A6. Lychnis alpina Heaths on Serpentine Soils

Meades (1983) described 2 subassociations that could be recognized as CNVC associations in this alliance. The Typicum subassociation occurs on rapidly drained boulder talus. *Arenaria humifusa, A. rubella and A. marcescens* are common species that prefer the serpentine habitat These are differntial species with respect to the Adiantetosum subassociation that represents the late snowbeds that retain moisture through most of the growing season. *Adiantum*

pedatum var. aleuticum, Sanguisorba canadensis, Sarracenia purpurea and other species of wet habitats dominate this community. CNVC could recognize 2 associations in this alliance:

1. Lychnis alpina-Arenaria humifusa Association 3 Sites
2. Lynchnis alpina-Adiatum pedatum Association 3 Sites

Dearden (1975,1979) also studied the serpentine heaths in Newfoundland. He used two dimensional ordination to explore relationships between species and habitat characteristics. The ordination delimates six abstract phytosociological groups but no cover or abundance values are provided in the species lists. Research has indicated that four soil properties, low available
calcium, and high magnesium, nickel and chromium contents are the dominant limiting factors for plant growth. Similar vegetation has been described from Mt. Alber , Quebec (Sirois and Grandtner 1992), Shetland Islands (Spence,1957) and Sweden (Rune,1953).

Tall Herb Vegetation

Meades(1983) also described the *Heraculetum-Sanguisorbetosum canadense* association which represents a lush snowbed community dominated by tall herbs (*Heraculeum maximum, Angelica laurentiana and Sanguisorba canadensis*) with patches of White spruce and Balsam fir. A full species listing of 6 Sitesis included in Table C (p.314) of the publication. Its not a heath but is included because it is a part of the limestone barren landscape. It is coastal so it might fit in M060/G660 NorthAtlantic Coastal Beach but it doesn't have any halophytic species and it’s a moist soil, but would not fit the wetland types.

Krummholz

In Newfoundland krummholz is so common that the locals call it "tuckamore" or "tuck"and the forest inventory recognizes a distinct mapping unit SCS = Softwood Scrub. Most scientific references imply that this is a subalpine to alpine vegetation created by wind exposure. While this is true, the winds in coastal Newfoundland create krummholz well below treeline. Despite being a common feature of the landscape there are few descriptions of the vegetation composition. Meades(1973) described 2 types from eastern Newfoundland:

Abietetum balsameae hudsoniae 14 Sites
Piceetum marianae semiprostratae 15 Sites

The Balsam Fir krummholz occurs on very exposed upland sites either on coastal headland or high ridges in the interior. The soils are usually well drained to moist and the understory shares many of the species common to more productive boreal forests. Height can vary from 0.5 to 3.0 m.

The Black Spruce krummholz usually occurs in the transition from peatlands to upland soils. This type is particularly extensive on the south coast where the blanket bogs dominate and

create a landscape highly exposed to wind. The understory is very similar to the forested bogs described by Damman (1967). Most of this krummholz consists of dense scrub less than 2.m in height on wet sites.

Its not clear where krummholz fits in the CNVC. Hustich (1939) described extensive stands of similar vegetation throughout coastal Labrador.

M131 Eastern North America Alpine Tundra

G910 Eastern Boreal Alpine Tundra

Meades (1973,1983) described the Alpine Heath (*Diapensio-Arctostaphletum alpinae* association) from 16 Sites in eastern Newfoundland. There are two subassociations; the *Juncus trifidus* (Juncetosum) representing interior "high" (350m) elevation sites and the *Betula pumila* (Betuletosum) subassociation ocurring on severely exposed coastal headlands on the southern Avalon and Burin peninsulas. Ahti(1959) described to alpine sites from the southern Long Range Mountains and Damman (1967) provided three descriptions from Lomond and Cape Ray. Otherwise there are general descriptions and species lists from Bouchard et al 1978 for the Long Range Mountains in northern Newfoundland and Hustich (1939) for coastal Labrador. The occurrence of Alpine vegetation near sea level with increasing latitude is well known and there may be a case for treating this variation as distinct from true Alpine vegetation.

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APPENDICES

Appendix 1. Crosswalk from Meades and Moore (1994) and the CNVC associations (From Chapman et al 2020).

A6 Table 5. Correlations between Newfoundland Forest Types (Meades and Moores 1994) and CNVC Associations. Some Newfoundland Forest Types relate to CNVC Associations in wetland Macrogroups, M299 [North American Boreal Conifer Poor Swamp] and M300 [North American Boreal Flooded & Rich Swamp]. Some M495 Associations that occur in insular Newfoundland were not treated in Meades & Moores and are not shown in this table: CNVC00309 [Abies balsamea / Vaccinium vitis-idaea / Pleurozium schreberi – Bazzania trilobata], CNVC00316 [Betula papyrifera / Alnus viridis / Solidago macrophylla] and CNVC00338 [Picea mariana / Rhododendron canadense – Taxus canadensis / Pleurozium schreberi].

Code Meades & Moores Forest Type	Relationship Macrogroup	Association	
Fre #1 Equisetum – Rubus – Balsam Fir	<	CNVC00348	M495
Fr #2 Rubus – Balsam fir	<<	CNVC00348	M495
	<<	CNVC00351	M495
Fc #3 Clintonia – Balsam Fir	<	CNVC00222	M495
Ft #4 Taxus – Balsam Fir	<	CNVC00222	M495
Fdh #5 Dryopteris – Hylocomium – Balsam Fir	<	CNVC00310	M495
Fd #6 Dryopteris – Balsam Fir	<<	CNVC00310	M495
	<<	CNVC00311	M495
Fdr #7 Dryopteris – Rhytidiadelphus – Balsam Fir	<	CNVC00310	M495
Fdl #8 Dryopteris – Lycopodium – Balsam Fir	<	CNVC00310	M495
Fh #9 Hylocomium – Balsam Fir	<	CNVC00222	M495
Fg #10 Gaultheria – Balsam Fir	<	CNVC0027	M495
Fp #11 Pleurozium – Balsam Fir	<<	CNVC00222	M495
	<<	CNVC00351	M495
Ss #12 Sphagnum – Black Spruce	<	CNVC00312	M299
SM/R #13 Black Spruce – Feathermoss / Bedrock	<	CNVC00350	M495
SM/vD #14 Black Spruce – Feathermoss / Very dry	<	CNVC00350	M495
SM/D #15 Black Spruce – Feathermoss / Dry	<	CNVC00350	M495
SM/B #16 Black Spruce – Feathermoss / Bog	<	CNVC00350	M495
SM/M #17 Black Spruce – Feathermoss / Moist	<	CNVC00350	M495
Sc #18 Carex – Black Spruce	<	CNVC00293	M300
SO #19 Osmunda – Black Spruce	<<	CNVC00293	M300
	<<	CNVC00312	M299
SK #20 Kalmia – Black Spruce	=	CNVC00307	M495
SKc #21 Cladonia – Kalmia – Black Spruce	=	CNVC00205	M495

SKn #22	Nemopanthus – Kalmia – Black Spruce	<<	CNVC00335	M299
		<<	CNVC00339	M299
SKs #23	Sphagnum – Kalmia – Black Spruce	<	CNVC00335	M299
BtA #24	Birch – Aspen	<	CNVC00349	M495
Bdc #25	Dryopteris – Clintonia – Birch	<	CNVC00315	M495
Br #27	Rubus – Birch	<	CNVC00349	M495
Bd #28	Dryopteris – Birch	<	CNVC00315	M495
BK #29	Kalmia – Birch	<	CNVC00237	M495