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Coastal Forest Communities of the Nova Scotian Eastern Shore Ecodistrict

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Introduction

Nova Scotia's sea-bound coastline stretches to include almost 10 500 km of bays, coves, harbours, inlets, passages, channels, basins, points, heads, promontories, islands, capes, beaches, estuaries and salt marshes (Nova Scotia, 1986). Along this coastline is a band of ecologically unique coastal forest. However, very little is known about the structure and dynamics of this coastal forest. The objective of this study was to describe the average stand condition, composition and ecology of the mature coastal forest. An improved understanding and delineation of the coastal forest will assist in sustainable forest management initiatives including old growth forest representation, forest management practices, wildlife habitat provisions and biodiversity representation.

Loucks (1962) briefly described the forests along the Atlantic eastern shore of Nova Scotia as containing white spruce, black spruce and balsam fir, with red spruce, eastern hemlock and white pine appearing at the inland limit of the coastal influence (See Appendix I for a list of common and scientific plant names). Red maple and yellow birch were noted as occurring on better drained soils. Other shrubs and plants included heart-leaf birch, mountain-ash, foxberry (cowberry) and red (Canada) raspberry.

Davis and Browne (1996) described a white spruce, fir - maple, birch mixedwood forest as the climax forest of the province's rocky and exposed southwestern to northeastern coastline (with stunted trees from severe wind exposure and salt spray - a krummholz condition). White spruce tends to occupy habitats along the immediate coast with balsam fir further inland. Red maple and white birch may be found inland with the spruce and fir as a result of fire or cutting activities. Along the eastern shoreline they report that black spruce assumes as much importance as balsam fir. The understory vegetation is dominated by Schreber's moss and broom moss with wood fern, wood sorrel, wild lily-of-the-valley, blue bead lily, starflower, goldthread, bunchberry and wood aster as associates. Recent work with lichens[1] has revealed that the coastal forests are home to several rare species, most notably the boreal felt lichen *(Erioderma pedicellatum)* which is provincially listed as an endangered species.

As expected, the coastal climate is largely influenced by the ocean. Compared to inland Nova Scotia, there is higher precipitation and humidity, cooler summer temperatures, milder winters with less snow accumulation, a longer frost-free period, stronger winds, fog and salt spray (Loucks, 1962; Davis and Browne, 1996; Neily *et al.*, 2003a). Natural disturbances that affect the coastal forest include extreme weather events such as hurricanes, fire, insects and disease (Neily *et al.*, 2003b).

[1] Robert Cameron, Ecologist, N.S. Dept. of Environment and Labour, March 2004

Figure 1. A portion of the A.F.Church map for Sheet Harbour, circa 1860 (Walling, 1861).

This study was designed to describe the natural condition of undisturbed mature to over-mature coastal forests. The Eastern Shore Ecodistrict of Nova Scotia (Neily *et al*, 2003a) was chosen as the area of study because there appeared to be a better prospect of finding natural, undisturbed forests as indicated by settlement patterns on maps by Walling (1861) (Figure 1) and Fernow (1912) (Figure 2). The first European settlers who arrived in 1784 immediately built a sawmill on one of the two major rivers in Sheet Harbour and by 1825 the lumbering industry was prosperous. A number of sawmills on both rivers used the abundance of quality timber inland from the coast (Kerr, 2001; Johnson, 1986; Rutledge, 1954). A map of Halifax County (Walling, 1861) showed that settlement in the Sheet Harbour area had occurred where the East and West Rivers enter the harbour. Fifty years later, farming had extended further inland and along the harbour and road access had been provided to coastal areas near Mushaboom, Sober Island and Beaver Harbour (Fernow, 1912). The first sulfite pulp mill in Canada was built in Sheet Harbour in 1885 only to burn down in 1893 (Johnson, 1986). In 1924, a groundwood pulp mill was established and continued to produce pulp until 1971 when rains and flooding associated with Hurricane Beth destroyed the mill. The quality of the coastal forest in terms of timber did not compare to that growing inland and harvesting of forest fibre was confined to only those sites supporting better than average quality.

Methods

Site Selection and Ecosection Representation

Aerial photography (1947, 1954 and 1992) and historical maps (Walling, 1861; Fernow, 1912) were examined to select mature to over-mature stands in natural condition with no evidence of past logging or settlement disturbance.

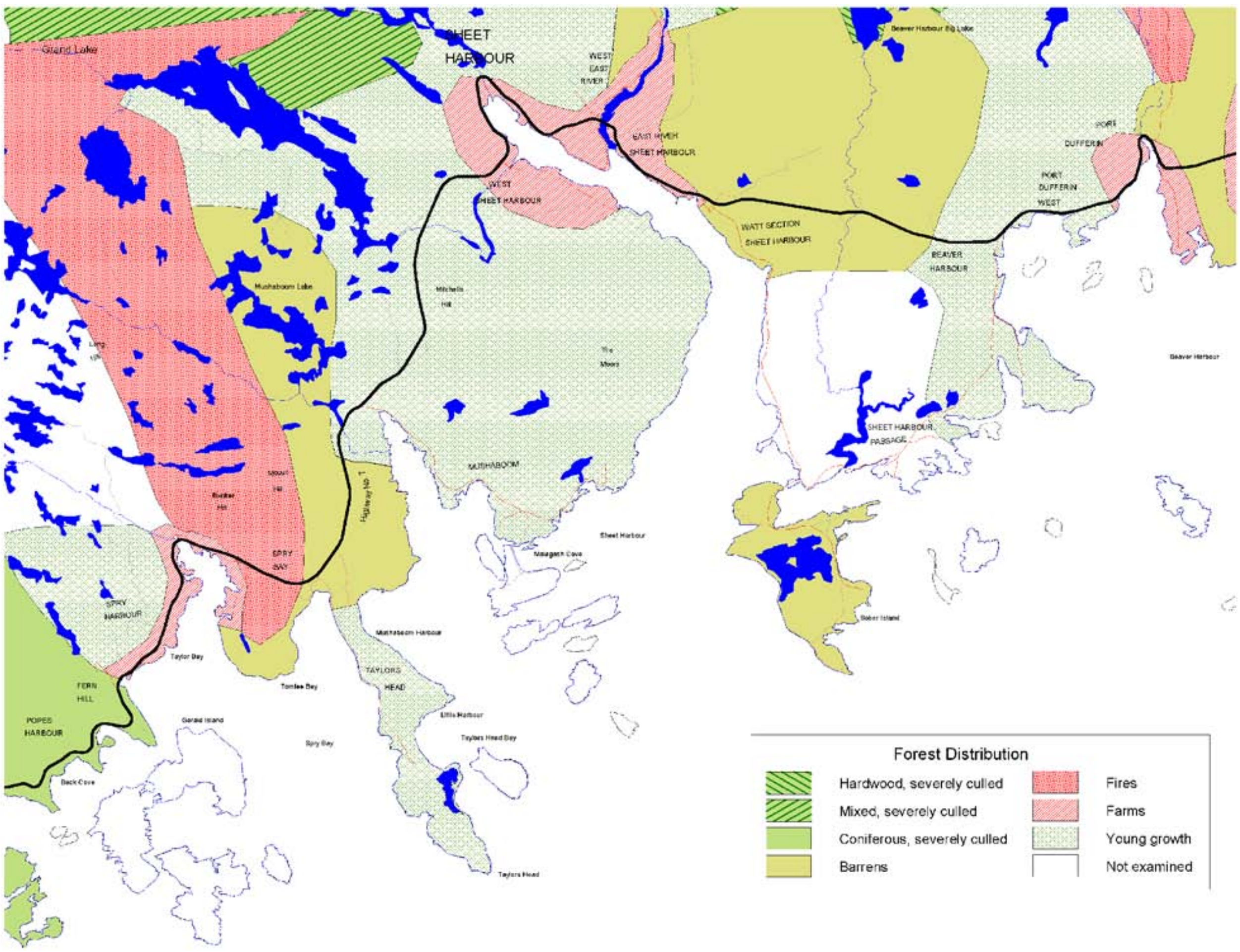

Figure 2. Historical forest inventory classification, circa 1900, of the Sheet Harbour area (Fernow, 1912).

The past harvesting described by Fernow (1912) was evident in the early aerial photos as overgrown trails and a somewhat patchy forest structure of pole and young mature stands. Among this heavily worked landscape structure, patches of older, apparently undisturbed mature timber were identified and provided the initial selection of stands for the study. Aerial photography from 1992 was used to determine if any of these had been disturbed since the earlier photography. A final selection (assisted by an aerial reconnaissance) was made of seven stands, each greater than four hectares in size and located on average sites representative of the natural forest conditions on the dominant ecosections within this coastal ecodistrict (Figure 3). The seven stands were distributed as follows:

Dominant Ecosections	% of Ecodistrict Area	# of Stands Sampled
IMHO - imperfectly drained, medium textured soils on hummocky topography	22	2
WMKK - well drained, medium textured soils on hilly topography	16	2
WCKK - well drained, coarse texture soils on hilly topography	15	0
WCHO - well drained, coarse texture soils on hummocky topography	8	0
IMRD - imperfectly drained, medium texture soils on ridged topography	6	2
WMRD - well drained, medium texture soils on ridged topography	5	1

Experimental Design

Stands selected for sampling (Figure 3) were delineated on 1:10 000 aerial photographs and plots were systematically located along a route through the stand that would minimize edge effect. At each sampling plot, the following data were collected:

- Live trees (species, diameter, height, breast height age, basal area)
- Shrubs (species, percent cover)
- Mosses, liverworts and common lichens (species, percent cover)
- Herbs (species, percent cover)
- Dead wood - standing snags and downed coarse woody debris (diameter, species, decay class)

Sampling occurred during October and November, 2002. Understory vegetation was assessed using a 100 m^2 (10 m x 10 m) plot. Polyareal point sampling was used for overstory trees. All vegetation was categorized into layers: Layer D - mosses, liverworts and lichens; Layer C - herbaceous and dwarf woody species; Layer B3 - regenerating trees (< 30 cm); Layer B2 - low shrubs and established tree regeneration (0.3-1.3 m); Layer B1 - tall shrubs (1.3-10 m); Layer A2 - suppressed trees; and Layer A1 - dominant, co-dominant and intermediate trees. Occurrences of species found outside the plot were recorded separately.

In order to ensure measurement of at least 15 live trees per plot > 7.0 cm diameter at breast height, a 2M or 3M basal area prism[2] was used. All live trees ≤ 7.0 cm diameter at breast height were counted with a 1M basal area prism to obtain an adequate sample of small trees for age determination. Land capability[3] was determined for each stand by averaging measurements

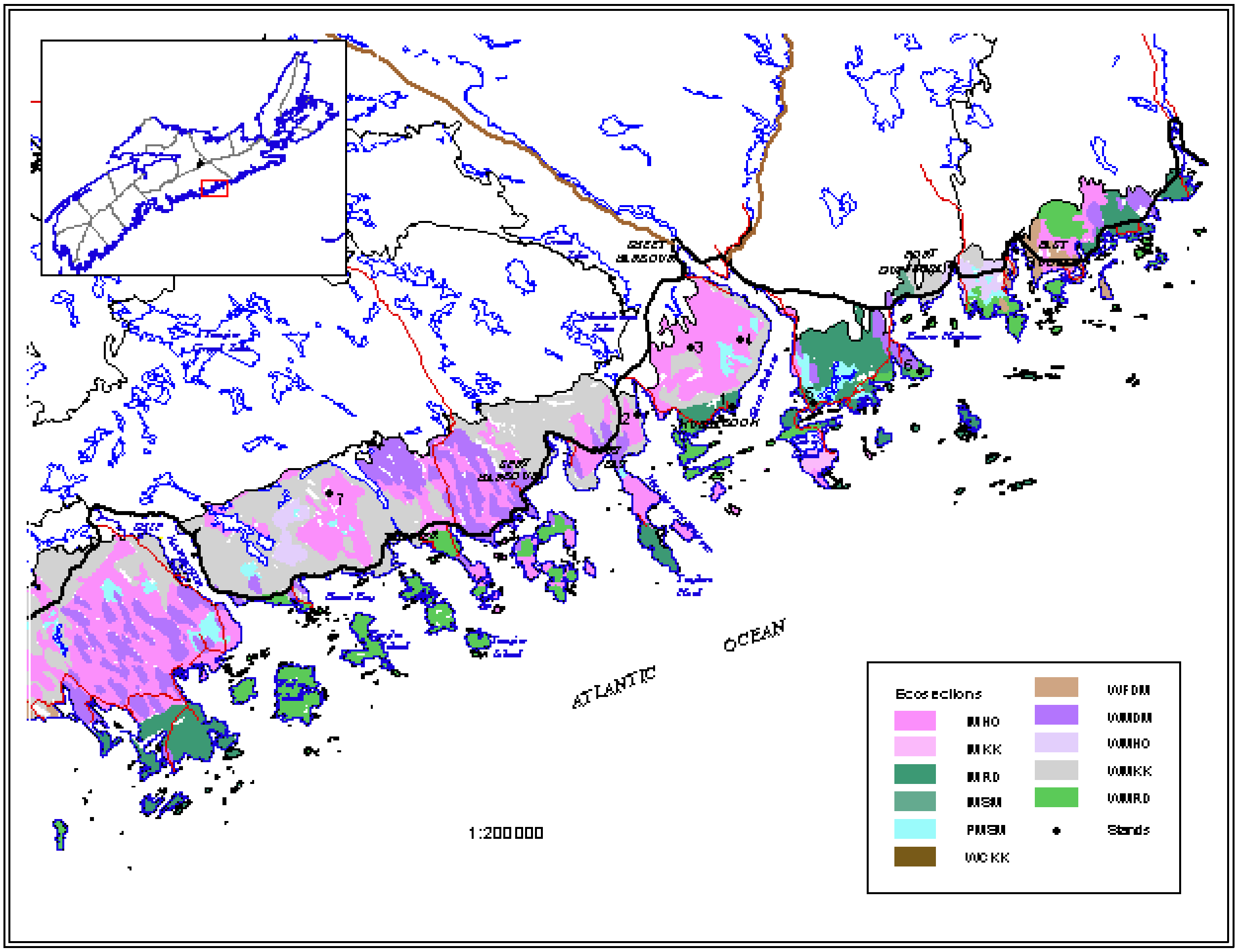

Figure 3. A portion of the Eastern Shore Ecodistrict showing the ecosections and locations of stands 1-7.

from the best growing tree in each plot.

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[2] Basal area prisms measure square meters of basal area per hectare. The tree count achieved with the prism is multiplied by the factor to give the basal area per hectare.

[3] Land capability is an estimate of potential forest productivity (m^3/ha/year) and is determined by height and age measurements (NSDNR, 1993).

All dead standing trees (snags) ≥ 7.5 cm diameter at breast height within the prism plot were measured. Snags < 7.5 cm diameter at breast height were not included in the assessment. Species, diameter at breast height, height, decay class (Appendix II), top diameter and heights by 10 cm diameter class were measured (McCurdy and Stewart, 2003). A triangular line transect with 30 m sides was used to assess downed coarse woody debris. Woody material ≥ 7.5 cm diameter (at the transect point) that intersected the 90 m triangle were sampled (Appendix III). Species, diameter at the transect point and decay class (Appendix II) were measured. Woody debris < 7.5 cm diameter were not included in the assessment.

One plot per stand was chosen for a detailed site and soil description. Site assessment included exposure, drainage, slope position and percent, seepage, rock outcrop and surface stoniness. Standard soil profile assessments, performed on the first five sites only, included depths of each horizon to the C layer, texture and consistence of each layer and the abundance of coarse fragments, fine roots and mottles in each layer. Dominant rock types found in the soil were also recorded.

Results and Discussion

The seven stands selected for this study were located along the Eastern Shore of Nova Scotia, from Tangier to Beaver Point. Distance from the coastline for these stands ranged from 100 meters to nearly 5 kilometers. Table 1 provides a site description summary for each study area.

Stands were predominantly balsam fir and/or black spruce (Table 2). Stand 3 had a significant component of red maple and white birch. Red spruce occurred at stand 7 and white spruce, a species considered predominant in the coastal forest (Loucks, 1962; Davis and Browne, 1996) was not found growing on any of the sites. However, white spruce was noted during stand selection and en route to study sites, associated predominantly with settlement areas, where land had been cleared for agriculture or used for pasture.

All stands were moderately stocked (basal area[4] = 24.0 - 36.0 m^2/ha) (Table 2) indicating that the stands had areas where overstory tree cover was absent. Average stand age ranged from 63 to 90 years with a maximum age of individual trees ranging from 85-145 years. The oldest trees found by species include balsam fir, 116; black spruce, 138; white birch, 117; and red maple, 145. Average stand height ranged from 7.4 m to 11.7 m which emphasizes the adverse effect of coastal exposure on tree growth. Land capability for these coastal stands reflects the stunted height growth with values from 0.6 to 4.0 m^3/ha/yr, which are lower than the provincial average of 5.2 m^3/ha/yr (NSDNR,1999). The two well drained sites (stands 2 and 3) had the highest land capability values of 3.3 m^3/ha/yr and 4.0 m^3/ha/yr and two black spruce stands on exposed sites had the lowest land capability values of 0.6 m^3/ha/yr and 1.5 m^3/ha/yr.

[4] Basal area for fully stocked softwood stands is normally 60 m^2/ha and for mixedwood stands 50 m^2/ha.

Table 1: Ecosection and site information for the seven stands.

Stand	# Plots	General Location	Ecosection	Exposure	Distance from Atlantic Coastline	Soil Drainage	Slope Position
1	4	Mushaboom	IMRD	Exposed [Coastal]	0 - 1 km	Imperfect	Middle to Level Upper
2	3	Taylor Head Prov. Park	WMKK	Moderate [Leeward side]	1 - 2 km	Moderately Well to Well	Lower to Upper
3	3	Mushaboom	WMKK	Moderate [Inland]	2 - 3 km	Well	Upper
4	3	West Sheet Hbr. Area	IMHO	Moderate [Inland]	1 - 2 km	Poor to Imperfect	Upper
5	3	Sheet Hbr. Passage	IMRD	Exposed [Coastal]	0 - 1 km	Moderately Well to Imperfect	Middle to Upper
6	3	Beaver Point	WMRD	Exposed [Coastal]	0 - 1 km	Variable	Middle to Level Upper
7	4	Tangier	IMHO	Moderate [Inland]	4 - 5 km	Imperfect	Lower to Level Upper

Table 2: Selected stand attributes from study sites.

Stand	Species Composition[1] (10% species)	Mean age[2] (years)	Mean height[3] (m)	Total Volume[4] (m^3/ha)	Basal Area (m^2/ha)	Mean DBH[5] (± 1 SD) (cm)	Total Density (trees/ha)	Land Capability m^3/ha/yr
1	5bS5bF(wB)	77	9.0	101.9	24.0	9.7 ± 5.3	2 481	1.5
2	6bF3bS1(wB,rM)	63	11.7	192.7	35.0	12.1 ± 4.7	2 627	3.3
3	6bF2rM2wB(bS)	84	11.4	187.6	36.0	14.3 ± 5.1	1 988	4.0
4	7bS3bF	75	10.4	121.7	25.0	14.1 ± 4.8	1 441	2.0
5	5bF5bS	77	11.5	146.4	27.7	15.1 ± 4.7	1 415	2.4
6	9bS1bF	86	7.4	95.2	25.7	7.0 ± 3.5	5 363	0.6
7	5bS3bF2rM(rS)	90	9.9	160.2	34.2	8.9 ± 5.6	3 976	2.1

[1] bS = Black spruce; bF = Balsam fir; wB = White birch; rM = Red maple; rS = Red spruce
[2] Age of tree of average basal area. Age measured at breast height.
[3] Lorey's Height = height of tree of average basal area (Husch *et al*., 1982).
[4] Total Volume calculated using metric diameter-height ratio equations (Honer *et al*., 1983).
[5] Mean DBH = arithmetic mean diameter at breast height

Soil profiles were assessed at stands 1 to 5 and were similar except for the deeper, well drained loam to sandy loam soil at stand 3 (due to the lateness of the year stands 6 and 7 did not have a soil assessment). Generally, soils were imperfectly drained to moderately well drained loamy sands to loams derived from glacial tills. Excluding stand 3, the forest floor layer was 22 cm and the average rooting depth into the mineral soil was 19 cm (stand 3 had a forest floor thickness of 5 cm and a rooting depth of 39 cm). Consistence was generally friable to firm. Maximum coarse fragment content ranged from 15 - 85%, except for stand 3 where 5% coarse fragments were found. Excluding stand 3, quartzite was the predominant coarse fragment and averaged 90% at the four stands (coarse fragments at stand 3 also included significant portions of grey sandstones and slates). Charcoal was found at stands 1, 2 and 3 indicating a past history of fire.

All stands show at least one significant recruitment period (Figure 4) for balsam fir and/or black spruce. Some of these stand initiating events can be associated with past hurricanes such as Edna in 1953, Carol in 1954 and two hurricanes that landed on the eastern shore in 1891 (Neily *et al.,* 2003b). Other stands illustrate a major stand initiating disturbance approximately 65 years ago. Although few in number, some relics from these disturbances have survived and now occupy older age classes. Stands 5 and 6 illustrate how a second disturbance may have only partially removed the original overstory and thus allowed regenerating fir and spruce in the understory an opportunity to grow into the canopy. Oliver and Larson (1996) developed a theory that irregularity [in stand composition] corresponds to the intensity of disturbance and condition of the stand. This condition is observed at stands 1, 4, 6 and 7 where an uneven-age structure has developed due to past disturbances of varying intensity creating gaps in the canopy allowing regeneration opportunities for several species.

The dominant recruitment species are black spruce and balsam fir, which share similar age structure/development patterns (Figure 4). The reaction to competition of black spruce and balsam fir ranges from intermediate to tolerant and together in the coastal forest, they can dominate a stand to the detriment of other species such as red maple and white birch. However, site conditions at stand 3 (well drained soils on an upper slope inland from the coast) allowed intolerant hardwoods to dominate in the overstory.

Representation of tree species in the canopy of the under 35 year age class was low for all stands, but there was extensive coverage to regenerating tree species in the B3 (<0.3 m), B2 (0.3-1.3 m) and B1 (1.31-10 m) layers (Appendix IV). Total coverage in these layers was close to 10% in all stands and will be sufficient to reforest the site following a stand initiating disturbance or to occupy holes in the canopy created by patch or individual tree mortality. Balsam fir and black spruce were the main species in the 'B' layers, with minor coverage to red maple and white birch.

A large variety of woody shrubs, 13 species in total, were identified (Appendix IV). Shrubs from the heath (ericaceous) family were found on all sites with lowbush and velvet-leaf blueberry being the most prevalent. Wild raisin and false holly also occurred in all stands.

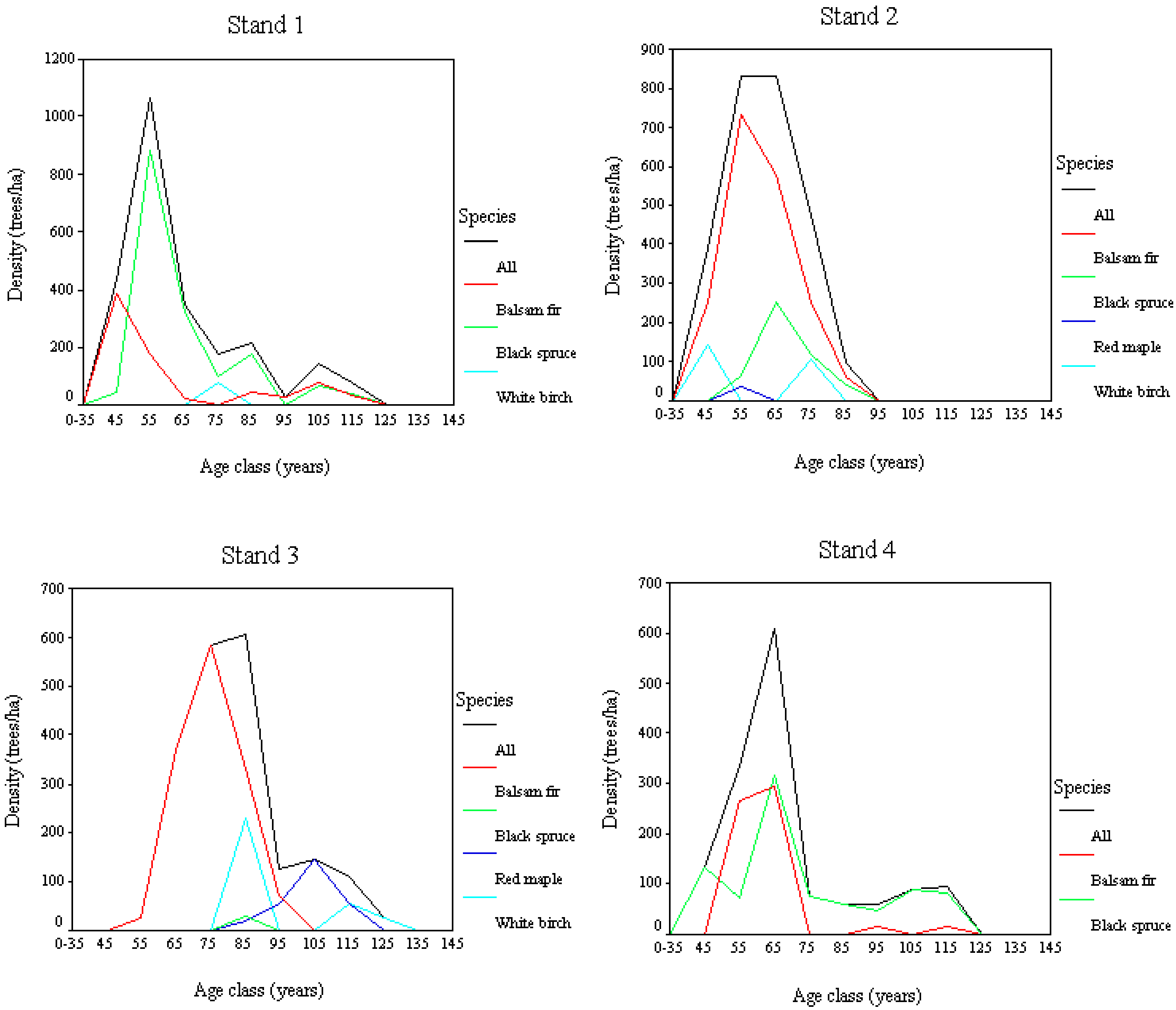

Figure 4: Age distribution graphs for seven coastal stands. Age information is shown for individual species and the total stand combined.

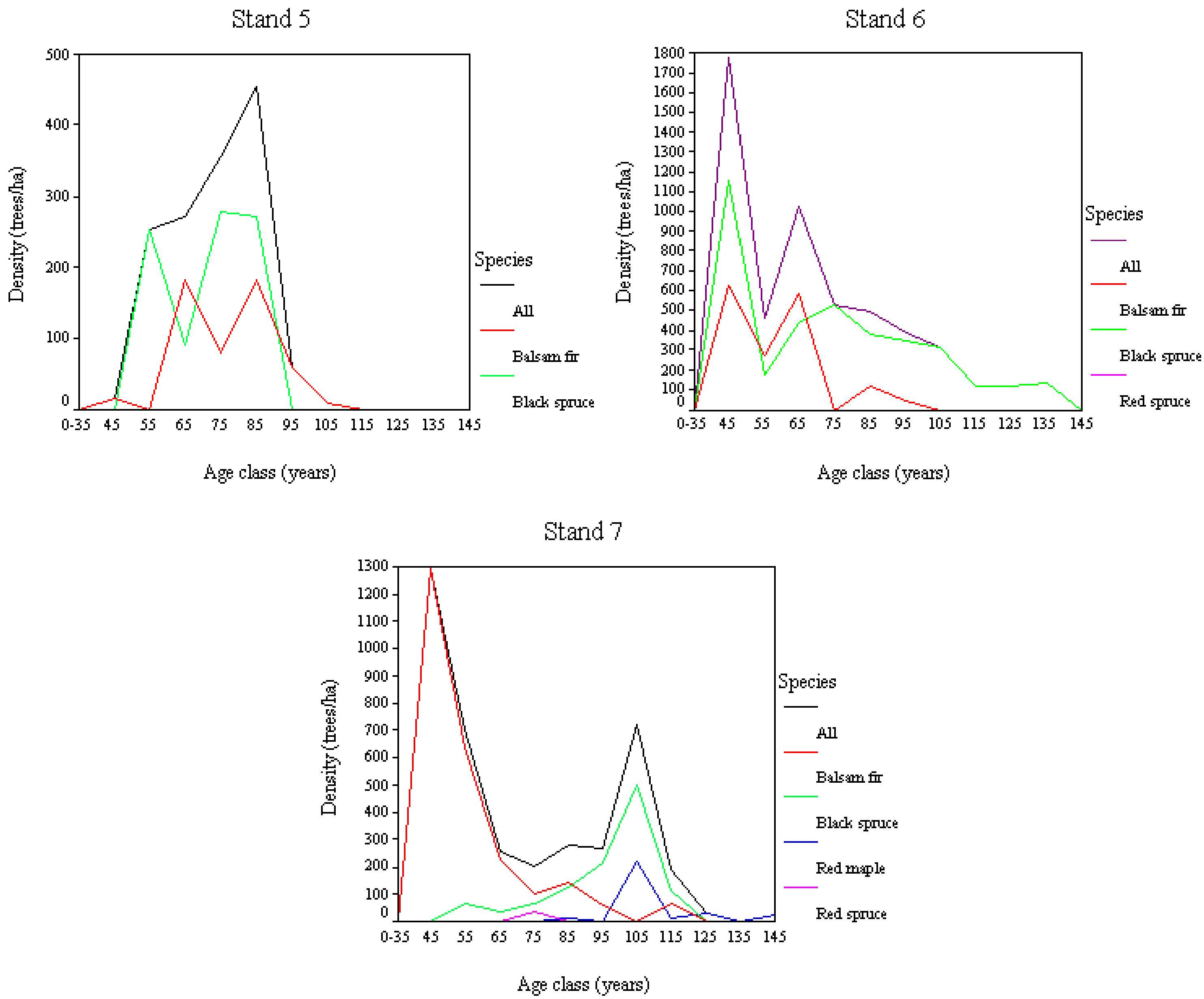

Figure 4 (continued): Age distribution graphs for seven coastal stands. Age information is shown for individual species and the total stand combined.

Chokeberry was found in five of seven stands and when present with other species (such as mountain ash and downy alder) may indicate the coastal influence.

Twenty-four herb and dwarf woody species were identified in the understory (Appendix IV). However, due to the lateness of the sampling, some species might have been missed. Of particular interest was the occurrence of foxberry at all the sites. Foxberry is common in many of the cooler regions of the Province such as bare headlands, barrens or other exposed sites near the sea and is occasionally found on barrens or heaths inland. At the inland locations it is seldom known to fruit (Roland 1998). Other species occurring at all sites were bunchberry, creeping snowberry, twinflower, goldthread, cinnamon fern, bracken fern and wild lily-of-the-valley. Bluebead lily and starflower were found at six of seven sites.

Thick, mossy layers on the forest floor are typical of the coastal forest and in this study 17 species of bryophytes were identified (Appendix IV). The most abundant species were Schreber's moss, stair-step moss, sphagnum moss (6 species), three lobed bazzania, broom moss and wavy moss. Plume moss and three species of reindeer lichens were also common throughout the stands.

Dead wood volumes ranged from 33.2 m^3/ha to 119.7 m^3/ha (Table 3). Snag volumes exceeded downed coarse woody debris volumes (except stand 3). All snags and coarse woody debris were less than 50 cm in diameter and most were less than 20 cm (Table 3). On average, 84% of the dead wood volume was under 20 cm in diameter, which have limited use as wildlife habitat (NSDNR, 1989). Snags greater than 30 cm at breast height can be used by some cavity-nesting birds. All coarse woody debris was less than 30 cm in diameter.

Species composition of the dead wood is similar to the current species composition of the overstory (Tables 2 & 3) and mortality is occurring at the stand level and is not species-specific. Therefore, between disturbance events the input of deadwood is roughly proportional to the species composition of the overstory. A broad range of decay classes for snags and downed coarse woody debris was also observed (Figures 5 & 6). This indicates that small-scale or gap-like mortality regularly occurs in the coastal forest between stand-initiating events associated with wildfires and hurricanes.

Table 3: Volume of deadwood (downed and standing) by species and diameter class.

Stand	Volume (m^3/ha)			Species (% by volume)	Diameter class (cm)	
	CWD	Snags	Total		D-Class	% Volume
1	12.2	34.2	46.4	Black spruce (50) Balsam fir (40) Other softwood (10)	7.5-9.9 10.0-19.9 20.0-29.9 30.0-39.9	24 51 17 7
2	9.0	50.2	59.2	Balsam fir (90) Other softwood (10)	7.5-9.9 10.0-19.9 20.0-29.9	15 71 14
3	65.5	54.2	119.7	Balsam fir 80 Red maple 20	7.5-9.9 10.0-19.9 20.0-29.9	15 57 19
4	24.9	41.4	66.3	Black spruce 50 Balsam fir 50	7.5-9.9 10.0-19.9 20.0-29.9 30.0-39.9 40.0-49.9	21 42 27 0 9
5	30.4	53.0	83.4	Balsam fir 90 Black spruce 10	7.5-9.9 10.0-19.9 20.0-29.9	20 74 6
6	9.6	23.6	33.2	Black spruce 100	7.5-9.9 10.0-19.9	70 30
7	14.0	41.0	55.0	Black spruce 50 Balsam fir 40 Other 10	7.5-9.9 10.0-19.9 20.0-29.9	22 67 11

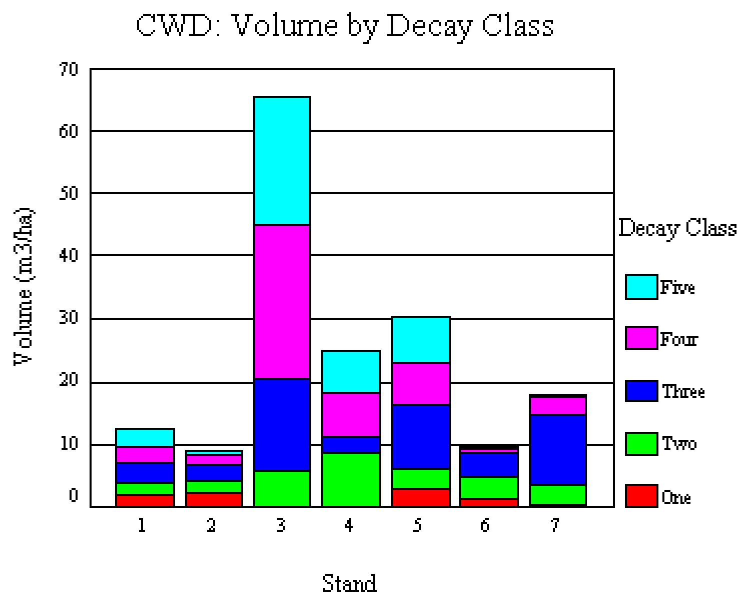

Figure 5: Volume of downed dead wood (CWD) (m^3/ha) by decay class (scale of 1-5; Appendix II).

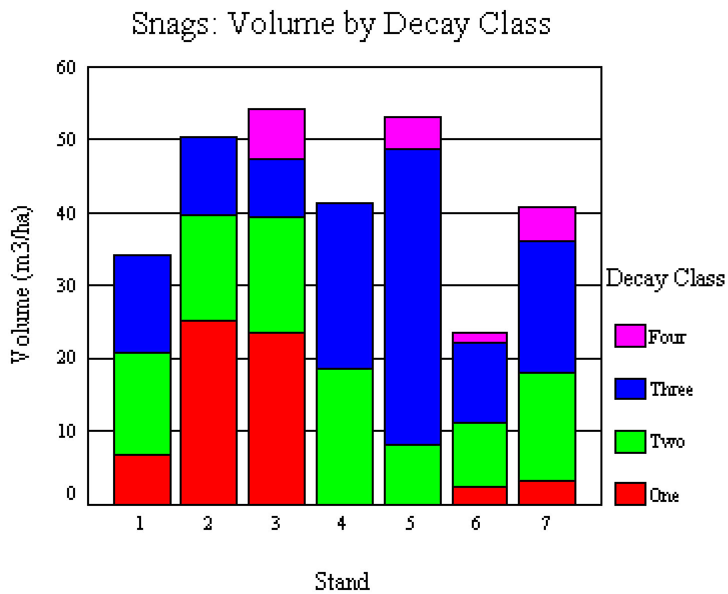

Figure 6: Volume of standing dead wood (snags) (m^3/ha) by decay class (scale of 1-4; Appendix II).

Conclusions

The ecology of the Atlantic coastal forests in Nova Scotia has not been studied as well as the more typical forests of the Acadian ecozone. The purpose of this study was to examine some of the structures, processes and flora of the coastal forest ecosystem. Conclusions derived from this study are conditional upon further investigation, but it is apparent that the Atlantic coastal forest is the product of an interaction between a harsh Maritime climate and its impact on the soils and site of the region.

The predominant physiognomic characteristic of the coastal forests of the Eastern Shore ecodistrict is a coniferous overstory dominated by black spruce and balsam fir. Red maple and white birch will occupy an intermediate position in the canopy and will only express dominance on sheltered, well drained sites or on sites greater than 1-2 km from the coast. White spruce will form pure stands on sites previously disturbed by settlement activities.

Based on the seven study locations used for this report, it can be suggested that the oldest cohort of trees within a stand seldom exceeds 100 years of age. Limitations to growth, imposed by both the local climate (e.g. salt spray, exposure to winds, cool temperatures) and soil and site influences such as moisture deficit and excess, and low nutrient availability give rise to an edaphic climax of balsam fir and black spruce. Frequent natural disturbances for example winds and storms, and to a lesser extent, fire and insects, combined with site limitations for growth, restrict the coastal forest ecosystems from developing into late successional hardwood forests of sugar maple, yellow birch and beech or softwood forests of red spruce, white pine and hemlock, indicative of the Acadian forest ecozone.

The even-aged appearance and structure of the coastal forests can be attributed to the frequency of the stand disturbances and the regeneration strategies of its dominant species. Balsam fir is usually abundant in the regeneration layer due to its ability to tolerate shade. Black spruce, although not as shade tolerant as fir, can be prominent in the regeneration layer due to its ability to layer young seedlings in the moist, mossy forest floor. Black spruce cones are also semi-serotinous and seed dispersal can occur at any time when sufficient heat is present to open the cones. These seeds can take advantage of microsites created by gap disturbances. Red maple regeneration can also withstand shade and will occur in the understory. Due to its small size, white birch seed can blow in from significant distances and use favourable seedbeds associated with weather related windfalls. Therefore, in coastal forests, advanced regeneration is often extensive and sufficient to reforest sites immediately after disturbance.

Gap and stand initiating events are the disturbance dynamics at work in the coastal forest. Small gap disturbances are continually creating conditions for regeneration establishment and development. Frequent stand initiating disturbances remove the overstory and release the regeneration to create stands of even-aged structure and composition. Since stand initiating events are frequent, gap disturbances small, and the longevity of the dominant species short, forests of several age cohorts (uneven-aged forests) are rare.

Defining the limits of coastal influence would be difficult for any study. The line of delineation between coastal and inland environments can be quite variable and mapping such a zone is difficult. Several factors vary the coastal influence and include: distance from the coast, topography (i.e. sheltered slopes and elevation), coastline configuration (i.e. inland bays and coves) and annual climatic fluctuations. The response of vegetation, bryophytes and lichens can therefore be quite variable within a short distance. The extent of the coastal forest can be estimated if a relationship between the presence or absence of some species can be inferred. From this study, it can be concluded that the absence of the tolerant species of the climatic climax Acadian forest, i.e. red spruce, white pine, eastern hemlock, sugar maple, beech, and to a lesser extent yellow birch, can be used as indicators of coastal influence. If using lesser vegetation, it appears that a cohort of species (namely foxberry, creeping snowberry, chokeberry, downy alder and American mountain ash) give some indication as to the extent of the zone. However, the best opportunity for an indicator species may lie within the lichen population and to a lesser extent within the bryophytes.

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Appendix I

List of Common and Scientific Species Names Used in this Report

Scientific names of plants and lichens are referenced in Roland (1998), Ireland (1982), and Brodo *et al*. (2001).

Trees & Shrubs

Balsam fir . . . . *Abies balsamea*
Bayberry . . . . *Myrica pensylvanica*
Black spruce . . . . *Picea mariana*
Chokeberry . . . . *.Aronia spp.*
Downy alder . . . . *Alnus viridis*
Eastern hemlock . . . . *Tsuga canadensis*
False holly . . . . *Neompanthus mucronata*
Heart-leaf birch . . . . *.Betula cordifolia*
Huckleberry . . . . *Gaylussacia baccata*
Labrador tea . . . . *Ledum groenlandicum*
Lambkill or Sheep laurel . . . . . *Kalmia angustifolia*
Lowbush blueberry . . . . . . *Vaccinium angustifolium*
Mountain-ash . . . . *Sorbus americana*
Red maple . . . . *Acer rubrum*
Red (Canada) raspberry . . . . *Rubus idaeus*
Red spruce . . . . *Picea rubens*
Serviceberry family . . . . *Amelanchier spp.*
Tamarack . . . . *Larix laricina*
Velvet-leaf blueberry . . . . . *Vaccinium myrtilloides*
White birch . . . . *.Betula papyrifera*
White pine . . . . *Pinus strobus*
White spruce . . . . *Picea glauca*
Wild raisin . . . . *Viburnum nudum*
Yellow birch . . . . *.Betula alleghaniensis*

Herbaceous & Dwarf Woody Species

Black crowberry . . . . *Empetrum nigrum*
Blue bead lily . . . . *Clintonia borealis*
Bracken fern . . . . *Pteridium aquilinum*
Bunchberry . . . . *Cornus canadensis*
Cinnamon fern . . . . *Osmunda cinnamomea*
Creeping snowberry . . . . *Gaultheria hispidula*
Eastern spreading wood fern *Dryopteris campyloptera*
Foxberry (cowberry) . . . . *Vaccinium vitis-idaea*
Goldthread . . . . *Coptis trifolia*
Indian pipe . . . . *Monotropa uniflora*
Mayflower . . . . *Epigaea repens*
One-sided wintergreen . . . . *Pyrola secunda*
Partridge-berry . . . . *Mitchella repens*
Pitcher-plant . . . . *Sarracenia purpurea*
Small cranberry . . . . *Vaccinium oxycoccus*
Starflower . . . . *Trientalis borealis*
Sundew family . . . . *Drosera sp.*
Teaberry . . . . *Gaultheria procumbens*
Three-seeded sedge . . . . *Carex trisperma*
Twinflower . . . . *Linnaea borealis*
Wild lily of the valley . . . . *Maianthemum canadense*
Wild sarsaparilla . . . . *Aralia nudicaulis*
Wood aster . . . . *.Aster acuminatus*
Wood fern . . . . *Dryopteris spp.*
Wood sorrel . . . . *Oxalis acetosella*

Mosses, Liverworts, & Lichens

Broom moss . . . . *Dicranum scoparium*
Brown fat-leaved sphagnum . *Sphagnum papillosum*
Cup lichens . . . . *Cladonia spp.*
Common green sphagnum . . *Sphagnum girensohnii*
Dicranum moss . . . . *Dicranum undulatum*
Green reindeer lichen . . . . *Cladina mitis*
Grey reindeer lichen . . . . *Cladina rangiferina*
Haircap moss . . . . *Polytrichum commune*
Bog haircap moss . . . . *Polytrichum strictum*
Ladies tresses sphagnum . . *Sphagnum capillifolium*
Naugehyde liverwort . . . . *Ptilidium ciliare*
Pale fat-leaved sphagnum . . . . . *Sphagnum centrale*
Plait moss . . . . *Hypnum imponens*
Plume moss . . . . *Ptilium crista-castrensis*
Red fat-leaved sphagnum . *Sphagnum magellanicum*
Schreber's moss . . . . *Pleurozium schreberi*
Sphagnum moss . . . . *Sphagnum fallax*
Stair-step moss . . . . *Hylocomium splendens*
Star-tipped reindeer lichen . . . . . . *Cladina stellaris*
Three lobed bazzania . . . . *Bazzania trilobata*
Wavy moss . . . . *Dicranum polysetum*

Appendix II

The five decay classes for dead wood (Sollins, 1982)

I. Freshly dead, bark intact , branches intact (including small), needle/leaf retention, bole sound, bole raised off ground on branches.

II. Beginnings of decay but not well established in wood that was sound at time of death. Bark mostly intact, branch stubs, bole not raised on branches, bole mostly sound.

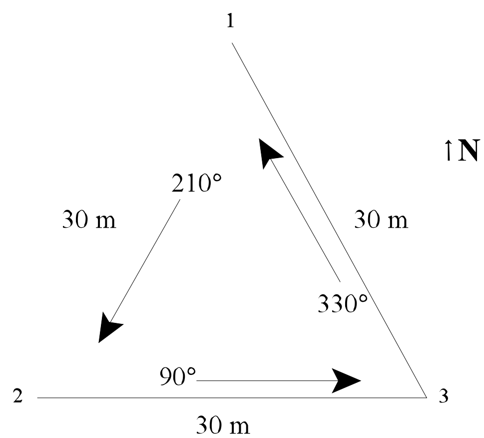
III. Rot becoming established but sound at core. Bark loose and mostly flaked off, bole beginning to rot but maintaining structural strength - round, straight, not sinking into ground.

IV. Advanced decay. Bark mostly absent, bole mostly decayed with little or no sound wood present. Colonized with vegetation. Lacking structural strength - bole oval and bending to shape of ground. Last stage for snags which will be rotted, wobbly, and could be easily pushed over.

V. Rotted through, becoming humus. Sunken into mound on the ground, but retaining a woody character, not yet part of the soil.

Appendix III

Line transect plot layout diagram



Appendix IV

Percent cover (average of all plots at that site), mean percent cover, and occurrence value for vegetation found in seven coastal sites. Species located outside plot boundaries are recorded as 0.001 percent cover.

Common Name	Percent Cover								Occurrence (%)
	Stand 1	Stand 2	Stand 3	Stand 4	Stand 5	Stand 6	Stand 7	Mean	
Layer A1: Dominant, co-dominant, and intermediate trees									
Black spruce	20	15	2	42	20	24	28	**21.6**	**100**
Balsam fir	15	25	20	4	22	3	8.5	**13.9**	**100**
White birch	2.5	2	22	0	0	0	0	**3.8**	**57.1**
Red maple	0	2	12	0	0	0	7.5	**3.1**	**57.1**
Red spruce	0	0	0	0	0	0	3.5	**0.5**	**14.3**
Tamarack	0	0	0	2	0	0	0	**0.3**	**14.3**
White pine	0	0	0	0	0	0	0	**0**	**14.3**
SUB-TOTAL	**37.5**	**44**	**56**	**48**	**42**	**27**	**47.5**		
Layer A2: Suppressed trees (understory)									
Balsam fir	2.5	15	10	0	0	0	9	**5.2**	**57.1**
Black spruce	0.5	2	0	0	0	0	1	**0.5**	**42.9**
White birch	0	3	0	0	0	0.2	0	**0.5**	**28.6**
SUB-TOTAL	**3**	**20**	**10**	**0**	**0**	**0.2**	**10**		
Layer B1: Tall shrubs and trees (1.3 - 10m)									
Balsam fir	7.5	1	0.2	0.7	0	0.7	6.5	**2.4**	**85.7**
Black spruce	5	0	0	0.7	0	0.3	3	**1.3**	**57.1**
Mountain-ash	0	0	0	0	2	0	0	**0.3**	**28.6**
Red maple	0.75	0	0.3	0	0	0	0	**0.2**	**28.6**
False holly	1	0	0	0	0	0	0	**0.1**	**14.3**
White birch	0	0	0	0.5	0	0	0	**0.1**	**14.3**
Wild raisin	0	0	0	0.3	0	0	0	**0**	**14.3**
SUB-TOTAL	**14.2**	**1**	**0.5**	**2.2**	**2**	**1**	**9.5**		

Common Name	Percent Cover								Occurrence (%)
	Stand 1	Stand 2	Stand 3	Stand 4	Stand 5	Stand 6	Stand 7	Mean	
Layer B2: Low shrubs and established tree regen (0.3 - 1.3m)									
Lambkill (or Sheep laurel)	15	7	4	35	4	10	12.5	**12.5**	**100**
Balsam fir	5	1	2	3	27	2	1.5	**5.9**	**100**
Black spruce	4	0.5	0.1	6	3	4	1	**2.7**	**100**
Wild raisin	1.5	0.5	0.07	3	0.7	0.7	1.5	**1.1**	**100**
False holly	2	1	0.1	0.7	0.4	0.7	0.25	**0.7**	**100**
Lowbush blueberry	0.2	0.2	0.04	1	0.07	0.2	1	**0.4**	**100**
Velvet-leaf blueberry	0.1	0.3	0.2	2	0	0	0.75	**0.6**	**71.4**
Chokeberry	0.01	0.1	0	0	0	0	0.1	**0**	**71.4**
Labrador tea	0	0.03	0	0.9	0	6	0.75	**1.1**	**57.1**
Red maple	0.5	0	0.1	0.2	0.03	0	0	**0.1**	**57.1**
White birch	0.05	0.1	0.03	0	0.03	0	0	**0**	**57.1**
Huckleberry	0	0	0	2.5	0	0	2	**0.6**	**42.9**
Mountain-ash	0.2	0.03	0	0	0.7	0	0	**0.1**	**42.9**
Serviceberry family	0	0	0	0	0.02	0	0.02	**0**	**42.9**
False holly	0	0	0	0	1	0	0	**0.1**	**28.6**
Downy alder	0	0	0	0	0	0	0	**0**	**28.6**
Bayberry	0.05	0	0	0	0	0	0	**0**	**14.3**
SUB-TOTAL	**28.6**	**10.8**	**6.6**	**54.3**	**37**	**23.6**	**21.4**		
Layer B3: Regenerating trees (<30cm)									
Balsam fir	4	5	17	2	32	0.4	0.6	**8.7**	**100**
Black spruce	0.3	0.2	0.2	4	2	1.3	0.5	**1.2**	**100**
Red maple	0	2	5	0	0	0	0	**1**	**42.9**
White birch	0.02	0	0.04	0	0	0	0	**0**	**42.9**
Red spruce	0	0	0.03	0	0	0	0	**0**	**14.3**
SUB-TOTAL	**4.3**	**7.2**	**22.2**	**6**	**34**	**1.7**	**1.1**		

Common Name	Percent Cover								Occurrence (%)
	Stand 1	Stand 2	Stand 3	Stand 4	Stand 5	Stand 6	Stand 7	Mean	
Layer C: Herbaceous and dwarf woody species									
Bunchberry	19	15	20	12	5	6	4	**11.6**	**100**
Creeping snowberry	3.5	2	1	1	30	15	3	**7.9**	**100**
Twinflower	2	7.5	0.3	0	13	0.08	0.05	**3.3**	**100**
Goldthread	0.1	4	9	0.5	0.7	0	8	**3.2**	**100**
Cinnamon fern	2	3	0	5	0.02	5	1	**2.3**	**100**
Bracken fern	3	2	0.3	4	0.3	1.5	2	**1.9**	**100**
Foxberry	6	0.1	0.4	0.3	0	3.5	1	**1.6**	**100**
Wild lily of the valley	0.2	2	0.4	0.4	0.02	0	0.08	**0.4**	**100**
Starflower	0.2	2	2	0.01	0.04	0	0.3	**0.7**	**85.7**
Bluebead	0	0.2	0	0.2	0	0	0.03	**0.1**	**85.7**
Indian pipe	0.01	0	0	0.03	0	0.01	0.05	**0**	**85.7**
Wild sarsaparilla	0.5	0.5	0.3	0	0.8	0	0	**0.3**	**71.4**
Three-seeded sedge	0.05	0	0	0.01	0	0.01	1.25	**0.2**	**57.1**
Wood sorrel	0.05	0.03	0	0	0.7	0	0	**0.1**	**57.1**
Wood aster	0	0.1	0.07	0	0.3	0	0	**0.1**	**57.1**
Mayflower	0.02	0.2	0	0.3	0	0	0	**0.1**	**57.1**
Eastern spreading wood fern	0.02	0	0.02	0	0	0	0	**0**	**42.9**
One-sided wintergreen	0	0.03	0	0	0	0.2	0	**0**	**28.6**
Teaberry	0	0	0	0.03	0	0	0	**0**	**28.6**
Black crowberry	0	0	0	0	0	12	0	**1.7**	**14.3**
Small cranberry	0	0	0	0	0	0.3	0	**0**	**14.3**
Sundew family	0	0	0	0	0	0	0	**0**	**14.3**
Partridge-berry	0	0.03	0	0	0	0	0	**0**	**14.3**
Pitcher-plant	0	0	0	0	0	0	0	**0**	**14.3**
SUB-TOTAL	**36.7**	**38.7**	**33.8**	**23.8**	**50.9**	**43.6**	**20.8**		

Common Name	Percent Cover								Occurrence (%)
	Stand 1	Stand 2	Stand 3	Stand 4	Stand 5	Stand 6	Stand 7	Mean	
Layer D: Moss and Lichen									
Schreber's moss	55	55	40	49	22	32	45	**42.6**	**100**
Stair-step moss	8	22	11	12	13	23	17.5	**15.2**	**100**
Three-lobed bazzania	8	10	13	3	27	5	16	**11.7**	**100**
Broom moss	2.5	2	3	2.4	6	0.3	1.5	**2.5**	**100**
Wavy moss	0.5	1	0.2	4	0.7	0.7	4	**1.6**	**100**
Ladies tresses sphagnum	18	4	0	23	11	33	6	**13.6**	**85.7**
Cup lichens	0	1	0.3	0.8	0	0.8	1.5	**0.6**	**85.7**
Plume moss	4	0.05	0	0	15	2	0	**3**	**71.4**
Grey reindeer lichen	2	1.3	0	1.25	0	1.4	1.5	**1.1**	**71.4**
Star-tipped reindeer lichen	0.5	0	0	0.07	0	0.7	0.3	**0.2**	**57.1**
Pale fat-leaved sphagnum	0	0	0	0.7	0	2	2.5	**0.7**	**42.9**
Haircap moss	0	0	4	0.5	0	0	0	**0.6**	**28.6**
Plait moss	0	0.5	2	0	0	0	0	**0.4**	**28.6**
Sphagnum moss	0	0.2	0	0.8	0	0	0	**0.1**	**28.6**
Naugehyde liverwort	0	0	0	0.03	0	0	0	**0**	**28.6**
Red fat-leaved sphagnum	0.5	0	0	0	0	0	0	**0.1**	**14.3**
Green reindeer lichen	0	0	0	0	0	0.2	0	**0**	**14.3**
Brown fat-leaved sphagnum	0	0.2	0	0	0	0	0	**0**	**14.3**
Common green sphagnum	0.1	0	0	0	0	0	0	**0**	**14.3**
Dicranum moss	0	0	0	0.04	0	0	0	**0**	**14.3**
Bog haircap moss	0	0	0	0.01	0	0	0	**0**	**14.3**
SUB-TOTAL	**99.1**	**97.2**	**73.5**	**97.6**	**94.7**	**100**	**95.8**		