T10.1 VEGETATION CHANGE

The plant life of Nova Scotia includes representatives of all main groups: algae, lichens, fungi, mosses, liverworts, and vascular plants (the seed-bearing plants, conifers, ferns and fern allies). Most plants are autotrophic, producing food material for energy and growth by trapping sunlight (photosynthesis), but some are heterotrophic, getting at least some of their energy by feeding on dead plant or animal material or by parasitizing other living organisms. The vascular plants are the most conspicuous group, found principally on land and providing the main energy and food supply to terrestrial ecosystems. In marine ecosystems, the algae are the essential elements of primary production and fill the role which vascular plants play on land. The distribution of plant-community species in Nova Scotia is influenced by the province's geographic configuration, its climate, geology and the use of plants as a resource. Some species are better studied than others, and gaps in distribution often indicate a lack of study.

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HISTORIC VEGETATION OF NOVA SCOTIA

The primary sources of recorded information about the early vegetation of Nova Scotia are the notes of Nicholas Denys (1600s) and Titus Smith, Jr. (1801–02). The maps in the report *Forest Conditions of Nova Scotia*, compiled by Fernow,[1] provide a further important source of historic information. Pollen-profile analysis from peat bogs and lake-bottom sediments has allowed researchers like Livingstone,[2] Railton,[3] Deevey,[4] and Ogden[5] to document major changes in the province's vegetation during interglacial and post-glacial times.

The major types of forest and non-forest plant communities in Nova Scotia have probably not changed dramatically during the past several hundred years. They were, in all likelihood, similar to those listed in Tables T10.4.1 and T10.4.2 for the present-day vegetation. But the proportion of the overall vegetation mosaic occupied by each of these vegetation types has undoubtedly changed markedly as a result of human settlement, insects, disease, fire (or in some cases, such as in pine forest, fire suppression) and forestry practice. Most of the province's forests are now of early-successional status following fire, cutting or agricultural activity.

The role of individual species within some forest types (e.g., American Beech, Hemlock, White Pine) may be less significant now because they have been affected by insects, disease or have been removed through selective cutting.

FACTORS CAUSING CHANGE

Many factors have caused change in the province's vegetation. Two major groups are evident:

1. those generally considered to be natural (e.g., wind, insects and disease, fire and natural succession)
2. those attributable primarily to human activity (e.g., most fires, harvesting and afforestation, agricultural use and land clearing, and urbanization)

The natural agents of change are discussed in this Topic. The following Topic, Successional Trends in Vegetation, describes the successional sequence of vegetation affected by these agents and anthropogenic agents. T12.10 provides the historical context for anthropogenic change.

WIND

Winds strongly influence forest habitats. They cause the stunted and sculptured growth (krummholz effect) evident in trees in coastal or highland areas. Wind-caused dessication probably limits growth of many upland forests. Strong winds can blow down individual old and shallow-rooted trees during storms. Occasionally, storm events are so severe that massive windfall occurs in certain forest types. Stanley et al.[6] drew attention to the possibility of an eighty-year cycle for this massive destruction. Titus Smith frequently mentioned the tangle of wind-thrown trees in southern and eastern Nova Scotia through which he had to make his way in the early 1800s. The "Saxby Gale" in 1869 caused major destruction of forests. Hurricane Edna in 1954 had similar effects. Wind has been a particularly destructive force in the shallow-rooted coniferous forests of Nova Scotia.

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INSECTS AND DISEASES

Every tree species has its insect pests. These are generally species specific and may eliminate their host species selectively from a forest. Sustained insect infestations can be catastrophic when forests are monospecific and have limited diversity. This phenomenon has occurred in Nova Scotia with the recent Spruce Budworm infestation of the boreal Balsam Fir forests of the Cape Breton highlands (District 210), where a very high degree of mortality in the forests has brought about massive changes in the vegetation structure. During the 1920s, beech trees throughout the province fell prey to the Beech Bark disease which eliminated most American Beech and left a legacy of cankered small trees. Both Beech Bark disease and Dutch Elm disease are caused by fungi transported by insects (see T11.16).

In the 1930s, White and Yellow Birch were destroyed in much of the province by the birch dieback disease. Red Oak was host to an infestation of the European Winter Moth during the 1940s. White Pine trees are deformed by the White Pine Weevil. The Larch Sawfly has regularly destroyed pure larch stands. Balsam Fir trees are frequently weakened by the Balsam Woolly Aphid and the Hemlock Looper, which is a serious defoliater to Balsam Fir stands.

Collectively, these insect pests and diseases have been major agents for change within forest stands in Nova Scotia and on occasion have greatly influenced forest types over large areas.

> *Beech Bark disease came to North America via Nova Scotia in the 1920s. The scale insect responsible for the disease had been detected in Halifax some thirty years previously and had apparently been imported with stocks of European Beech. Landscape specimens of American and European Beech often escape infestation because they offer a less favourable habitat for the insect.*

FIRE

Fire from lightning strikes has been an agent for natural vegetation change in certain parts of the province. Evidence of charcoal in lake sediment and peat profiles throughout Nova Scotia indicate that fire, whether human induced or natural, has been a major causative factor for vegetation change for thousands of years. Some species have adapted to frequent fires by root sprouting (e.g., aspen and beech) or by opening cones when a certain heat is reached (e.g., Jack Pine). There is a feedback link between the fire and the vegetation.

Natural fires played a major role in the vegetation patterns of the fire-prone landscapes of southwestern Nova Scotia (in particular in District 410). Most upland areas of the province do not exhibit an extensive fire history. During the past 250 years, however, fires caused by humans have, at one time or another, burned over much of the province. Fire has become a dominant causative factor leading to the development of a number of our present early-successional plant communities.

The suppression of fire now being undertaken by government agencies promises to result in vegetation changes in these fire-originated communites. Fernow determined that 20 per cent of the Nova Scotia land base of his day was old burns and barren, and that recent burns covered 5 per cent of the land.[1] Hawboldt and Bulmer indicate that, in 1958, only 8 per cent of the province's land base was in the "old burn and barren" class and that an insignificant portion was recently burned.[7] A continuation of these trends will, over time, lessen the importance of fire as a change agent in Nova Scotia.

NATURAL SUCCESSION

Every plant community inherently grows toward change. In forest stands, seeds germinate, trees grow and become decadent, other trees replace them. If unaffected by other agents, forest stands will change naturally, with species which are better adapted to the site and its environment replacing their predecessors. The main shade-tolerant species will, over time, replace the shade-intolerant ones.

In the long term, as moisture conditions change from wet (hydric) and dry (xeric) toward moist, the more mesic species replace the hydric and xeric species. If left undisturbed, this process results in a forest type which changes little. At this late stage in succession, individual species reproduce themselves but the species mix remains relatively constant.

Marine vegetation changes primarily as a response to the environment in which it grows. Over a period of time, change can result from erosion or deposition of the substrate. Significant natural changes to marine vegetation can occur as a result of sea-level rise and ice-scouring. Anthropogenic influences include conditions generated by causeways, such as at Windsor (Sub-Unit 511a). Short-term changes in marine vegetation are generally a result of changes in water temperature, salinity or the availability of nutrients (e.g., red tide; see T6.2 and T10.9).

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Associated Topics

T4.1 Post-glacial Climatic Change, T4.2 Post-glacial Colonization by Plants, T6.2 Oceanic Environments, T10.2 Successional Trends in Vegetation, T10.3 Vegetation and The Environment, T10.4 Plant Communities in Nova Scotia, T10.12 Rare and Endangered Plants, T11.16 Land and Freshwater Invertebrates, T12.10 Plants and Resources

Associated Habitats

H1 Offshore, H2 Coastal, H3 Freshwater, H4 Freshwater Wetlands, H5 Terrestrial Unforested, H6 Forests

References

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3 Railton, J.B. (1975) "The postglacial history of Nova Scotia." In *Environmental Changes in the Maritimes*. Nova Scotian Institute of Science, Halifax.
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T10.2 SUCCESSIONAL TRENDS IN VEGETATION

Each change agent has a predictable impact upon the vegetation type that it influences. It is possible to document these changes. Succession occurs at different rates within habitats and within ecosystems and varies according to
1. site characteristics
2. type and intensity of disturbance
3. dispersal and reproductive strategy of existing and nearby potentially colonizing species (see Table T10.4.1)

Succession is a process whereby the biotic components of the ecosystem affect the physical sufficiently to create a change. Successional stages can be interrupted or maintained by natural causes and management. Ideally, vegetation succession begins with pioneer species colonizing bare soil or rock (e.g., soil builders such as lichens), progresses to early-successional, shade-intolerant species, gradually to be dominated by shade-tolerant species in climax or steady-state conditions. Disturbances alter primary-succession sequence and secondary succession occurs. The descriptions presented here are generalizations of the effects that each change agent may bring about in the various vegetation types. This Topic deals with terrestrial vegetation, in particular forest species, as the most conspicuous vegetation in Nova Scotia. Figure H61.1 in the Introduction to Forest Habitats simplifies successional sequences of forest associations in Nova Scotia. Succession also occurs in non-forested, freshwater and marine environments and is discussed in the **Habitat** section. A classic example of succession in Nova Scotia is the oldfield (see H5.2). The historical context for the anthropogenic vegetation changes in discussed in T12.10.

NATURAL

Forest vegetation on most poorly drained (Black Spruce/Larch), mesic (Red Spruce, Eastern Hemlock, White Pine) and dry (Red Pine and Red Oak) sites within Nova Scotia's flatter lowland areas evolves toward a coniferous climax forest type composed of various mixtures of Red Spruce, Eastern Hemlock and White Pine. Well-drained sloping upland sites, if left undisturbed, will evolve toward deciduous regional climax forest types dominated by Sugar Maple, Yellow Birch, and American Beech. The generally accepted, theoretical climax forest for Nova Scotia and much of northeastern North America is the Eastern Hemlock, White Pine, northern-hardwood forest. Plant ecologists believe that the physiographically controlled regional climax forests (Red Spruce, Hemlock and White Pine; and Sugar Maple, Yellow Birch, American Beech), if left to evolve naturally, would develop in equilibrium with the climatic conditions of the region. Few examples of undisturbed climax forest exist in Nova Scotia; however, some old-growth stands have been identified.[1]

The highlands of northern Cape Breton (District 210) are characterized by a unique boreal climatic regime, and the climax forest for this part of Nova Scotia is Balsam Fir. The dominant factors maintaining such a forest type are climate and, very probably, recurring insect infestations.

Long-term succession (i.e., over thousands of years) is the gradual change of a habitat into another. For instance, a shrub swamp on a hydric site can eventually infill and develop into a forest. Likewise, a bog can evolve from *Sphagnum*-dominated hydric conditions to more mesic conditions dominated by shrubs and eventually tree species.

Generally, most of the non-forest climax plant communities that occur in Nova Scotia (bogs, salt marshes) are sustained by some ever-present environmental factor (high water table, flooding, etc.) which prevents these communities from eventually becoming forests.

FIRE

The impact of fire upon vegetation varies with the local moisture conditions, the spatial arrangement of various terrestrial and hydrological ecosystems, and the original vegetation. Fire frequently destroys most, or all, of the existing vegetation cover. Occasionally, small patches are left unburned, and individual trees may survive. From time to time, fires will burn through the understorey of a forest stand and leave the overstorey virtually intact. These residual trees and forests, together with the surrounding unburned forests, act as seed sources for recolonization of burns. Seeds from tree species like the pines, beeches and oaks may survive fire *in situ*. Species that sprout from a root system are early post-fire immigrants (e.g., maples, beech and aspens). Fires often expose a mineral soil surface as a base for recolonization. Herbaceous vegetation moves into a burnt-over area quickly. On well-drained, deep soils, the early post-fire forest type is usually a mixture of intolerant deciduous (Red Maple, White and Wire Birch, the aspens and, in south-western Nova Scotia, Red Oak). Red Maple also colonizes the more imperfectly drained sites, frequently in combination with Black Spruce, Balsam Fir, and Red and White Pine. Black Spruce, White and Red Pine, Balsam Fir, and White and Grey Birch also follow fire on heath-covered post-fire sites throughout southwestern Nova Scotia, where soils are often sandy, rocky, and mineral depleted.

On the most sterile, shallow-soil sites and where frequent fires have burned the vegetation overlying bedrock, the vegetation cover is transformed to a barren characterized by low woody shrubs (e.g., Lambkill, Rhodora, huckleberry and blueberry), lichens and mosses. When seed sources exist on such sites (e.g., Blandford [Unit 832] and Neils Harbour [District 210]), Jack Pine occasionally mixed with Red Pine or Black Spruce follows severe fires. This species will grow in an open savannah-like forest or in a relatively dense forest (e.g., Oxford [Unit 521a], Neils Harbour [District 210a], and Purcells Cove [Unit 851]). Occasionally, when mineral soil is exposed, White Spruce enters a forest-cover type following fires.

In southwestern Nova Scotia, particularly in District 440, the Eastern Shore and northeastern Cape Breton Highlands, the recurrence of fire on some poor sites has resulted in the creation of permanent low-shrub barrens. In the most impoverished of these barrens, vegetation change occurs very slowly.

FORESTRY

It is difficult to describe the successional trends that follow forest-cutting activities in Nova Scotia. Over time, varied techniques have been used in a diversity of forest-cover types. Under a selective regime of harvesting, the trees that were not cut or damaged would become the main components of the subsequent forest. Significant changes in species composition occurred in the forest type under these conditions, although the regenerating forest type would, in some cases, resemble the original forest. With the opening up of a forest stand, the less-shade-tolerant species like Red Maple, White Birch and aspen become more important. The resulting stands would be composed of multi-aged trees, and over time the shade-intolerant trees would be crowded out by the more shade-tolerant Sugar Maple, Yellow Birch, Hemlock and Red Spruce. In Nova Scotia, much of the forest cover is maintained at an early or secondary successional growth.

Harvesting techniques which involve “clear-cutting” of a forest type (substantial or total removal of the tree canopy) have a far-reaching impact upon the successional vegetation on those sites. Clear-cutting could be compared to fire in this regard. With the removal of trees, herbaceous vegetation inevitably invades a forest site, often choking out the shade-loving ground-cover vegetation and tree seedlings that remain. Sun-seeking species like White Birch and aspen spread into these clearcuts. Red Maple stumps send up many new stems. Balsam Fir seedlings establish themselves in the organic surface layers, along with Red Spruce on the moister sites. Mixedwood forest types are encouraged. In time, the more shade-tolerant Hemlock, Red Spruce, Sugar Maple and Yellow Birch become established under the canopy of undisturbed post-fire mixedwood stands. Former stands of spruce and fir on moist sites often regenerate into dense spruce and fir.

INSECTS AND DISEASES

Insects that primarily attack individual species have an effect similar to selective cutting on the multispecies forest. Although the species attacked is often removed from the forest canopy, there is no dramatic change in the structure of multi-species stands. The space occupied by the removed species can be assumed by regeneration from the forest understorey. In some cases, the branches from the remaining trees can extend into the openings and shade out any regeneration.

Insect infestation may or may not cause significant change in species composition (i.e., associated plant and animal species) and forest-stand structure. A lot depends on the diversity, site conditions and overall health of the original stand.

The Hemlock Looper, Spruce Budworm and Larch Sawfly have been known to affect coniferous forests.[2] Other invertebrates participate in the transmission of diseases such as Beech Bark disease and Birch Dieback (see T11.16).

LAND ABANDONMENT AFTER FARMING

Over the past seventy years, there has been a dramatic decline in the amount of land being cultivated for agricultural use. Much of the abandoned agricultural land was only marginally productive.

In most instances, and depending upon the type of farming practiced, the abandoned fields are first colonized by a variety of grasses and annual herbs. On

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well-drained sites in the Annapolis Valley (Region 600), central and eastern parts of the province (Region 500), White Spruce, in pure stands, invades the old fields, resulting in a monoculture. Speckled Alder precedes White Spruce and larch on more poorly drained soils throughout most of Nova Scotia. Old abandoned well-drained farm fields in the drumlin landscape of southwestern Nova Scotia (District 430) are colonized by pure stands of White Pine, a phenomenon that recurs in New England. These White Pine trees are of little use for lumber, as they are infested with the White Pine Weevil, which causes deformation in their normal growth. Oldfield White Spruce stands, if not harvested, begin to break up when the trees approach 100 years of age. The invasion of Balsam Fir and, occasionally, shade-tolerant hardwoods into the understorey signals this stage in evolution. Under natural conditions, these stands eventually approach the climax vegetation types for the region and site where they occur.

WINDFALL

Most windfalls are individual trees that blow down within a stand which is otherwise unaffected. When whole stands are destroyed by wind, the result is a tangle of coniferous biomass. If the trees are not removed, the understorey vegetation eventually reaches up through the fallen trees, which continue to provide a measure of shade. In many cases, the major species of the original coniferous forest will remain dominant.

URBANIZATION

In most cases, urban developers remove the natural vegetation and replace it with pavement, buildings, grass, and introduced shrubs and trees. Most of the vegetation grown in these habitats does not reproduce and spread. Urban environments and waste places are characterized by the presence of annual weedy species. The majestic American Elm population characteristic of many of our towns and cities, and in natural settings has, in recent years, fallen prey to the Dutch Elm disease, an introduced epidemic. Where the elms were a major factor in the urbanized environment, their loss will bring about dramatic changes in the appearance of our small towns.

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Associated Topics
T5 Climate, T10 Plants, T11.2 Forest and Edge-habitat Birds, T11.16 Land and Freshwater Invertebrates, T12.10 Plants and Resources

Associated Habitats
H1 Offshore, H2 Coastal, H3 Freshwater H4 Freshwater Wetlands, H5 Terrestrial Unforested, H6 Forests

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T10.3 VEGETATION AND THE ENVIRONMENT

The present landscape of Nova Scotia represents the accumulation of systematic and interactive responses between geology, landform, climatic influence, vegetation development over thousands of years and human involvement in the last 500 years.

VEGETATION AND CLIMATE

From the most general approach, the vegetation of the province as it reflects climate may be subdivided into three broad landscape regions (see T4.2). All of mainland Nova Scotia and the lowlands of Cape Breton Island are characterized by a similar climatic region. Here the Acadian Forest, typical of much of northeastern North America, flourishes with its giant melting pot of Boreal, Canadian and Alleghenian tree species. Variety abounds. Where elevations increase above 330 m on the highlands of Cape Breton (Region 100, District 210), climatic conditions become more severe: winters are much longer, snowfall is greater, persistent winds are stronger, and mean annual temperatures are lower. These boreal conditions cause the formation of a much less diverse forested landscape, characterized by windstunted pure stands of old-growth Balsam Fir over much of the land. At even higher elevations—over 450 m—the boreal landscape in Cape Breton gives way to a Boreal-Tundra transition of the Plateau-Taiga (Region 100). This is characterized by a gnarled, windswept dwarf vegetation composed of Black Spruce, Balsam Fir and Larch, interspersed on poorly drained lands with extensive blankets of peatlands developed from sedges and *Sphagnum* spp. and with dry ericaceous and lichen-covered barrens.

The Acadian Forest, along its more exposed ocean flanks, is so influenced by seawinds and salt spray that the identification of a separate coastal vegetation landscape region is justified (Region 800).

VEGETATION AND LAND FORM

Within the broad climatic and geologically controlled landscape regions of the province, vegetation responds locally to physiographic and landform variation (e.g., hills and swales; outwash plains and till moraines; broad expanses of rolling terrain; rivers; floodplains; steep ravine walls; eskers and drumlins; barrens and bogs; and coastal beaches). Recurring

	SL-M	SF-M	SFP-MB	P	MOB-PS	TOTAL
Rapid					65	100
Well			20	10	29	100
Moderate	17	20	34			100
Imperfect	64	17				100
Poor	64	17				100
Very Poor	91					100

Table T10.3.1: Percentage of soil-drainage class occupied by forest types, Kejimkujik National Park*

* Forest types occupying ten per cent or more of specified soil drainage class.
N.B.— Kejimkujik National Park occupies part of Units 412a, 433 and 451a.

SL-M ... Red or Black Spruce, Larch-Maple
SF-M ... Red or Black Spruce, Fir-Maple
SFP-MB ... Red or Black Spruce, Fir, Pine-Maple, Birch
P ... Pine
MOB-PS ... Maple, Oak, Birch-Pine, Red or Black Spruce.

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patterns of these elements form relatively homogeneous districts, which characterize the Nova Scotia landscape. Although the relationships between vegetation types and landforms are imperfectly understood, the primary causal factors are thought to be soil moisture and stand history.

Table T10.3.1, taken from the Biophysical Survey of Kejimkujik National Park[1], provides evidence for a clear relationship between soil moisture and forest stand occurrence.

VEGETATION AND SOIL

The soils of the province have evolved over 10000 years at the interface between mineral substrate and vegetation. Endless variations in soil horizons, chemistry, fertility and texture occur. As the products of vegetative growth die and decompose, the flushing action of rainwater seeping through the mineral substrate carries the decomposed organic matter down through the soil profile. The products from decomposition of coniferous-tree detritus tend to be more acidic and provide less fertility to a soil horizon than deciduous-tree litter. As succession occurs, and coniferous and deciduous forest types exchange dominance on a site, the influences upon soil-forming process vary greatly from this factor alone. The nature of these processes is not sufficiently understood to provide full knowledge of the longer-term changes and relationships that exist between vegetation and soil.

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Associated Topics

T3 Landscape Development, T4.1 Post-glacial Climatic Change, T4.2 Post-glacial Colonization by Plants, T5 Climate, T9 Soils

References

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T10.4 PLANT COMMUNITIES IN NOVA SCOTIA

Plants grow where they do for a reason. Among the most significant factors affecting the colonization and growth of plants are

1. the availability of light
2. soil-moisture conditions
3. nearness of a seed source
4. animal activity
5. soil fertility
6. leaf-litter fall, in the case of forest understorey plants
7. site history

Each species of plant responds to varying combinations of these environmental factors. Their propagules may either establish themselves and the plant may grow and thrive, or they may not grow at all under the prevailing set of site conditions. They may germinate but find the site and its environmental conditions marginal, in which case the plant might grow, although probably not in abundance. Each species has a set of conditions under which it makes optimum growth. Generally, assuming availability of growth requirements, species with similar sets of requirements will be found growing together. These recurring groups of plants form the plant communities of the province. In most instances, one or several species will assert dominance by being more abundant or more influential than the others. Most plant communities also have characteristic species, which, although not dominant, are found most commonly, if not solely, within that community type.

A PLANT-COMMUNITY CLASSFICATION FOR NOVA SCOTIA

Even though the vegetation of Nova Scotia has been heavily disturbed by human activity, it has been possible to define broad plant assemblages, within which much of the province's vegetation can be placed. Each assemblage (or "patch") varies in its composition of species and in species' relative abundance at specific locations. The amount of variability from site to site, in both species composition and abundance within any community type, is usually great. However, despite this factor, the assemblage of plants present and the relationship between those plants show a recurring basic similarity from one example to another across the province.

Forest communities have been more extensively studied in Nova Scotia than non-forest communities. The Nova Scotia Department of Natural Resources has an ongoing inventory program of forest-stand types in the province. The Forest Inventory contains forestry-related information such as species composition, stand height and age. The Inventory forms the basis for classifying forest species' associations in Nova Scotia (of which there are approximately 160).[1] The federal government has proposed a vegetation-classification system for Canada which would provide a standard framework for systematic analysis of vegetation.[2]

Table T10.4.1 contains a list of common forest plant communities found in Nova Scotia. The forest communities correspond to the forest associations described in the Forest Habitats (H6). Table T10.4.2 lists the non-forest plant communities for the province. General descriptions of these communities and their successional status have been included in the Habitat section.

The ground-cover vegetation in forest plant communities is characterized by one of the following plant associations:

A. Bracken Fern
B. Humus-Moss (primarily Schreber's Moss, Step Moss and Broom Moss)
C. Cinnamon Fern
D. Sedge–Sphagnum *(Carex stricta* and *Sphagnum fallax*)
E. Wood Fern–wood-sorrel
F. Various Ferns–Striped Maple

General descriptions of the small plant associations found in forest plant communities accompany the habitat descriptions of this document. A great deal of research remains to be done in order to confirm the presence and completeness of these plant communities, especially for central and northern Nova Scotia.

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FOREST COMMUNITIES	TYPICAL SITE CONDITIONS	SUCCESSIONAL STAGE	SITE HISTORY	PER CENT AREA OF NOVA SCOTIA*
HARDWOOD (H6.1)				
Red Maple, Oak, White Birch	Well-drained rolling hills	Early-successional	Fire	10.0
Sugar Maple, Yellow Birch, Beech	Well-/ rapidly- drained uplands/Slopes	Climax	Natural/Cutting	9.0
Sugar Maple, Elm	Well-drained floodplains	Near-climax	Natural	—
SOFTWOOD (H6.2)				
White Spruce	Imperfectly/ well-drained fields	Pioneer	Cultivation	10.0
Spruce, Fir, Pine	Imperfectly/ well-drained lowland	Mid-successional	Fire	3.0
Pine (White, Red and Jack)	Well-/ rapidly- drained sand plains/ Barrens/Fields	Pioneer to near-climax	Fire/Cultivation	2.0
Red Spruce, Fir	Poorly/imperfectly drained lowlands	Mid-successional	Natural/Cutting	11.5
Black Spruce, Larch	Poorly drained bog/swamp	Early to mid-successional (Edaphic climax)**	Natural	10.0
Red Spruce, Hemlock, Pine	Imperfectly/ well-drained lowland	Climax	Natural/Cutting	9.0
Fir	Imperfectly/ well-drained boreal plateau	Climax	Natural	14.0
MIXEDWOOD (H6.3)				
Spruce, Fir, Pine-Red Maple, White Birch	Imperfectly/ well-drained lowland	Early to mid-successional	Cutting/Fire	6.0
Black Spruce, Fir-Maple	Poorly- drained swamps	Early to mid-successional (Edaphic climax)**	Natural	12.5
White Spruce, Fir-Red Maple, White Birch	Imperfectly/ well-drained coasts	Near climax	Natural/Cutting	3.0

Table T10.4.1: Major forest plant communities in Nova Scotia. This table indicates the relationship between the forest community (association) conditions, seral or successional stage and site history. * Data derived from Permanent Sample Plot data summaries, Dept. of Natural Resources (Lands and Forests) c. 1980. DNR has 1600 Forest Inventory Permanent Sample Plots in Nova Scotia. ** This seral stage is maintained in relation to steady site conditions. Note: Where Red Spruce is named, this may include Black Spruce or a Red-Black hybrid.

Associated Topics
T9 Soils, T10 Plants

Associated Habitats
H2 Coastal, H4 Freshwater Wetlands, H5 Terrestrial Unforested, H6 Forests

References

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PLANT COMMUNITY	TYPICAL SITE CHARACTERISTICS	ORIGIN
Sphagnum Moss - Cranberry	Peatlands (including bogs and fens)	Natural
Cattail	Shallow lakes and ponds, marshes	Natural
Bluejoint Grass - Spiraea - Sweet Gale	Streambank (Sedge ferns)/ Peatland edges	Natural
Leather Leaf - Rhodora	Streambank (Sedge ferns)/ Peatlands and peatland edges mainland N.S.	Natural/Fire
Water Lily - Pond Lily	Streams/Shallow lakes and peatland ponds	Natural
Speckled Alder	Stream banks/Oldfield	Natural/Cultivated
Crowberry	Coastal headlands and bogs	Natural/Salt Spray/Exposure
Broom Crowberry	Barrens	Severe repeated fire
Reindeer Moss - Blueberry	Barrens/Cape Breton Highlands	Fire
Huckleberry - Lambkill	Fire barrens/Mainland N.S.	Fire
Marram Grass	Sand dunes	Natural
Rush - Goldenrod	Gravelly lake shore (S.W. Nova Scotia)	Natural
Royal Fern - Sweet Gale	Peaty lake shore (S.W. Nova Scotia)	Natural
Bent Grass - Poverty Grass	Abandoned fields	Cultivation
Cord Grass *(Spartina alterniflora)*	Lower tidal marsh	Natural
Marsh Hay *(Spartina patens)*	Upper tidal marsh	Natural
Seaweeds	Rocky shores	Natural
Eelgrass	Subtidal/Soft substrate	Natural
Corallina - Lithothamnium	Subtidal/Hard substrate	Natural

Table T10.4.2: Some major non-forest plant communities of Nova Scotia.

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T10.5 SEED-BEARING PLANTS

There are approximately 1500 species of seed-bearing plants growing wild in Nova Scotia's marine, freshwater and terrestrial environments. These include

1. herbs—herbaceous species without a woody stem, which are divided into graminoids (grass-like species) and forbs
2. shrubs—woody, multi-stemmed perennial species
3. trees (see T10.6) woody single-stemmed perennials (Enlargements/ reductions in the diagrams are approximate.)

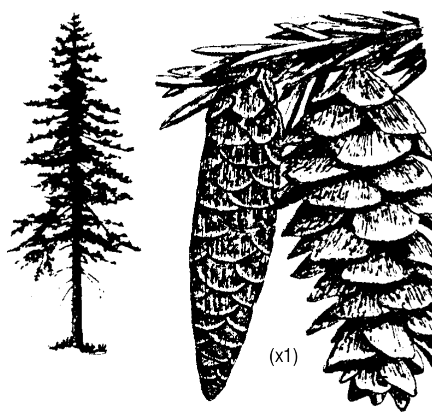

Figure T10.5.1: Cone and silhouette of the gymnospern White Spruce.

Only a small number of seed-bearing plants are gymnosperms, those plants that have needle or scale-like leaves, and bear "naked seeds" (i.e., not enclosed by carpels which form a fruit), which developed as the result of only one sperm fertilizing the egg—unlike the flowering plants, where "double fertilization" occurs. They include the pines, spruces, fir, hemlock, larch and cedar, which are all trees, and the junipers and yew, which are shrubs (see Figure T10.5.1).

The vast majority of seed plants are angiosperms, which bear flowers and have seeds enclosed in an ovary (carpel). The angiosperms are further divided into two main groups.

1. The Liliopsida (monocots) include those plants with a single seed leaf, floral parts usually in threes, and parallel veins in the leaves (see Figure T10.5.2). The majority of the monocots belong to the grass and sedge families. Others include the rushes, the pondweeds, the arums, the lilies, the irises, the orchids and several aquatic groups. In Nova Scotia all are herbaceous, with the exception of Green Brier, *Smila rotundifolia,* which is a woody vine found in forests of the southwestern part of the province.
2. The magnoliopsida (dicots) generally have floral parts in fours and fives, 2 seed leaves and net venation in their leaves (see Figure T10.5.3). The dicots form a larger and more diverse group of plants in Nova Scotia. Some are herbs, while others are shrubs or trees (Figure T10.5.4). A few are aquatic, but most are terrestrial. The most conspicuous families include the roses, the heaths, the legumes, the mustards and the asters.

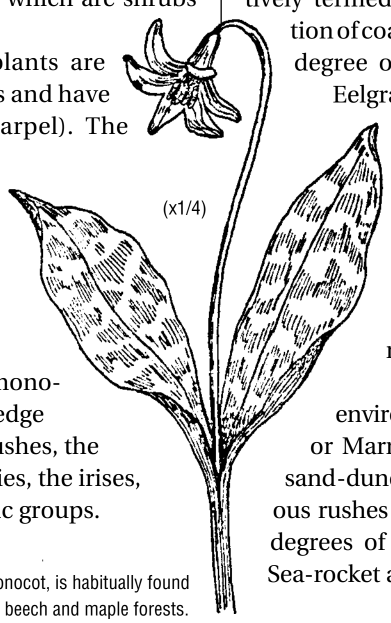

Figure T10.5.2: Trout-lily, a monocot, is habitually found in older beech and maple forests.

Figure T10.5.3: The dicot, Coltsfoot, is one of our earliest flowering plants.

SALT-TOLERANT ANGIOSPERMS

Plants which tolerate salt are collectively termed halophytes. The zonation of coastal habitats indicates the degree of tolerance. For instance, Eelgrass is a marine aquatic angiosperm which inhabits shallow bays along the coast. Some species of pondweed *(Potamogeton)* and all ditch-grass (*Ruppia* and *Zannichellia*) can be found in brackish as well as saline environments. The Cord Grasses are monocots associated with tidal marshes.

Other monocots which inhabit coastal environments include American Beach Grass or Marram Grass which forms the dominant sand-dune communities, Arrow grass and various rushes and sedges. Dicots exhibiting varying degrees of salt tolerance include Sea-lavender, Sea-rocket and Orach.

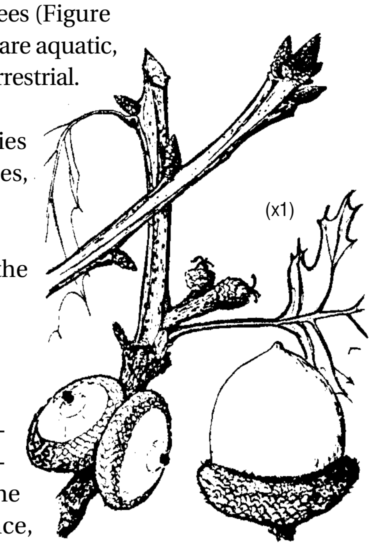

Figure T10.5.4: The acorn of Red Oak (dicot) stores the energy that fuels the growth of the seedling.

Eelgrass Beds

Eelgrass is one of the few flowering plants to share its habitat with the true seaweeds. It grows in dense stands and roots in the muddy bottom of sheltered subtidal environments (see Plate H.1.2 in Benthic Habitats). The presence of Eelgrass calms the water and increases sediment deposition.

Eelgrass beds provide shelter for the young stages of many coastal fish and invertebrates and can be home to commercially important species, such as oyster. They are frequently associated with tidal marshes and require fine sediment in which to anchor their roots. Eel Grass is widely distributed in Nova Scotia (see distribution of Tidal Marsh Habitat, H2.5) but rare in the Bay of Fundy (an exception is a bed near Five Islands on Minas Basin [Unit 913a]). The beds appear to be slow to recover after disturbance, such as when sediment is washed away in a storm or when ice scours patches from the bottom. Ice damage in Pomquet, Nova Scotia, on the Northumberland Strait (Unit 914), creates gaping holes in the cover which can take several years to regrow.[1]

Eelgrass beds frequently contain seaweeds which have broken loose and float freely. In Northumberland Strait, these seaweeds (including Irish Moss, *Gracilaria*, *Polysiphonia* and *Sphaerotrichia*) may continue to grow and make up a large proportion of the plant growth in the bed.[1] Many epiphytes grow on the surface of Eelgrass blades and are the principal food source for small invertebrates—including the snails *Bittium alternatum* and *Mitrella lunata*, the amphipods *Corophium insidiosum*, *Amphithoe longimana*, and *Gammarus mucronatus*, and the isopods *Jaera marina, Idotea balthica*, and *Idotea phosphorea*. Numbers of organisms and diversity is greater in Eelgrass beds than in adjoining areas.[1]

Eelgrass beds are also home to higher vertebrates such as waterfowl and fish. Birds, such as Brants and Canada Geese, can feed directly on *Zostera*. Eelgrass beds along portions of the Atlantic Coast (District 820, Units 833 and 841) are major overwintering areas for Canada Geese. In the 1930s, these beds virtually disappeared from the Atlantic Coast, an occurrence which adversely affected geese populations at that time.

Eelgrass leaves die in the winter, and many leaves are broken off by waves, tides and the activities of animals. The leaves form a significant part of the flotsam which washes up on shore. The bacteria growing on decaying blades and fine particles is more important as a food source for the marine ecosystem than the fresh blades.[1]

The dried leaves of Eelgrass are similar in texture to shredded paper. Eelgrass predates fibreglass as the insulation of choice in Nova Scotia homes. A significant industry once existed in the province.

Nova Scotia's Eelgrass beds are a northern parallel to the productive seagrass beds found world wide, principally in the tropics, and containing various seagrass species, such as turtle-grass (Thalassia *spp.*) *the species common in Florida and home to the famous manatee and sea turtle.*

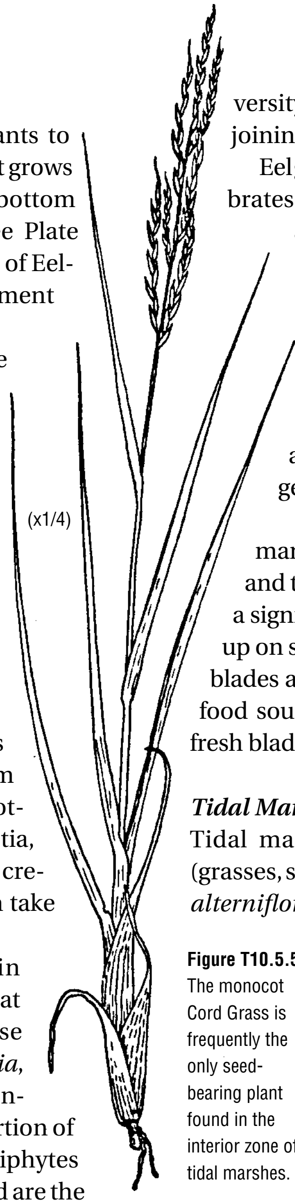

Figure T10.5.5: The monocot Cord Grass is frequently the only seed-bearing plant found in the interior zone of tidal marshes.

Tidal Marshes

Tidal marshes are dominated by graminoids (grasses, sedges and rushes). The grasses *Spartina alterniflora* (Cord Grass) and *S. patens* (Marsh Hay) account for a large percentage of the biomass of tidal marshes throughout the province. Tidal marshes are the most productive of our ecosystems.

Cord Grass dominates the low-marsh zone, which is flooded twice daily (see Figure T10.5.5). The high marsh is typically more diverse, but is dominated by *S. patens* and other monocots. Several species of dicots, including Sea-lavender and Seaside Goldenrod, grow in high marshes.

Very salt-tolerant species, such as Seaside Plantain, Sea-blite and Ditchgrass, can be found in the pannes or depressions formed in the high-marsh zone. At the upper edges of tidal marshes, bulrushes, cattails, sedges and *Spartina pectinata* may be found.

FRESHWATER ANGIOSPERMS

Freshwater plants are characteristic of the littoral zone of most lakes and ponds as well as some slow-moving streams. There are three groups of aquatic angiosperms: emergent, submerged and floating. They typically grow in distinct zones, starting near the shoreline and ending in deep water (see Figure H3.6.1); some species can be found in more than one zone. The gradation of plants from land into

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water represents a transition from one ecosystem to another. A representative situation is described as follows.

Emergent angiosperms

Emergents are plants rooted in shallow water but with much of their stems and most of their leaves above the water. Hence, carbon dioxide for primary production is obtained from the air, while nutrients are taken from beneath the water surface. These plants exhibit similarities to terrestrial plants, except they are nearly always rooted in deoxygenated mud rather than aerated soil. Some of the more common emergent dicots found in Nova Scotia include Water Parsnip, Bog Buckbean and Water Lobelia, while common monocots include Pipewort, Pickerel-weed, arrowheads, cattails, bulrushes and spikerushes.

> *In order to supply oxygen to their roots, emergent plants have stems with air-filled spaces which permit the transport of oxygen. These spaces are why most emergents feel "spongy" when squeezed and also dictate the maximum depth they can grow.*

Floating-leaved angiosperms

Floating species are generally characterized by long underwater stems rooted to the bottom and large leaves generally at the surface (see Figure T10.5.6). Water-lilies and pond-lilies are the most commonly recognized dicots (see Figure T10.5.7). Duckweeds (*Lemna* and *Spirodela*) are monocots which can sometimes be found covering the surface of quiet ponds. Their roots extend down from the surface, but they usually do not reach the bottom.

Submerged angiosperms

Submerged species may be either rooted to the bottom or floating freely in the water column. Since these plants must extract oxygen only from the water, their leaves tend to be thin and finely divided. This adaptation also makes the leaves very flexible, able to avoid damage by water movements. The pondweeds (*Potamogeton* spp.) are the most common. The introduced *Elodea canadensis* is abundant in the Truro area and in the Cornwallis River (District 570). Some of the common submerged dicots are the milfoils and White Watercrowfoot.

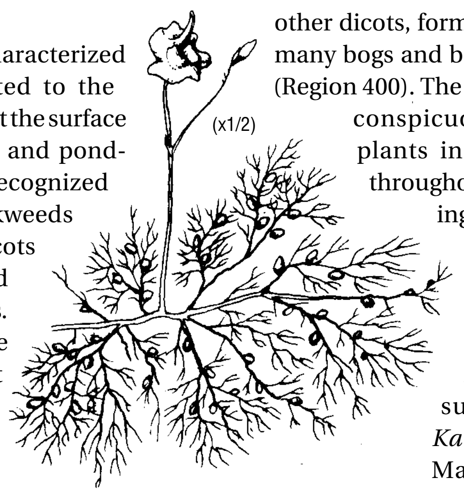

Figure T10.5.6: Bladderwort (*Utricularia* spp.) is a carnivorous submergent common to pond environments.

TERRESTRIAL FOREST AND NON-FOREST ANGIOSPERMS

Terrestrial plants can be broadly grouped by their structure, as herbs, shrubs and trees. The three categories create a vertical zonation which is generally most evident in forest plant communities. The composition of species is influenced by site conditions, including topography, substrate and drainage.

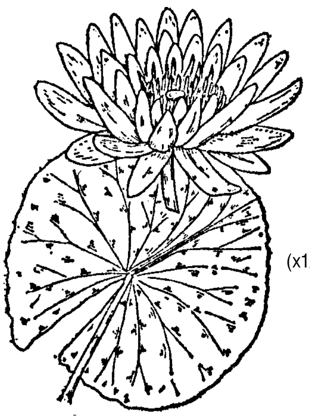

Figure T10.5.7: The water-lilly *Nymphaea odorata* (a floating leaved angiosperm) is recognizable by its large white flowers.

Grasses, sedges and rushes are primarily monocots of open, non-forested habitats. Some species within these groups dominate the vegetation in those places (e.g., Bluejoint Grasses and the sedge (*Carex aquatilis*) predominate in the vegetation on the banks of slow-flowing rivers and streams, also Sweet Gale. Bayberry, False Holly and Canada Holly.)

Common groundcover species can be herbaceous, such as Bunchberry and False Lily of the Valley, or woody, such as Crowberry and Blueberries. The ericacous or heath plant group, along with other dicots, forms the dominant vegetation of many bogs and barrens of the Atlantic Interior (Region 400). The asters and goldenrods are the conspicuous late-summer flowering plants in recently abandoned fields throughout the province, often growing with their earlier flowering cousins, the daisies, ragworts and dandelions.

The shrub layer in forested and non-forested plant communities constitutes genera such as *Alnus, Viburnum, Kalmia* and *Rhodora*. Striped Maple and Honeysuckle form typical shrub layers in hardwood forests. The tree species complete the vertical zonation in forest plant communities as the canopy layer. The composition of species is influenced by site conditions such as topography, substrate and drainage, and in forest plant communities, the tree canopy plays a role in determining species composition of the herbs and shrubs.

T10.5
Seed-bearing
Plants

Associated Topics
T10.1–T10.12 Plants

Associated Habitats
H2 Coastal, H3.3 Bottom Lotic (Rivers and Streams), H3.4 Bottom Lentic (Lakes and Ponds), H3.5 Water's Edge Lotic (Rivers and Streams), H3.6 Water's Edge Lentic (Lakes and Ponds), H4 Freshwater Wetlands, H5 Terrestrial Unforested, H6 Forests

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T10.6 TREES

Nova Scotia has about forty species of native trees.[1] Some (e.g., cherry, mountain ash, Staghorn Sumac, Witch Hazel, Striped and Mountain Maples, Shadbush, hawthorn, willow and alder) are large shrubs that often reach tree status. Numerous exotics have been introduced as ornamentals and fruit trees and for reforestation.

Traditionally, people have grouped temperate forest trees as softwood or hardwood. While foresters also use this grouping, they consider the terms coniferous (or evergreen) and deciduous (shedding leaves yearly) more useful. However, these terms do present some problems. Larch or tamarack, though cone-bearing, sheds its needles annually; by contrast, all other native conifers lose their needle-leaves over a three- to five-year period and replace them each spring with new needles formed at the growing tips. The aspens and Balsam Poplar are

Species	Shade Tolerance	Moisture Status	Topography	Common Reproductive Method	Successional Status	Life Span*
Hardwoods						
Red Maple	Low/ moderate	Wet–dry	Swamps to uplands	Seed/ Vegetative	Early-mid	2a
Yellow Birch	Moderate	Moist/dry	Slopes and uplands	Seed	Mid-to-near climax	3
Sugar Maple	High	Moist/dry	Deep soils on slopes and uplands	Seed	Climax	3
White Birch	Low	Moist/dry	Steep slopes; Burned lowlands	Seed	Early	2a
Mountain Paper Birch	Low	Moist/dry	Cooler maritime areas; High elevations	Seed	Early	2a
Large-toothed Aspen	Low	Moist/dry	Rolling topography after burns	Seed/ Vegetative	Early	1
Trembling Aspen	Low	Moist/dry	Rolling topography after burns	Seed/ Vegetative	Early	1
Balsam Poplar	Low	Dry	River floodplains in Cape Breton	Seed/ Vegetative	Pioneer	1
Beech	High	Moist/dry	Hills	Seed/ Vegetative	Climax	3
Red Oak	Moderate	Moist/dry	Hills	Seed	Early-to-mid	3
White Ash	Moderate	Wet/moist	Seepage hills; Swamps	Seed	Mid	2b
Grey Birch	Low	Moist/dry	Hills after fire	Seed	Early	1
American Elm	Low	Moist	River floodplains; Occasional uplands	Seed	Early-mid	2b
Black Ash	Moderate	Wet/moist	Swamps and river intervals	Seed	Mid	2b
Ironwood	High	Moist/dry	River floodplains; Uplands	Seed	Near climax	2b

Table T10.6.1a: Characteristics and site preferences of native Nova Scotian trees —Hardwoods. **Note:** The symbol (-) indicates a range from one status to another; the symbol (/) indicates separate preferences. *Life Span: 1 – 50 to 100 years • 2a –100 to 150 years • 2b –100 to 350 years • 3 –250 to 450 years

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Species	Shade Tolerance	Moisture Status	Topography	Common Reproductive Method	Successional Status	Life Span*
Softwoods						
Balsam Fir	High	Moist/dry	Highlands; Rolling lowlands; Exposed coastal headlands	Seed	Early pioneer/Climax	1
Red Spruce	High	Moist	Rolling lowlands	Seed	Near climax	3
White Spruce	Low	Moist/dry	Abandoned fields; Exposed coastal headlands	Seed	Early/pioneer	2a
Black Spruce	Moderate	Wet/dry	Shallow organic, flat lowlands	Seed/ Vegetative	Early	2a
White Pine	Moderate	Moist/dry	Sandy to rocky lowlands	Seed	Early-mid oldfields and post-fire	3
Hemlock	High	Moist	Ravines and slopes; Lowlands	Seed	Climax	3
Red Pine	Moderate	Dry/moist	Sandy lowlands	Seed	Early post-fire	2b
Larch	Low	Wet	Swamps/Bogs; Moist oldfields	Seed	Early	2a
Jack Pine	Low	Dry	Shallow, rocky fire barrens	Seed	Early post-fire	2a
Cedar	Low	Wet/moist	Swamps	Seed	Early	2a

Table T10.6.1b: Characteristics and site preferences of native Nova Scotian trees —Softwoods. **Note:** The symbol (-) indicates a range from one status to another; the symbol (/) indicates separate preferences. *Life Span: 1 –50 to 100 years • 2a –100 to 150 years • 2b –100 to 350 years • 3 – 250 to 450 years

other exceptions: although they are grouped with hardwoods because they are deciduous, their wood is softer than that of any native softwood except cedar.

Table T10.6.1 shows the major characteristics of the most conspicuous of Nova Scotia's native trees.

Coniferous and deciduous species are further divided into two broad groups on the basis of ability to tolerate shade in youth. Yellow Birch, Sugar Maple, beech, and Ironwood are classed as shade-tolerant, while White and Grey Birch, Large-toothed and Trembling Aspen and Balsam Poplar are considered shade-intolerant. Among native conifers, the most shade-tolerant are Red Spruce, Hemlock and Balsam Fir; White Spruce, Jack Pine and Larch are shade-intolerant; Red Maple, ash, Red Oak, American Elm, White Pine, and Black Spruce are intermediate in shade tolerance.

Most hardwood species prefer the better-drained sites. Shade-tolerant hardwoods constitute the climax species on the slopes and well-drained hilltops throughout the province. Softwoods are more typical of the imperfectly and poorly drained sites in Nova Scotia. Red Spruce, White Pine and hemlock form the climax forest type in flatter, moderately well-drained to very dry sites. When the topography is mixed and rolling, the climax vegetation types approach the regional climatic climax, the "Eastern Hemlock, White Pine Northern Hardwood" forest of Nichols.[2] Certain species of hardwood and softwood are typical of old forests. These trees and their relative ages are listed in Table H61.1 in Introduction to Forest Habitats.

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Associated Topics
T9 Soils, T10 Plants,

Associated Habitats
H2.6 Dune System, H4 Freshwater Wetlands, H5.1 Barren, H5.2 Oldfield, H5.4 Talus Slope, H6 Forests

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T10.7 PTERIDOPHYTES (FERNS AND THEIR ALLIES)

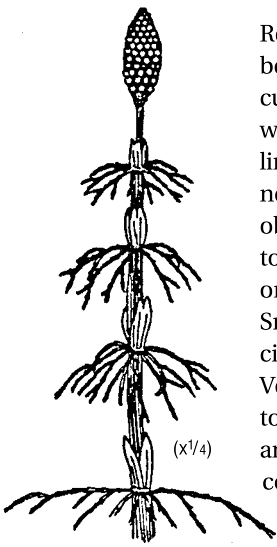

Figure T10.7.1: Horsetail

Representatives of this group of spore-bearing (non-flowering) herbaceous vascular plants may be found in association with most terrestrial and freshwater shoreline habitats. Most are conspicuous components of the vegetation; a few are small and obscure. Several species are restricted to specific habitats and are rare or only locally abundant. Roland and Smith's flora included forty-four species of ferns and twenty-three allies.[1] Von Aderkas updated the taxonomy to include several additional species and provided a detailed catalogue of collection localities.[2] (Enlargements or reductions in the diagrams are approximate.)

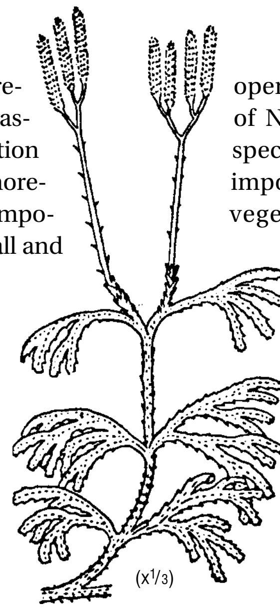

Figure T10.7.2: A club moss

FERN ALLIES

Quillworts, horsetails and club mosses are all spore bearing vascular plants which lack typical fern structure. The horsetails (Equisetaceae) include eight species which grow in open ground, woodland and littoral habitats (see Figure T10.7.1). The eleven species of club mosses (Lycopodiaceae) are common in various types of woodland and are occasionally found on barrens and in bogs (see Figure T10.7.2). Two species of *Selaginella* also occur but are rare in Nova Scotia. There are seven species of quillworts (Isoetaceae) in Nova Scotia, all emergent or submergent, and in littoral freshwater habitats[3] (Figure T10.7.3).

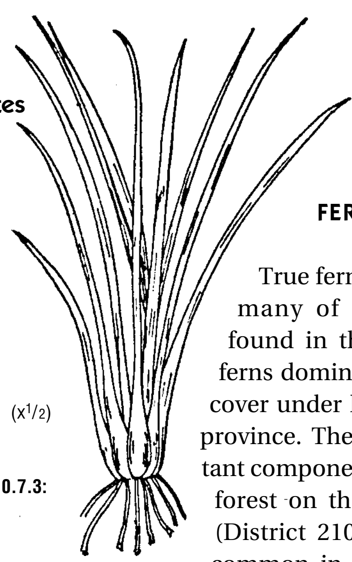

Figure T10.7.3: Quillwort

T10.7 Pteridophytes (Ferns and their Allies)

FERNS

True ferns play a significant role in many of the plant communities found in the province. A variety of ferns dominate the ground vegetation cover under hardwood throughout the province. The Wood Fern is an important component of the boreal Balsam Fir forest on the Cape Breton highlands (District 210), while Bracken Fern is common in the ground vegetation of open forest stands throughout much of Nova Scotia. It is also a pioneer species following fire. Ferns form an important part of the Arctic-Alpine vegetation community found on seepy cliffs in northern Cape Breton Island (District 220). Cinnamon Fern is common in swamps and wet places. Hay-scented Fern is found on grazed land and in disturbed forests. Ostrich Fern is prevalent in the understorey vegetation of fertile, river floodplain forests, especially in the Carboniferous Lowlands (Region 500).[2] The evergreen leaves of Christmas Fern are conspicuous in rich hardwood stands (see Figure T10.7.4). The grape-ferns are a small group of uncommon and generally obscure ferns with succulent leaves and sporangia clustered like tiny grapes (see Figure T10.7.5).

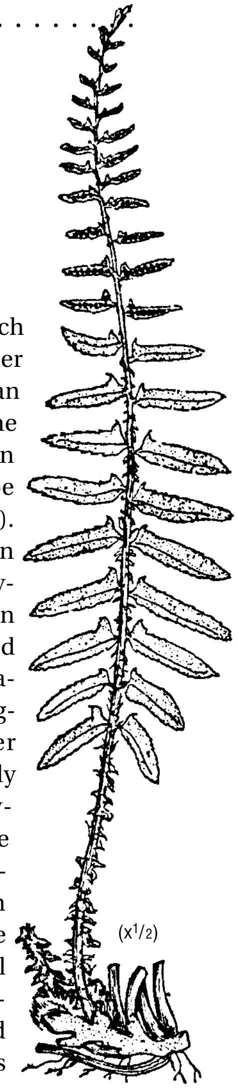

Figure T10.7.4: Christmas Fern

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Associated Topics

T10.2 Successional Trends in Vegetation, T10.4 Plant Communities in Nova Scotia, T10.6 Trees, T10.12 Rare and Endangered Plants

Associated Habitats

H4.2 Fen, H4.3 Swamp, H5 Terrestrial Unforested, H6 Forests

References

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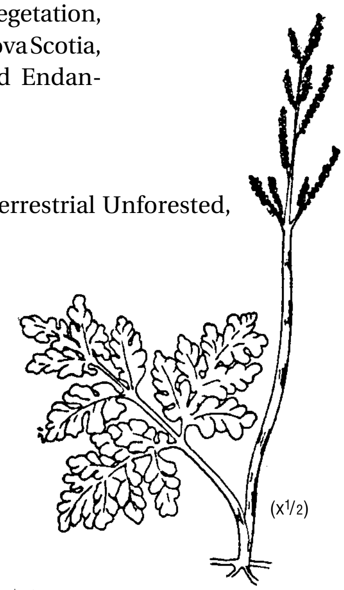

Figure T10.7.5: Grape-ferns grow in a variety of habitats but are only scattered throughout Nova Scotia.

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Plate T10.7.1: The Interrupted Fern *(Osmunda claytoniana* L.*)* is a common fern from a wide variety of habitats. The spore-bearing leaflets "interrupt" the vegetative leaflets on the frond. It is similar to the Cinnamon Fern, which has separate spore-bearing fronds. Photo: A. Wilson

2 Von Aderkas, P. (1986) "Collection of ferns and fern allies in Nova Scotia." *Proc. N.S. Inst. Sci.* 37.

3 Britton, D.M. and J.P. Goltz (1991) "*Isoetes prototypus*, a new diploid species from eastern Canada." *Can. J. Bot.* 69.

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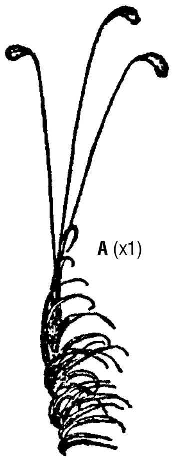
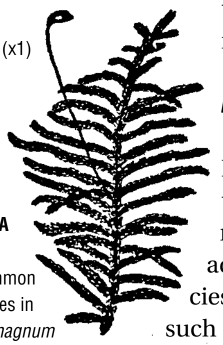
Plate T10.7.2: The Royal Fern *(Osmunda regalis* L.*)* is a large and distinctive fern usually growing in wet areas. Photo: A. Wilson

Plate T10.7.3: The Bracken Fern *(Pteridium aquilinum* L.*)* is common on poorer soils. It is often the first plant to grow after a forest fire. Photo: A. Wilson

T10.8 BRYOPHYTES (MOSSES, LIVERWORTS AND HORNWORTS)





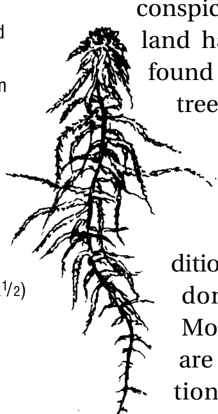


Figure T10.8.1: Broom mosses **A** and Schreber's Moss **B** are common woodland mosses in Nova Scotia *Sphagnum* **C** may grow in wet pockets in woodland environments but is most conspicuous in wet open areas, forming the major component of bogs.

T10.8 Bryophytes (Mosses, Liverworts and Hornworts)

These are the simplest of the land plants and are often conspicuous in moist, terrestrial habitats in Nova Scotia. Brown[1] and Erskine [2,3,4] both made significant contributions to the study of bryophytes in Nova Scotia. However, Ireland's *Moss Flora*[5] and his abbreviated *Illustrated Guide*[6] are the most useful recent works. The 1987 Checklist of the Mosses of Canada lists over 550 taxa from the province.[7] (Enlargements or reductions in the diagrams are approximate.)

MOSSES

Mosses (Musci) are scattered throughout most terrestrial and many littoral, aquatic habitats. Many species are rather small, but some, such as the Hair-cap Moss are common and conspicuous on the ground in open woodland habitats. Some species may also be found on rock surfaces and on the trunks of trees.

Mosses are the dominant ground-cover plants in two situations in Nova Scotia. The dense canopy of most mature softwood forests creates conditions suitable for development of a moss-dominated ground cover. Schreber's Moss Stair-step Moss and broom mosses are common species under such conditions (see Figure T10.8.1). Sphagnum mosses are prevalent in wet boggy habitats, where their remains accumulate during slow decomposition, to form the organic substrate peat. Various species of *Sphagnum* occupy a range of moisture conditions in bogs from the pond edge (*S. cuspidatum*) to the dry hummocks (*S. fuscum*) (see Figure T10.8.1). Maass published a series of studies on the taxonomy and distribution of *Sphagnum*[8], and Anderson made extensive studies on the commercial aspects of peat (see Figure T.8.3).[9]

The aquatic species, such as *Fontinalis* species, are commonly found growing on rocks and boulders in stream beds and wave-washed lake shores. These plants can tolerate both submergence and exposure, as dictated by seasonal water level variations (see Figure T10.8.2).

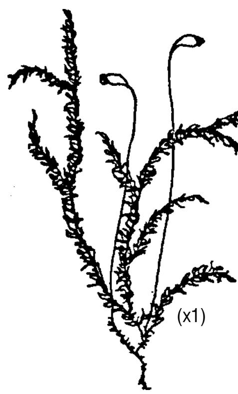


Figure T10.8.2: Hypnum grow in edge habitats of rivers and streams

LIVERWORTS

Liverworts (Hepaticae) of both the leafy forms (Jungermanniales) and thalloid (rosette-like) forms (Metzgeriales and Marchantiales) occur widely in moist, terrestrial, semi-aquatic situations in Nova Scotia (see Figure T10.8.3). Leafy forms commonly occur with mosses in mature woodland (e.g., *Bazzania trilobata*). Thalloid forms such as *Conocephalum conicum* are often conspicuous near the water along the banks of rivers and in springs.

HORNWORTS

Hornworts (Anthocerotae) are thalloid plants with a cylindrical (hornlike) sporangia (spore-bearing structure) arising from the thallus surface (see Figure T10.8.4). They are scarce, occurring on moist soil at edges of lakes, streams, ditches, paths and woodland roads.

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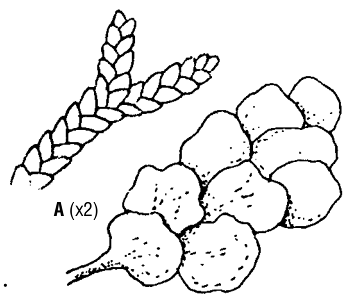
Associated Topics
T10.4 Plants Communities in Nova Scotia, T10.6 Trees, T10.11 Lichens

Associated Habitats
H3.3 Bottom Lotic (Rivers and Streams), H3.5 Edge Lotic (Rivers and Streams), H3.6 Edge Lentic (Lakes and



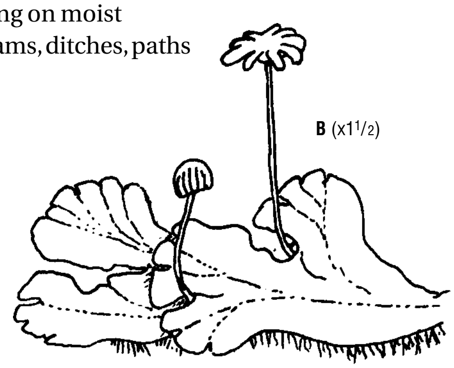


Figure T10.8.3: Liverwort. Leafy liverworts **A** are often confused with mosses, whereas thalloid liverworts **B** are quite distinctive.

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Ponds), H4 Freshwater Wetlands, H5 Terrestrial Unforested, H6 Forests.

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3 Erskine, J.S. (1969) *The Hepatics or Liverworts of Nova Scotia.* Unpublished MS.
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8 Maass, W. (1966-67) *"Studies on the taxonomy and distribution of Sphagnum." Bryologist* 69(1) *and* 70(2); *Nova Hedwigia* 13 and 14.
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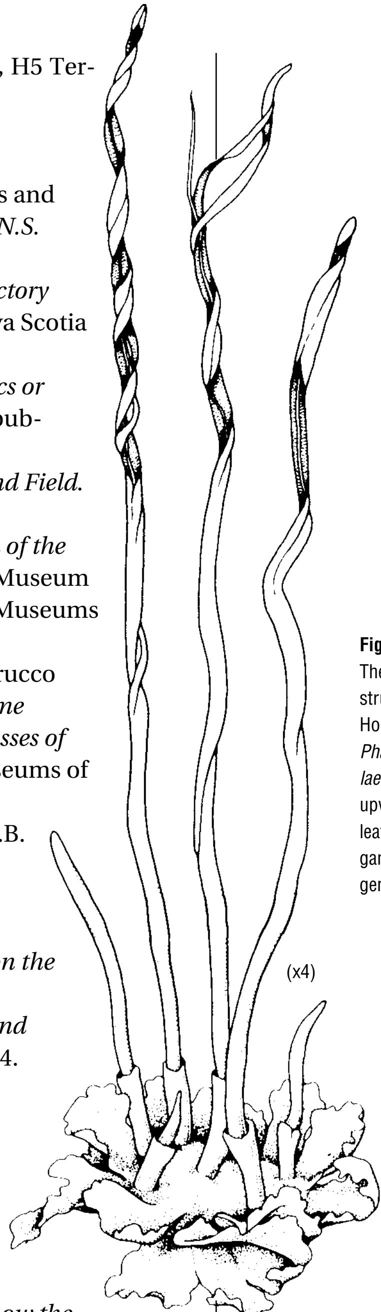

Figure T10.8.4: The spore-bearing structures of the Hornwort *Phaeoccerous laevis* grow upwards from the leaf-like gametophyte generatioin.

T10.9 ALGAE

Algae are primitive plants with no vascular structure, largely dependent upon water for their sustenance and reproduction. They range in size from microscopic cells the size of bacteria (the blue-green algae) to the massive fronds of the kelps (*Laminaria* spp.), which are the tallest marine plants known; in Nova Scotia they can reach up to 10 m in length. Those that float freely in the water are known as phytoplankton and are generally single-celled and microscopic, although some species are large enough to be observed by the naked eye. Multicelled or macrophytic algae are usually attached to the bottom or other solid substrate (benthic).

Algae occupy either freshwater or marine environments, sometimes both, and some species can tolerate relatively extreme conditions of temperature and salinity. In addition, some can be found in moist terrestrial habitats. Because they are immersed, the algae do not require specialized tissues for internal transport, as do the higher land plants, but obtain their nutrients directly from the surrounding water by diffusion. Algae also use water, much as some land plants use wind, to achieve fertilization and dispersal of their reproductive products. (Enlargements or reductions in the diagrams are approximate.)

FRESHWATER ALGAE

Algae can be divided into two categories: phytoplankton (microscopic algae) and macrophytes (larger algae and all seed-bearing plants) (see T10.5.). Both types are characteristic of most freshwater ecosystems found in Nova Scotia, although their abundance and diversity vary greatly according to each particular habitat.

Freshwater phytoplankton, mainly diatoms, green algae and blue-green algae, is the most abundant form of plant life in the open-water habitats, although less obvious than the associated benthic macrophytes. This collection of minute plant organisms is responsible for primary production and therefore is essential to all other forms of life in the aquatic ecosystem. Phytoplankton can range in size from single cells to clusters of cells large enough to be observed without a microscope. The numerous species differ in the depths they inhabit, the type of nutrients they require, their growth rates, and reproductive seasons. Phytoplankton abundance in Nova Scotia lakes is closely associated with nutrient status. Low pH tends to limit diversity.[1] Freshwater algae often give rise to a greenish tinge in lakes and ponds, by multiplying rapidly to create what are known as algal blooms at the surface.

MARINE ALGAE

Like the freshwater algae, marine algae may be microscopic or macrophytic. Microscopic algae of various kinds live in the upper layers of the ocean, in a huge but inconspicuous biomass, and contribute oxygen to the surface waters. They are also the primary food source for the oceans and support major offshore fisheries. Thus, these algae or marine phytoplankton are of basic importance to ocean ecosystems.

The macrophytic marine algae, or seaweeds, are usually the most conspicuous of our marine plants. They grow on rocky shores around the coast of Nova Scotia, and those in the intertidal zone are periodically exposed to air. Like the phytoplankton, they contribute oxygen to the water and also provide shelter to various marine animals. Larger species protect coastlines by moderating waves and currents.

ALGAL GROUPS

Early attempts to divide the algae into groups relied on their pigmentation (and this still applies to most groups), but modern taxonomy relies on other characteristics as well.[2] All the recognized algal groups occur in Nova Scotia, and the seven classes that are the most apparent and abundant in this area will be considered here.

(x600)

Figure T10.9.1: The silica cell walls of diatoms fossilize as accumulations of diatomaceous earth.

DIATOMS (CHRYSOPHYTA)*

Diatoms are microscopic organisms identified by cells encased in a rigid cell wall (frustule) with a high silica content (see Figure T10.9.1). These are often decorated with complex geometric patterns representative of different species, which can make identification relatively easy. Diatoms occur singly or in

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chains and can be so numerous as to colour the water. They are prone to sinking because of their dense frustules, and so rely on vertical water movements to keep them in near surface waters.

**Not all Chrysophyta are diatoms. There are many others, some of which are macrophytic.*

Freshwater

These plants are present in lake water the year round but only begin to grow and divide rapidly in the spring. The population growth rate depends on the amount of silica in the water column. When the diatoms die, the heavy frustules fall to the bottom. Since these shells remain recognizable for long periods after the cells have died, they can be used in analysing the history of lake-bottom sediments. Typical genera include *Stephanodiscus* (often shaped like a disk) and *Asterionella*, which floats in the water like a parachute.

Marine

Diatoms are perhaps the most important group of marine algae, as they indirectly support most of the world's major fisheries. Genera common to the offshore areas of Nova Scotia include *Nitzschia, Thalassiosira, Coscinodiscus* and *Chaetoceros.*

GREEN ALGAE (CHLOROPHYTA)

All types of algae contain chlorophyll. The colour of this group, however, is not masked by any other pigment, which accounts for its characteristic bright-green colour. Green algae have evolved the greatest diversity of morphological forms found among algae[2], ranging from single-cells, membranous forms to filaments (floating or attached), as well as some floating colonial types. *Chlorella* is a common single-celled green algae, while *Volvox* is a colony of cells large enough to be seen with the naked eye. Green algae, mainly *Trebouxia*, form a symbiotic association with fungi in lichens.

Freshwater

Desmids are a specialized group of single-celled freshwater green algae found in many shapes and sizes and are usually more prevalent in small ponds than in lakes (see Figure T10.9.2). Filamentous genera, commonly form "pond scum," and include *Spirogyra*, *Zygnema* and *Oedogonium,* which are often studied in elementary botany classes. *Spirogyra* and the desmids are important to the ecology of lakes, often producing an enormous amount of biomass where levels of nitrates and phosphates are high.

What is "spring bloom"?

This is an event which occurs in many lakes and offshore waters of the Northern Hemisphere during May and June and involves the rapid reproduction of diatom and other microalgal populations (some of the most conspicuous and spectacular blooms are dinoflagellates). It is primarily the result of the following combination of circumstances. During the winter, cold water temperatures and reduced light allow only a low rate of photosynthesis, resulting in the accumulation of nutrients in the water. When temperature and light conditions become favourable, these organisms proliferate until the supply of nutrients has been exhausted (see Figure T10.9.7), at which time the population of algae goes into decline.

Terrestrial

Green algae are also found in moist terrestrial habitats. The genus *Protococcus* lives on tree trunks and is particularly conspicuous after rain.

Marine

Seaweeds are the principal form in which green algae occur in the sea. They need the high light levels found near the sea surface and are most common at higher intertidal levels, or subtidally in shallow water.[3] Nova Scotia has about 82 species of Chlorophytes, of which common intertidal forms include *Enteromorpha* spp. (hollow tubular species), *Ulva lactuca* (Sea Lettuce) and *Cladophora* (a filamentous form) (see Figure T10.9.3).

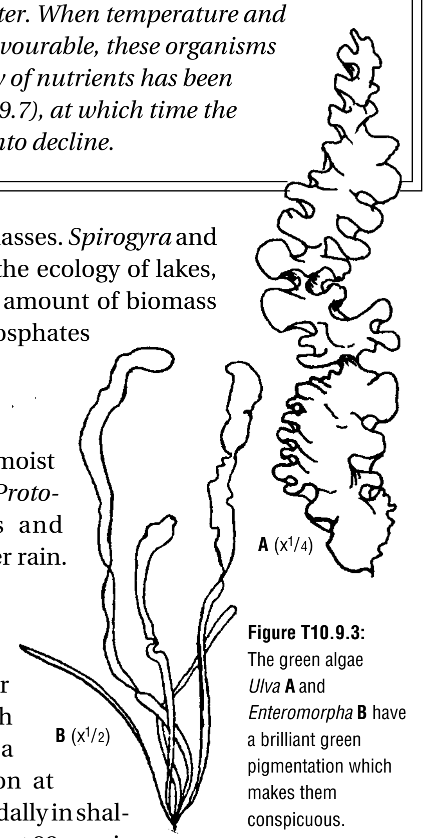

Figure T10.9.3: The green algae *Ulva* **A** and *Enteromorpha* **B** have a brilliant green pigmentation which makes them conspicuous.

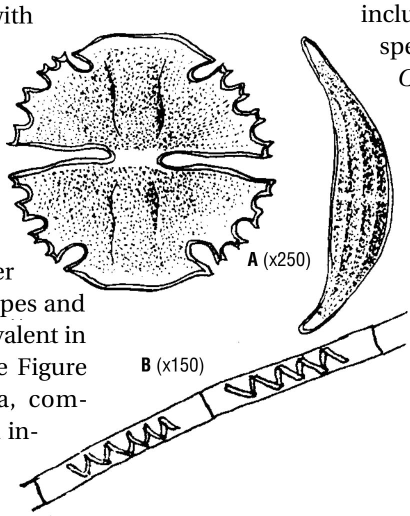

Figure T10.9.2: The desmids **A** *Micrasterias* (upper left) and *Closterium* (upper right) exist as single independent cells in fresh water. The filamentous algae **B** exist as colonies — with cells attached together.

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BLUE-GREEN ALGAE (CYANOPHYTA)

Blue-green algae have cell structures similar to bacteria and are sometimes called cyanobacteria. They do not have the membrane-bound organelles like a nucleus, which are found in the majority of green plants, and are therefore classified as prokaryotes.[2] Populations may consist of single-celled species or colonies of long filamentous chains. Some scientists believe that the chloroplasts of higher plants may have evolved from symbiotic blue-green algal cells. Many blue-green algae are able to fix gaseous nitrogen into nitrates and thus perform the same role in water as is performed by bacteria in soil.

Freshwater

Blue-green algae inhabit muddy surfaces rich in organic materials in freshwater ponds, small lakes and as epiphytes. Common genera include *Anabaena, Microcystis, Oscillatoria* and *Rivularia.*

Marine

Blue-green algae, which frequently form mats on the surface of muds, are important to the ecology of mud flats and tidal marshes. They are major nitrogen fixers and can make significant contributions to the nutrient concentrations in shallow coastal waters[4] and in tidal marshes.[5] Colonial and solitary forms can be found floating in the open waters offshore.

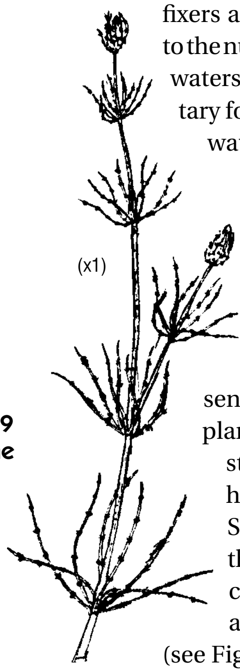

Figure T10.9.4: The stoneworts are easily distinguished because of its rough texture and rank odour.

STONEWORTS (CHAROPHYTA)

Stoneworts are submerged macrophytes with advanced morphological features (reproductive organs, nodes and internodes, etc.). It has been suggested they may represent a link between the algae and the higher plants. Most produce a calcareous supporting structure around their cells and generally inhabit fresh water with a high calcium content. Stoneworts frequently grow at greater depths than other plants because their thin-walled cells do not contain air spaces, but instead absorb oxygen directly from the water. *Chara* (see Figure T10.9.4) is often found in ponds in gypsum areas of Nova Scotia (sub-Unit 511a), and *Nitella* has been reported from various locations throughout the province.

RED ALGAE (RHODOPHYTA)

Red algae are mostly macrophytic and are associated mainly with the marine environment. Several single-celled genera are known, from both marine and fresh waters, and a few species of macrophytes are known to inhabit the rocky shorelines of lakes across the province. The macrophyte *Batrachospermum* inhabits lakes in Kejimkujik National Park[6] and Cape Breton Highlands National Park.[7]

Marine

Red algae form a common group of seaweeds occurring in the intertidal zones and below the low-water mark on rocky shores. Their pigments enable them to use light that is greener than the brown or green algae can use, enabling their growth at greater depths. They include leafy, filamentous branched and crustose forms. Several species, mostly crusts, have calcareous walls and are the so-called coralline algae, *Corallina officinalis* and *Lithothamnium* spp. (see Figure T10.9.5). The latter form pink stony crusts on rocks. Corallines occur the deepest of any algae and can be found at depths of 80 to 100 m in clear water. Bird and McLachlan have published a recent account of the most common red algae of the area.[8]

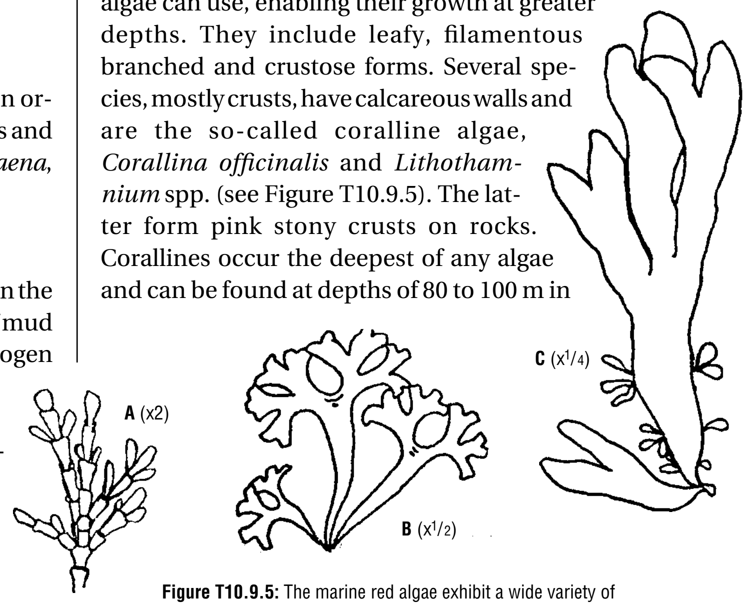

Figure T10.9.5: The marine red algae exhibit a wide variety of morphological forms. **A**: *Corallina*, **B**: Irish Moss, **C**: Dulse

BROWN ALGAE (PHAEOPHYTA)

Brown algae are exclusively marine and are the dominant group of seaweeds found in the intertidal and immediate subtidal zones of hard-bottom shores, particularly in areas exposed to wave and surf activity but also in tidal marshes and on stones on muddy shores. They are highly variable in form, ranging from thin crusts and tiny, intricately branching species to the heavy, thick blades of kelps, which are the largest seaweeds (see Figure T10.9.6A, B and C). In colour, they range from blackish to greenish brown and yellowish brown. The rockweeds *Ascophyllum nodosum* and *Fucus* spp. are the most common intertidal algae, while the kelps *(Laminaria digitata, L.longicruris, Agarum clathratum* and *Alaria*

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esculenta) are found in the subtidal zone of rocky shores on the Atlantic Coast (Region 800). There are 109 species of brown algae in the Maritimes.[9]

DINOFLAGELLATES (DINOPHYTA OR PYRROPHYTA)

Dinoflagellates, along with diatoms and a group known as haptophytes, are among the most important groups of unicellular algae in the sea. The motion of their hair-like "tail" or "tails" (the flagella), which arise from a groove around the middle of the cell, helps suspend them in the water (see Figure T10.9.7). Common genera include *Ceratium* and *Prorocentrum.*

Some marine species of dinoflagellates carry potent toxins. Paralytic shellfish poisoning in humans is caused by eating mussels, oysters and clams that have consumed large numbers of these dinoflagellates. Such incidents occur when the dinoflagelates are so abundant as to colour the water red or reddish brown, in "red tides." Red tides and shellfish poisoning occur typically in summer in the Digby-to-Yarmouth area but may occur more widely and at other seasons of the year.

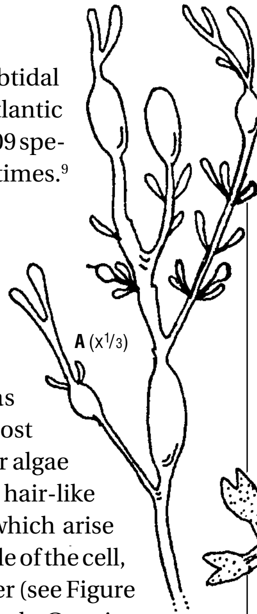
DISTRIBUTION OF MARINE ALGAE

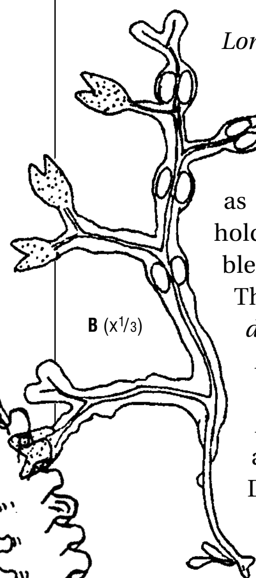
The three major coasts of Nova Scotia—Bay of Fundy (District 910), Atlantic Coast (Region 800) and the Northumberland Strait (Unit 914)—have particular species associations. MacFarlane and Milligan's checklist[10] is set up to reflect these areas and Wilson et al.[11] give a detailed list and distribution map for benthic species of the Bay of Fundy.

Furcellaria is a cold-water, subboreal species. Its success in the Gulf is partly due to thermal stratification, where the bottom water generally remains cold. It is confined to the Gulf where it was introduced and has not yet spread widely from it.

Other species, including *Gracilaria tikvahiae, Stilophora rhizodes, Dasya baillouviana, Chondria baileyana, Griffithsia globulifera,* and *Lomentaria baileyana*, need the warm water that occurs in the lagoons in summer but can tolerate the cold water in the winter. Some of these algae, such as *Griffithsia* and *Lomentaria*, have holdfasts containing starch that enables the plant to survive the winter. The deep-water red algae *Odonthalia dentata* is common only along the Atlantic Coast.

Certain marine dinoflagellates are unique among algae in having the capability for bioluminescence. In Nova Scotia waters, Gonyaulax polyedra *is commonly responsible for glowing wakes of ships and flashes of light observed in footsteps in the intertidal zone at night.*





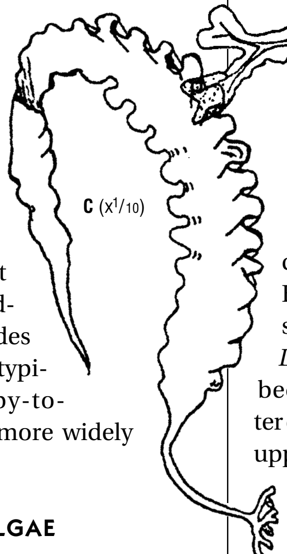


Figure T10.9.6: Brown algae vary from inconspicuous filamentous forms to the larger rockweeds, such as *Ascophyllum* **A** and *Fucus* **B**, and the kelps, such as *Laminaria* **C**, which has been known to grow up to 10 metres in the Bay of Fundy.

The encrusting brown algae *Ralfsia fungiformis* can be found in abundance along the outer coast near Digby Neck (Unit 912). Algae in the Minas Basin (sub-Unit 913a) frequently cannot develop due to the high siltation rates. However, occasional clear bedrock areas, such as those near Blomidon Provincial Park, have well-developed seaweed communities (including the kelp *Laminaria saccharina* and dulse).[12] Significant beds of dulse grow near Parrsboro, and warm-water cyanophytes can be found in micro-habitats in the upper reaches of the Minas Basin.

The extreme tidal range in the Bay of Fundy briefly exposes subtidal seaweeds, making a unique opportunity for study. On rocky shores, seaweeds occupy distinct vertical zones corresponding to their ability to tolerate exposure to the air during the low-tide period.

CULTURAL FACTORS

Fossil deposits of diatom frustules are found in the bottoms of Nova Scotia lakes.[13] This diatomaceous earth can be mined and used as a filtering agent, abrasive and insect powder.[2] Seaweeds, such as Irish Moss, are harvested around the world for chemicals and food (see Figure T12.10).

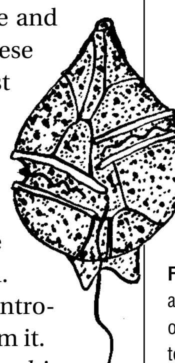


Figure T10.9.7: Dinoflagellates are obscure microscopic organisms, but are well known to the general public because of their role as the causitive agent of paralytic shellfish poisoning.

T10.9
Algae

Associated Topics
T6.1 Ocean Currents, T6.2 Oceanic Environments, T6.3 Coastal Aquatic Environments, T8.1 Freshwater Hydrology, T8.2 Freshwater Environments, T10.5 Seed-bearing Plants, T10.11 Lichens, T11.12 Marine Mammals, T11.13 Freshwater Fishes, T11.17 Marine Invertebrates, T12.8 Fresh Water and Resources, T12.10 Plants and Resources

Associated Habitats
H1 Offshore, H2 Coastal, H3 Freshwater, H4 Freshwater Wetlands

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T10.10 FUNGI

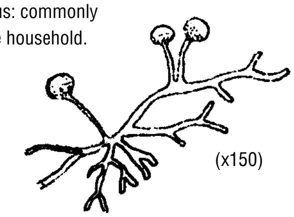
This is a diverse group of heterotrophic plants (without chlorophyll). They are mainly saprophytes inhabiting decomposing organic substrates in the soil, in fresh water and in seawater. Some species are parasitic on either plants or animals, and others form a symbiotic association with green and, occasionally, with blue-green algae, as lichens. Fungi only become conspicuous where their filaments (hyphae) become concentrated into a mycelium on rich substrates or to facilitate reproduction. The mushrooms and bracket fungi commonly seen in forest habitats are specialized spore-producing structures.[1] The most recent list of Nova Scotian fungi has been published by C.O. Gourley.[2] They are divided into two classes, the Myxomycota (slime fungi) and the Eumycota (true fungi), of which there are four divisions. (Enlargements or reductions in the diagrams are approximate.)

The Chanterelle mushroom Cantharellus cibarius *grows in the forests of Nova Scotia and is highly prized as a gourmet food in Western Europe. Although it has been recognized and appreciated by mycologists for many years, it has only been since the post-World War II immigration of continental Europeans into Nova Scotia that this native delicacy has been actively sought. Chanterelles can occur singly or in groups and are apricot to egg-yolk yellow. They could be confused with the poisonous Jack O'Lantern (*Clitocybe illudens*), a bright-yellow mushroom growing in large clusters around stumps. There is no agreement amongst harvesters as to where the best growths of Chanterelles may be found; some claim that White Spruce stands are superior; others suggest hardwood stands are better.*

SLIME FUNGI

Myxomycota (slime fungi) consist of a naked mass of protoplasm capable of amoeboid movement. They are often considered to be an intermediate between animals and plants. The aggregate form, known as a plasmodium, is most commonly seen, as a yellow mass, on damp rotting wood in forests and other shady places.

Figure T10.10.1: Moulds are a true fungus: commonly found in the household.



TRUE FUNGI

Phycomycetes

These algae-like fungi are composed of hyphae without dividing cell walls (coenocytic) (see Figure T10.10.1). These forms are widespread and include moulds, blights and parasites of insects, fish and amphibians.

Deuteromycetes

Deuteromycetes (fungi imperfecti) are a widespread group of fungi in which only asexual reproduction is known. Many are responsible for plant diseases.

Ascomycetes

Ascomycetes (cup or sac fungi) are almost all saprophytic and include various moulds and mildews, yeasts and *Penicillium*. Some are significant tree parasites, causing Black Knot in plum, Dutch Elm disease and some witches[3]-brooms. Larger forms include the edible and much-sought-after morels (*Morchella* spp.) (see Figure T10.10.2. The cup fungi (*Peziza* and *Sarcoscypha*) are sometimes brightly coloured and conspicuous.

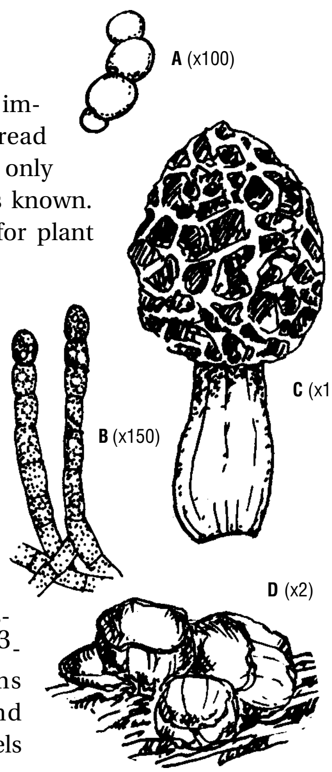


Figure T10.10.2: Ascomycetes vary from microscopic yeasts **A** and mildews **B** to the more conspicuous morels **C** and cup fungi **D**.

Basidiomycetes

Basidiomycetes (basidia fungi) include mostly saprophyte species and contain all the woody fungi and most of the large fleshy fungi (e.g., the conspicuous gill and bracket fungi). This class also includes parasitic forms, such as the smuts and rusts of grasses and White Pine Blister Rust. The mushrooms and bracket fungi, commonly seen in forest and other habitats, all belong to this group. As they are conspicuous, and include both edible and poisonous species, the group attracts a good deal of

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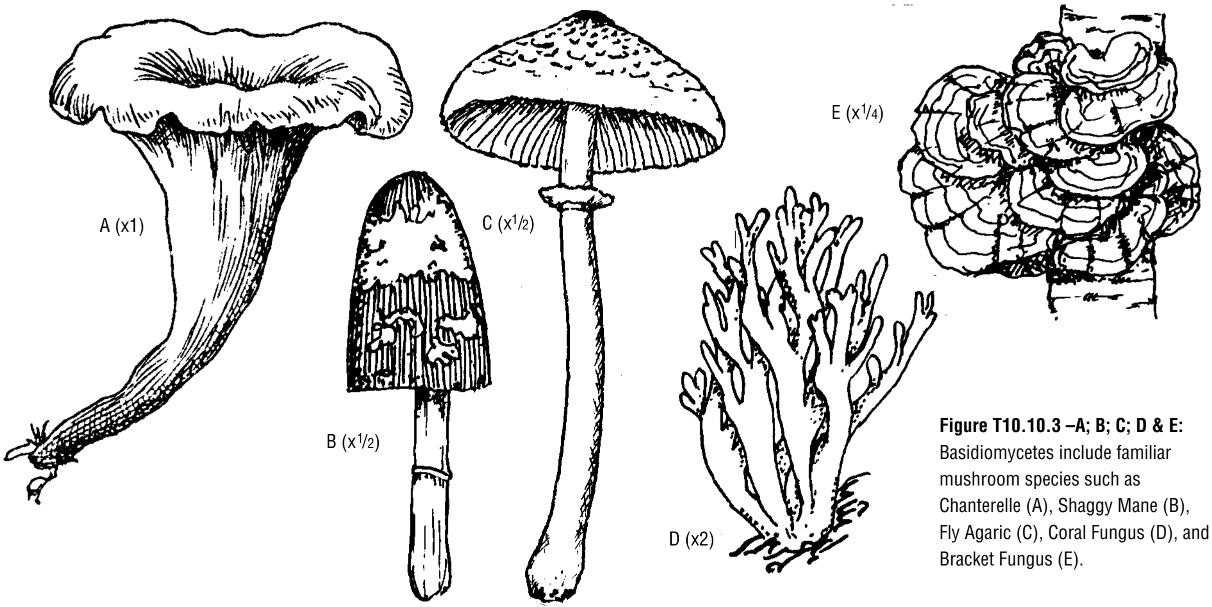

Figure T10.10.3 –A; B; C; D & E: Basidiomycetes include familiar mushroom species such as Chanterelle (A), Shaggy Mane (B), Fly Agaric (C), Coral Fungus (D), and Bracket Fungus (E).

public interest. Many species have specific relationships with common forest trees[3,4] (see Figure T10.10.3).

• • • • • • • •

Associated Topics

T9.3 Biological Environment, T10.5 Seed-bearing Plants, T10.6 Trees, T10.9 Algae, T10.11 Lichens, T11.16 Land and Freshwater Invertebrates, T12.10 Plants and Resources

Associated Habitats

H2.5 Tidal Marsh, H5 Terrestrial Unforested, H6 Forests

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T10.11 LICHENS

Lichens are marvellous examples of symbiosis, a mutualistic partnership between ascomycete or basidiomycete fungi and green algae (mainly *Trebouxia*) or, less often, blue-green algae (various spp.). The fungal component (mycobiont) absorbs nutrients and provides structural support, while the algal partner (photobiont) produces carbohydrates by photosynthesis.[1] Lichens can be conveniently referred to by their gross structural forms: crustose (flat crusts), foliose (leafy), fruticose (shrubby or filamentous).[2] The term "macrolichen" is applied mainly to non-crustose species having large thalli (i.e. *Lobaria, Parmelia*). Corticolous lichens colonize tree bark; saxicolous species occupy rocks and boulders; terricolous lichens occur on soil.[2] The reproduction of lichens is achieved in several ways: by vegetative dispersal (thallus fragments, isidia, soredia); sexually (apothecia) or asexually (aplanospores).[1,2] Although no complete list has yet been compiled, there are approximately 550 different species recorded from the province. (Enlargements or reductions in the diagrams are approximate.)

DISTRIBUTION

Lichens colonize a variety of natural substrates (bark, rock, soil, mosses and other lichens)[1,2] and occasionally man-made surfaces (concrete, metal).[3] Conspicuous organisms in Nova Scotia, lichens are common in many habitats: bogs, barrens, cliffs, forest, rocky shore, talus slope. Abundant lichens such as corticolous *Hypogymnia*, saxicolous *Porpidia*, and corticolous and saxicolous *Xanthoria* are common in all regions. In disturbed habitats (e.g., along highways), characteristic species include *Baeomyces fungoides* on graded slopes and *Stereocaulon* spp. on exposed rock and fill.[3]

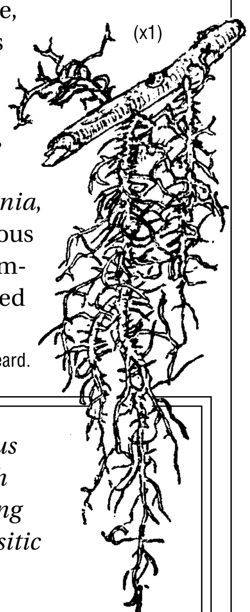

Figure T10.11.1: Old Man's Beard.

One of the most conspicuous of the corticulous lichens is Old Man's Beard, Usnea *spp. which colonizes mostly coniferous trees. This hanging lichen is often mistakenly thought of as parasitic due to its habit of colonizing already dead or decaying trees.*

CORTICOLOUS LICHENS

Corticolous lichens form distinct successions of species on tree bark and dead wood, paralleling the successional developments of the forest itself.[1,2] Hardwood and softwood trees in dry, mesic and wet sites support moderate to abundant lichen growth.[4] On mountain slopes of the Atlantic Interior (Region 400) and Avalon Uplands (Region 300), corticolous macrolichens grow among numerous microlichens on the trunks of shade-tolerant hardwood trees.[3] Typical of the moist pioneer forest are *Alectoria, Bryoria, Fistulariella, Graphis, Platismatia* and *Tuckermanopsis*.[5,6,7] In the climax forest, *Flavopunctelia, Heterodermia, Lobaria,*

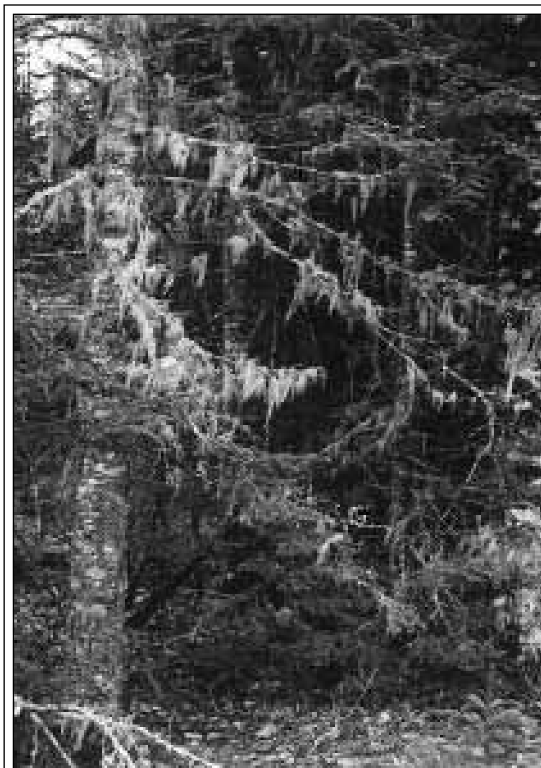

Plate T10.11.1: The *Usnea* spp. are commonly known as Old Man's Beard, shown here in a typical spruce forest near Stewiacke in sub-Unit 511a. Photo: P. Blades

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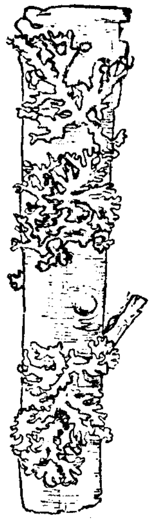
Parmotrema, Pseudocyphellaria and *Sticta* colonize beech, birch, maple and oak on mesic and dry slopes.[5,6,7] Cool temperatures and abundant precipitation, typical of the climax forest along the Atlantic and Fundy coasts, support rare North American boreal species such as *Cavenularia hultenii, Erioderma mollissimum, and E. pedicellatum.*

Fir and spruce are often draped with dark strands of *Alectoria sarmentosa,* greyish-green *Bryoria trichodes* and yellow-green *Usnea filipendula*[8,9] (see Figure T10.11.1 and Plate T10.11.1). These filamentous lichens are also common on slopes and ridges of the Atlantic Interior[5] (Region 400) and the coastal/stoney and wet/clay plains of the Carboniferous Lowlands (Region 500)[3].



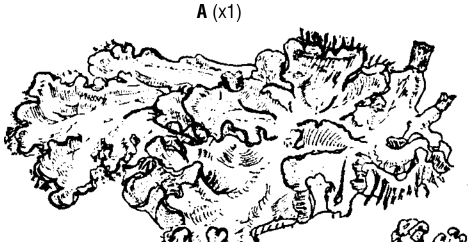
(x 1/2)

Figure T10.11.2: *Hypogymnia physodes,* commonly known as Puffed Lichen, is a corticolous species most frequently found growing on trees and shrubs; however, it has been known to colonize sand on Sable Island.

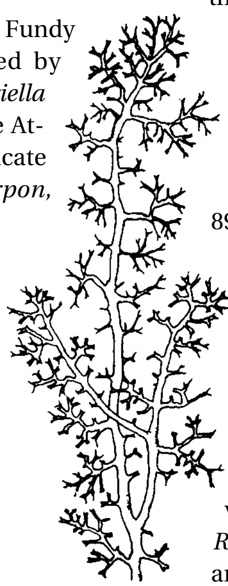
SAXICOLOUS LICHENS

Basalt and conglomerate cliffs along the Fundy coasts (Districts 620, 720) are lichenized by saxicolous *Acarospora, Caloplaca, Candellariella* and *Collema.*[3,6] Quartzite headlands of the Atlantic Coast (Region 800) support umbilicate genera such as *Actinogyra, Dermatocarpon, Lasallia* and *Umbilicaria.*[10,11]

A (x1)



B (x2)



C (x1 1/2)

Figure T10.11.3:
Dog Lichen **A** x 3/4;
British Soldier Lichen **B** x1;
Reindeer Moss **C** x1.

Reindeer Mosses are commonly mistaken for moss, but are in fact soil-inhabitating lichens. These species are common winter food for deer, who also browse on tree lichens. Browse lines in forest stands are a common sight in Nova Scotia after a harsh winter.

Plate T10.11.2: A saxicolous lichen, *Actinogyra muehlenbergii*, on a granite boulder. Photo: T. Casselman

TERRICOLOUS LICHENS

Terricolous *Cladina* and *Cladonia* colonize mossy sites characteristic of bogs, hummocks and exposed bedrock, especially in the Plateau-Taiga (Region 100) and Granite Barrens (District 440) and other areas throughout the province.[5,6,12]

The tiny pink mushroom-like *Baeomyces fungoides* is common across the province along roadcuts, where it functions as a pioneer species on the poorer, disturbed soils.

Lichens found on Sable Island (District 890), where flora and habitats are subject to severe ecological conditions, grow atypically.[13] Here the corticolous macrolichen *Lobaria pulmonaria* (see Plate T10.11.3) was found growing on Crowberry.[12] Blueberries, Heather and Sheep-laurel support corticolous species such as *Cetraria ciliaris* and *Hypogymnia physodes* (see Figure T10.11.2), but thalli are smaller and less vigorous than those in mainland habitats.[3] *Ramalina* and *Usnea* species on fenceposts and telegraph poles are typically stunted; however, in the island's heaths, terricolous *Cladonia* and *Cladina* spp. are abundant[12,13] and more typical in form. Corticolous and/or saxicolous *Physcia* and *Xanthoria* colonize concrete and metal on Sable Island[3] and have been found on horse skulls and bones.[14]

T10.11
Lichens

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Plate T10.11.3: *Lobaria pulmonaria* a foliose, corticolous macrolichen characteristic of old-growth deciduous forest. Photo: A. Wilson

TOLERANCE

Some lichens can tolerate high levels of dessication and illumination while others depend on high humidity and shade.[1] *Parmelia sulcata* is common[5,7,12] on hardwoods and conifers in the open forests and fields of the rolling uplands/hills and valleys of the Carboniferous Lowlands (Region 500) and the hardwood plateaus of the Avalon Uplands (Region 300). *Parmotrema crinitum*, on the other hand, colonizes shaded bark and mossy rocks[5,7,12] within the same regions. Saxicolous *Lasallia papulosa* prefers sloping or vertical surfaces of granite[2,4,11] near lakes and waterways, whereas *Xanthopermelia conspersa* and *X. cumberlandia* flourish on cemetery stones,[10] outcrops and boulders.[11]

CULTURAL FACTORS

Humans have used lichens as food, fodder, medicine, dyes, cosmetics, litmus and pollution monitors for at least three thousand years.[4,10] Mammals (e.g., white-tailed deer) forage on lichens, and birds (the Northern Parula Warbler) use filamentous species like *Bryoria* and *Usnea* to build nests.[4]

Indicators

Lichens obtain much of their nutrient requirement from rainwater and thus are highly sensitive to airborne pollutants.[15,16] The abundance of pollution-tolerant species is indicative of deteriorating air quality; consequently, lichens are used in many studies to monitor pollution.[15,16] Trees in urban areas of the Granite Uplands (Unit 451) are increasingly colonized by pollution-tolerant *Hypogymnia physodes*, *Lecanora conizaeoides*, *Parmelia sulcata* and *Physcia adscendens*.[3,15]

Humans represent the greatest threat to lichens today.[15,16] The dangers are pollution, agriculture and loss of habitat.[4,8,9,10,15,16] Habitat destruction (highway construction, logging, residential development) and recreational land use (all-terrain vehicles) in many upland, highland and interior areas of the province pose a hazard to lichen communities that were previously inaccessible. Removal of granitic bedrock and boulders has seriously depleted suitable substrate for saxicolous lichens.[4,10] Clear cutting affects those few locations known to support documented rarities such as *Erioderma* and *Sticta*.[8,9] The removal of bog vegetation (peat moss production) poses a future risk, as does the continuing problem created by pollution levels that indicate deteriorating air quality.[15,16]

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Associated Topics
T9.1 Soil-forming Factors, T10.4 Plant Communities, T10.6 Trees, T10.8 Bryophytes, T10.9 Algae, T10.10 Fungi

Associated Habitats
H5 Terrestrial Unforested, H6 Forests

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T10.12 RARE AND ENDANGERED PLANTS

Rare plants are those which grow, without the aid of cultivation, in only a few locations or are thought to be represented in our flora by only a small number of individuals. Although rarities account for a tiny percentage of the total plant biomass in Nova Scotia's wildlands, the number of species so designated is surprisingly large. Maher *et al.* listed 222 of this province's approximately 1500 vascular plants as rare.[1]

Various schemes have been devised to quantify degree of rarity. Argus and Pryer[2] considered forty-five of our native vascular plants to be rare in Canada and gave each a conservation priority ranking from #1 (extreme risk) to #5 (little risk). To date, COSEWIC (Committee on the Status of Endangered Wildlife in Canada) has assigned status (i.e., endangered, threatened, or vulnerable) to nine native Nova Scotia plants—Eastern Mountain Avens,[3] New Jersey Rush,[4] Pink Coreopsis,[5] Thread-leaved Sundew,[6] Golden Crest,[7] Plymouth Gentian,[8] Sweet Pepperbush,[9] Water-Pennywort,[10] *Lilaeopsis.*[11]

ENDEMICS

The most noteworthy of our rare native plants are those species in which the entire population is restricted to a small geographic area. There are three widely accepted endemics in Nova Scotia. *Euthamia galetorum* (= *Solidago g.*) is a narrowleaved goldenrod which grows only on lakeshores in southwestern Nova Scotia but can be quite abundant. Eastern Mountain Avens, is found on Brier Island (District 810) and mountain tops in New Hampshire. The third is *Carex viridula* var. *saxilittoralis*, a diminuitive seashore sedge, also known from Brier Island and a few coastal locations in Newfoundland. A few other natives have been suggested as endemics, but their taxonomic status has been questioned (e.g., *Epilobium nesophilum* var. *sabulonense*, a willowherb unique to Sable Island (District 890), is now considered the more widespread *E. leptophyllum.* (*Amelanchier lucida*, a shadbush described from Nova Scotia and unknown elsewhere, is currently the topic of investigation).

Most of the rare plants in Nova Scotia are species at the edge of their range and are, indeed, quite common near the centre of their distribution pattern.

ARCTIC–ALPINE SPECIES

We have a number of Arctic–Alpine species which manage to compete only in the Cape Breton highlands (Region 200) or in coastal environments where conditions are severe.[12–17] These include the dwarf birches and willows, Arctic Blueberry, the tiny Moonwort Fern, Beach Senecio and Scurvygrass.[18]

COASTAL–PLAIN FLORA

Others are southerners which are likely to be found in somewhat more protected habitats. This group includes a number of coastal-plain disjuncts—species which grow primarily along the mid-Atlantic seaboard and in southwestern Nova Scotia but not in the northern states or New Brunswick.[3,9,14,20] These plants may have colonized Nova Scotia from vast offshore refugia exposed during maximum glaciation some 16–12 000 years ago. As the water returned to the ocean from melting ice, sea levels rose relative to the land. Some southern species were able to establish themselves on the newly exposed land adjacent to these refugia. Plymouth Gentian, Pink Coreopsis, water-pennywort (see Figure T10.12.1), Goldcrest, Redroot, Netted Chain Fern, Long's Bulrush,[21] Sweet Pepperbush,[22] Thread-leaved Sundew,[6] and Poison Sumac are rare representatives of this coastal-plain assemblage. Others in this group have become quite abundant and widespread in Nova Scotia, for example, Lance-leaved Violet, Bog-pink and Bog Huckleberry.

Other rarities in Nova Scotia are associated with very specific habitats; those that have become less common in the province or never were well represented in the province. The intervales, wooded floodplains along slow-moving rivers, have been much altered for agricultural purposes, for commercial and residential development and by the removal of hardwoods (American Elm and Sugar Maple). The few remaining undisturbed intervales are prime localities for Hepatica, Maidenhair Fern,[24] Wild Leek, Blue Cohosh and Canada Lily, among others. The Canada Violet and Ram's-head Lady's-slipper are known only from alkaline soils like those in the gypsum areas around Windsor, a relatively scarce habitat in the province.

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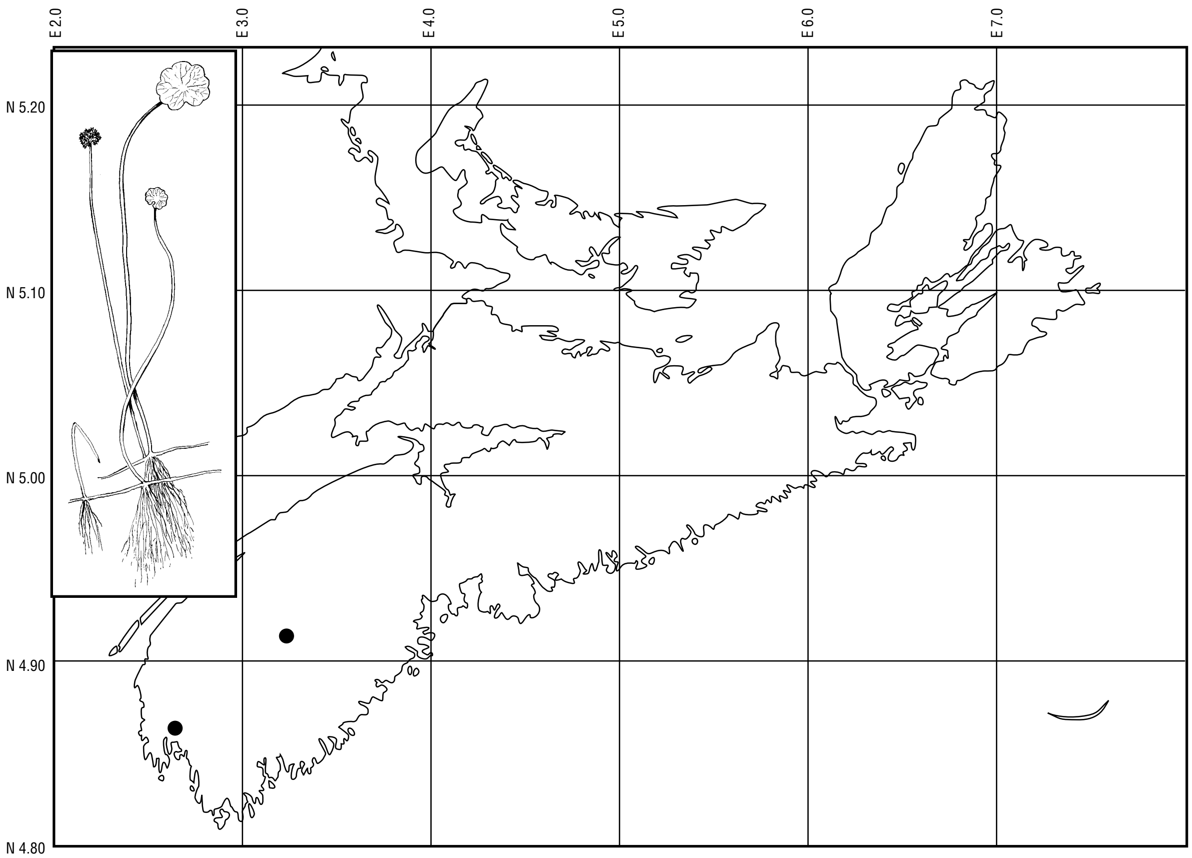

Figure T10.12.1: Records of the rare Water-pennywort[26] This coastal-plain species is classified as endangered under COSEWIC. It grows on edge habitats, wet/gravelly margins of lakes.

Many of the new records of plants in Nova Scotia published recently must be assumed to be rarities, as the flora of this region has been well studied for such a long time (e.g., *Isoëtes prototypus* Britton is a new species to science described from three Nova Scotia lakes).[25]

PROTECTION

At present, rare plants are protected in Nova Scotia only when they grow in a park or a nature reserve (as designated under the Special Places Protection Act of the Nova Scotia Legislature 1980). However, they are given serious consideration in the environmental assessment process. *An Atlas of Rare Vascular Plants in Nova Scotia* has been compiled from existing herbarium records.[26] This has already been very useful in assessing upcoming projects. Probably the most intensively studied subject in this context is Thread-leaved Sundew and the proposal to extract peat from Swaines Road Bog near Barrington (Unit 841), Shelburne County.[27,28]

There appears to be acceptance, from both the general public and government, that biodiversity must be preserved. The issue is addressed in "A Sustainable Development Strategy for Nova Scotia," a report from the Nova Scotia Round Table on Environment and Economy. In addition to potential future commercial uses, it is stated that "there are moral, aesthetic, cultural, educational, recreational and purely scientific values associated with wild materials ... Preservation of Nova Scotia's biological diversity means adequate representation of all its species, habitats and ecoregions." These views are supported by "The Convention on Biodiversity" adopted by the Rio Convention in May 1992, which is currently being developed as a strategy for Canada.

ADDENDA

In addition to the academic literature on rare plants in Nova Scotia, there is a growing body of interpretive material aimed at laypersons.[29,30] The Nova Scotia Museum of Natural History has produced a series of Species Status Sheets on taxa of special concern. A number of rare plants are included in the fifty sheets now in various stages of production. The exhibition "Rare for a Reason," which includes numerous plants, opened in 1993 and has travelled throughout the province.

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Associated Topics
T4.2 Post-glacial Colonization by Plants, T10 Plants, T11.18 Rare and Endangered Animal Species

Associated Habitats
H3.5 Water's Edge Lotic (Rivers and Streams), H3.6 Water's Edge Lentic (Lakes and Ponds), H4.1 Bog, H5.3 Cliffs and Banks, H6.1 Hardwood

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