T12.1 COLONIZATION BY PEOPLE

The story of habitation in Nova Scotia extends over 11,000 years and is known from oral and written history. It is also known from physical evidence of human activity in the landscape: buildings, roads, managed land, etc. In order to interpret the landscapes of today, we need to understand the history of human settlement and land use.

Distinct periods of history have been dominated by specific cultures that have interacted with the land in individual ways. This topic identifies the main periods during which human interaction with the landscape has changed significantly. It provides the temporal framework for the subsequent topics, which discuss the evolution of the use of resources in Nova Scotia.

Figure T3.3.5 in T3, Landscape Development, shows the correlation between climatic changes and human settlement. Refer to the *Historical Atlas of Canada* series[1,2,3] for a more comprehensive interpretation of human colonization of Nova Scotia.

11,000–10,000 BP: PALEO-INDIANS

By 11 000 years ago, the glacial ice had all but disappeared, and a tundra environment prevailed (see T3.3 and T4). The earliest-known inhabitants in Nova Scotia were peoples we now call Paleo-Indians. Excavations at Debert (District 620) have uncovered one of their campsites. (Others, as yet unexcavated, are known from this area.) This camp was situated on a high knoll overlooking the tundra, with a freshwater spring to the north, good drainage and a view of the Caribou winter-migration route into the Cobequid Hills (Unit 311). Analysis of blood residues on a blade from the Debert site shows three overlapping smears of caribou blood. These people may also have hunted other large mammals, such as mastodon and bear.

Following this period, the environment underwent rapid change (see T3.3). In all likelihood, a temporary readvance of glaciers forced the first peoples of the Maritimes to abandon the region.

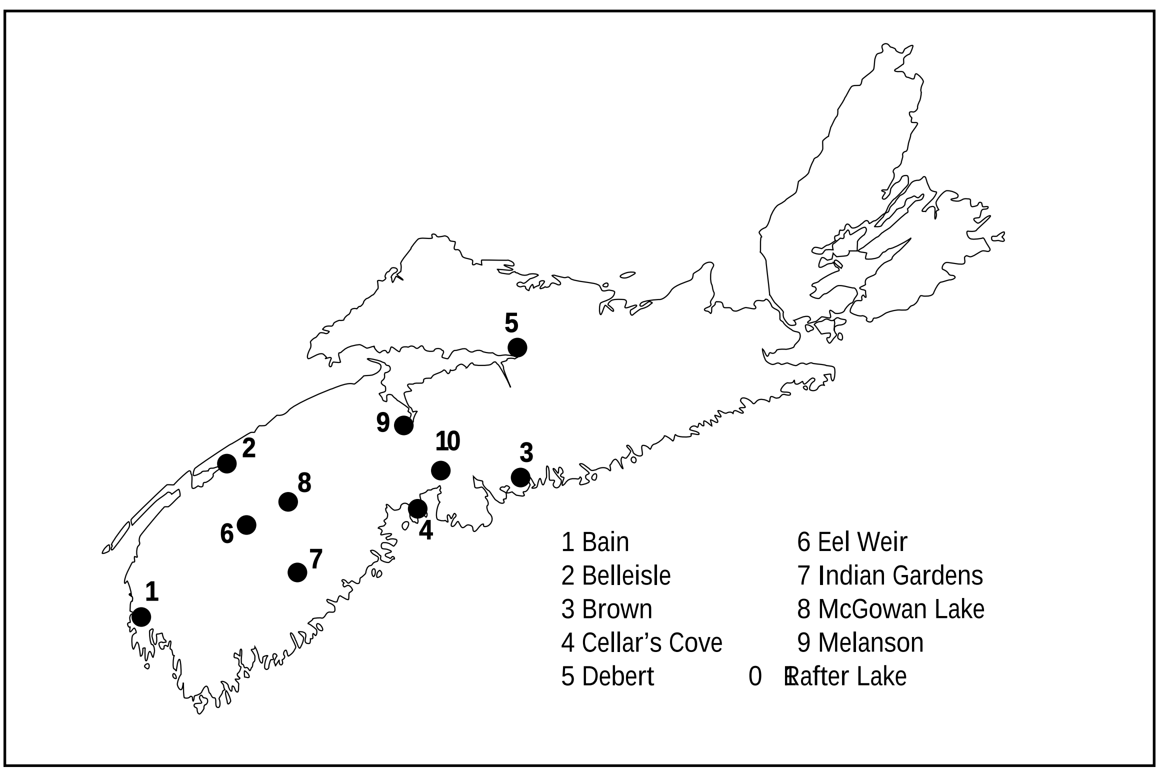

Figure T12.1.1: These sites represent the main Ceramic Period sites that have been excavated and reported in Nova Scotia. Adapted from Davis, 1991.[4]

10,000–5000 BP: THE GREAT HIATUS

There is no archaeological evidence that Nova Scotia was inhabited between 10 000 and 5000 years ago. A rapid increase in temperature and subsequent rise in sea level during this period may have obliterated evidence of any habitation. One archaeological theory proposes that Nova Scotia was occupied by people settled along coastlines that are now under water.

5000–3500 BP: THE ARCHAIC PERIOD

The major regional culture during this period, the Maritime Archaic Tradition (5000–3500 BP) was characterized by large woodworking tools of stone, made by grinding as well as flaking. These were probably used in the manufacture of dugout canoes. These people were taking Swordfish, a deepwater fish that can put up a good fight. Draggers in the Bay of Fundy and along the north shore of Prince Edward Island have brought up artifacts that might be stone knives and implements from this period.

A culture known as the Susquehanna Tradition (3500–2500 BP) originated in the mid-Atlantic States. Isolated finds related to this culture have been discovered in southwestern Nova Scotia. The artifacts suggest that new ideas or people came into Nova Scotia during this period.

2500–500 BP: THE CERAMIC PERIOD

Pottery and burial mounds, already tradition in other areas of North America, were introduced to Nova Scotia during this period. A burial mound (10 m across and dating to 2300 BP) has been uncovered in Whites Lake, Halifax County (Unit 851). Sites from this period are scattered throughout the province (see Figure T12.1.1).

500–100 BP: THE CONTACT PERIOD

Norse people reached the shores of Newfoundland and possibly Nova Scotia approximately 1000 years ago. There is no documented evidence that they colonized Nova Scotia. However, butternuts and butternut wood have been found in Newfoundland that can only have come from New Brunswick, Prince Edward Island or Nova Scotia. Portuguese and Basque fishermen were probably the first Europeans to establish a continuous connection with Nova Scotia, around 500 years ago.

The environment which the fishermen found, and in which the Mi'kmaq lived, was very different from today's. The only clearings in the forest were natural meadows, marshes and bogs or sections burnt over by forest fires. The Mi'kmaq harvested most of their food along the shores of the ocean and up inland waterways. They ate marine and land mammals, fish, birds and shellfish. Plants provided food, smoking material, shelter, medicine and implements. Mineral pigments were used as dyes.

The Mi'kmaq population was greatly reduced after contact with the Europeans and exposure to alien diseases. This coincided with a cultural change in Nova Scotia and subsequent increases in human impact on the landscape.

> *The name Mi'kmaq comes from their word "nikmaq", which means "my kin-friends." They used this word as a greeting when speaking to the newcomers from Europe, and it soon became associated with the speakers themselves.*

1605–1755: THE ACADIAN PERIOD

John Cabot's arrival in North America in 1497 and the lure of the cod fishery off its shores began a hundred years of European exploration and seasonal fishing on the banks by various nations trading with the Mi'kmaq (see T12.11). Europeans did not establish a permanent settlement north of the Gulf of Mexico until 1605, when the French, attracted by the opportunities offered by the fur trade and the fishery[5], erected a fort at Port Royal in the Annapolis Basin.

The military struggle between France and England delayed agricultural development in Nova Scotia. For several decades the Acadian population increased as more French people arrived to settle the land. The settlers dyked the extensive tidal marshes around the Bay of Fundy from the Annapolis Basin to the Peticodiac River in New Brunswick (see T12.7). The major population was concentrated along the Annapolis River, the Minas Basin and the Chignecto Isthmus.[6] The Acadians' use of tidal marshes for agriculture minimized their encroachment on forested areas.

The Acadian population continued to increase and extend into new areas. By the mid-1700s, it numbered as many as 10 000 people. They maintained their agricultural traditions and traded with the French fortress at Louisbourg and with New England. Most of the rest of Nova Scotia was wilderness, thinly occupied by Mi'kmaq.

1749-1867 : THE BRITISH PERIOD

The British regarded the Atlantic region more for its strategic military position and its fisheries than for its settlement potential. Colonization efforts were concentrated elsewhere until the capture of Quebec in 1759. In 1755, the British had deported the Acadians from the entire Maritime region, and with the capture of Louisbourg three years later, British control of Acadia was complete.

The nature of land settlement changed as the British gained control in Nova Scotia. Policies concerning settlement, granting of land and exploitation of resources were worked out by the British government. The colonial government assumed power to parcel Nova Scotia into land grants to encourage settlement. The years following the Acadian deportation brought an influx of European and American cultures to the province. Settlement continued along the coasts but also developed inland along routes established for trading or military use. Drumlins, recognized as areas with good soil, were cleared and farmed (see T12.4).

Vacated Acadian lands were settled through a migration of New Englanders, or Planters as they were then described, who established farming townships from the Chignecto Isthmus to the Annapolis Basin. The Digby shore and Cheticamp in Cape Breton were settled by the Acadians who remained after the deportation. Beginning in 1764, many Acadians returned and were given lands in southwestern Nova Scotia.

Between 1725 and 1763, the British and Mi'kmaq signed a number of treaties to allow for British settlement and the preservation of Mi'kmaq hunting grounds.

The American Revolution and the influx of Loyalist settlers changed the relationships between the European settlers and the Mi'kmaq. The pattern of British settlement greatly interfered with traditional native hunting and migratory habits. In 1783, lands were granted to the Mi'kmaq along coastal routes

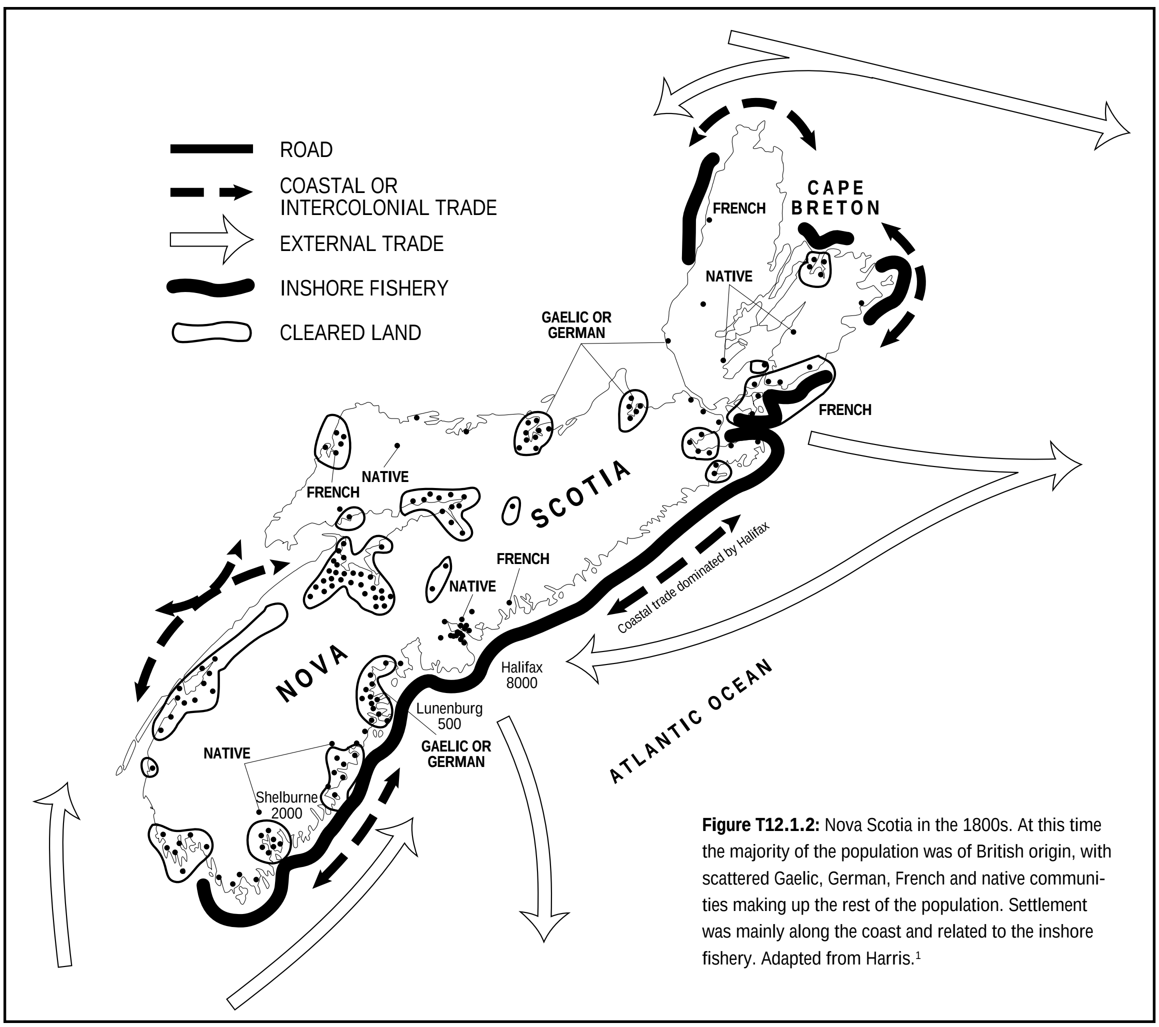

Figure T12.1.2: Nova Scotia in the 1800s. At this time the majority of the population was of British origin, with scattered Gaelic, German, French and native communities making up the rest of the population. Settlement was mainly along the coast and related to the inshore fishery. Adapted from Harris.[1]

and rivers in recognition of their traditional occupation of the land.

A major migration of Europeans to Nova Scotia occurred in the 1770s and early 1800s, when large numbers of Highland Scots and Irish immigrated to eastern Nova Scotia. Approximately 17 000 of these immigrants settled lands on Cape Breton Island. Upland areas were generally settled by later immigrants, as the more desirable lowland locations had already been occupied by earlier settlers.

By the late 1820s, large-scale coal mining had begun in Pictou and Sydney (see T12.3). This marked the beginning of the industrial era in Nova Scotia and resulted in many small communities scattered across the province in areas rich in mineral deposits. Settlement and clearing continued relative to exploitable resources. The necessary buildings and roads were built to harvest or process resources, and towns developed where industries grew from resources, such as the large lumbering and shipbuilding industry in Lunenburg (see T12.10).

Transportation routes developed rapidly in the nineteenth century, as trails turned into tracks, dirt roads and then into the "great roads" linking main communities.[7] These "highways" led out of Halifax to Windsor and Truro, connecting with smaller roads and providing access to more remote areas of the province. The roads followed ancient canoe and portage routes used by the Mi'kmaq, linking the Minas Basin and Cobequid Bay with Chebucto Harbour (see Figure T12.1.2). The first train ran between Halifax and Windsor in 1856, following the road and increasing commercial transport. As technology developed, populations expanded and access routes opened up, the human imprint on the landscape continued to progressively broaden into the twentieth century.

THE TWENTIETH CENTURY

During this century, land use in Nova Scotia has been heavily influenced by resource industries and development, and landscape modification has continued to reflect local and international markets and economies. The World Wars altered the population structure in the province. Rural communities fluctuated, and population growth increased around urban centres such as Halifax. The advent of paved roads and then highways increased our ability to develop new areas of land.

At the end of this century, less land is now farmed; consequently, former farmlands have regenerated into forests (see H5.3). Coastal communities, once dependent on the fisheries, now look to tourism as a resource. Immigration to Nova Scotia continues with European, American, African, Asian and South American cultures contributing to the province's diversity.

Our modern settlement patterns have evolved from those of the previous century as depicted on historical maps of land grants. The overall pattern of development is much the same as in the last century, with large areas of land in the interior of the province undeveloped and used mainly for primary resource management, wildlife management or recreation.

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Associated Topics

T3.3 Glaciation, Deglaciation and Sea-level Changes, T4 Colonization, T12.2–T12.11

Associated Habitats

H5.3 Oldfield

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T12.2 CULTURAL LANDSCAPES

This Topic defines "cultural landscape" and outlines a classification system for Nova Scotia based on the principles of landscape ecology. The purpose is to demonstrate that all landscapes are a visual manifestation of integrated natural and cultural elements and processes and can be classified according to the ratio of these components. In this text, the term "landscape" implies a structurally distinct land mass varying in size that can be subdivided into ecosystems and habitats.

DEFINING THE CULTURAL LANDSCAPE

The phrase "cultural landscape" is used by geographers to define the interaction of humans with their environment. When viewed from an airplane, landscapes appear as a relatively homogenous matrix interrupted by patches and corridors. Some of these patches and corridors, e.g., forests and streams, are distinctly natural, while others, e.g., towns and roads, are predominantly man-made. The ratio of natural to human elements determines the nature of the landscape. For instance, we often use the term "urban landscape" to describe an area that is predominantly developed, such as the Halifax-Dartmouth area. Elements of "natural" forest, such as park land, may make up components of the overall landscape, but its structure and function are generally maintained by human influence. Likewise, a "natural or wilderness landscape", such as Kejimkujik National Park, may contain elements of human infrastructure, e.g., logging roads; however, it is considered a predominantly natural landscape.

Technically speaking, the cultural landscape is distinctively artificial and can be recognized by its appearance or structure.[1] The visible modification of the landscape often reflects the resources available in the area, e.g., the Sydney coal field or the Acadian dykelands of the Annapolis River.

It is also important to recognize more subtle cultural influences, such as the acidification of fresh water, that might have less immediate impact on the look or structure of a landscape and more of a long-term effect on the function. Using this principle, there are relatively few parts of Nova Scotia that have not to some degree been altered by humans. Our cultural landscapes are the result of cultural interactions with resources over time.

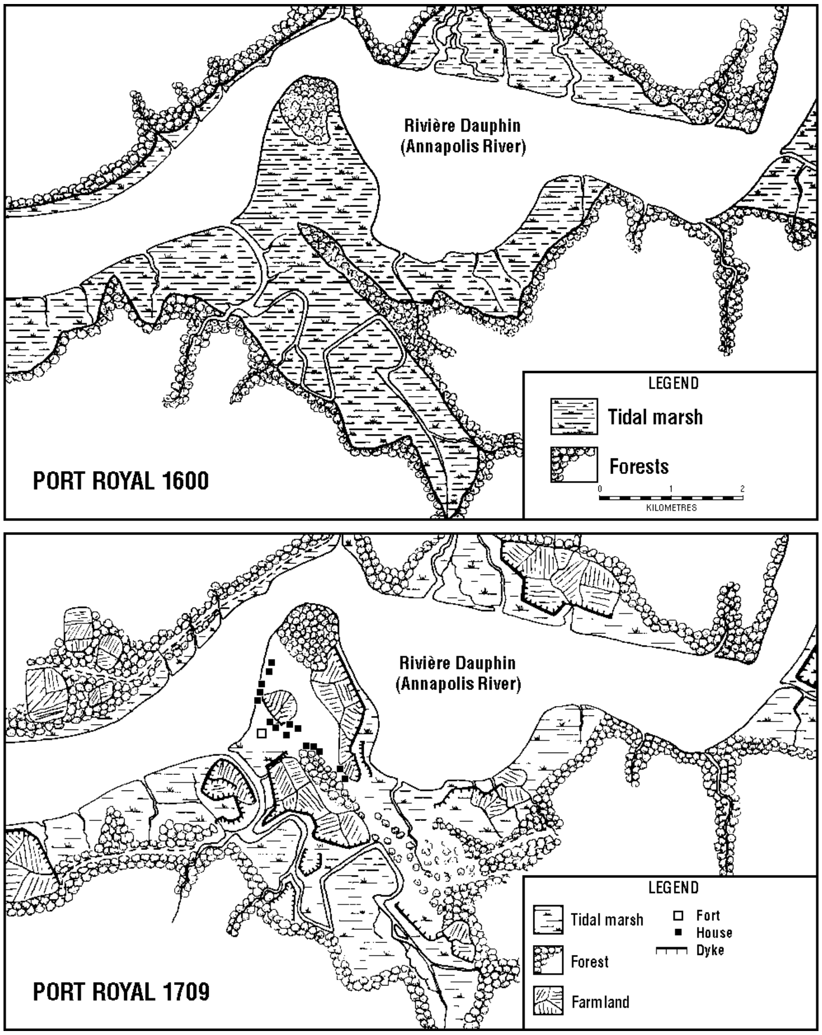

Figure T12.2.1: Plan view of cultural changes in the landscape between 1600 and 1709. A comparison of the natural tidal marsh and forest at the future site of Port Royal and the cultural landscape 100 years later shows the result of early European settlement. The conversion of tidal marsh to farmland is still evident at Annapolis and other coastal areas in the Bay of Fundy (District 610) today (see Plate T12.7.1).

A LEGACY OF CHANGE

On a geological time scale, humans have actually been a tangible factor in the evolution of Nova Scotia's landscapes for only a very brief time. (See Figure T3.3.5). However, during the last 10,000 years, we have interacted with biotic communities, influenced natural succession and modified the physical environment to various degrees.

The degree to which humans can alter the landscape relates to prevalent cultural values, technologies that allow us to access resources and the ratio of people to the resources. Native people, who were relatively few in number, developed a culture based on subsistence living. They were aware of the limitations of resources and accommodated their activities to fit within those limitations. European settlers were able to modify their landscape to a greater degree, but in relative terms they were also limited by available technology. Colonial settlement patterns in Nova Scotia were directly influenced by physical environment and proximity to resources (see Figure T12.2.1). Settlers tended to congregate around water, leaving relatively large uninhabited areas. Settled areas were modified for defense and aesthetics, as well as for survival. As new technologies and values were introduced to Nova Scotia through different cultures, more and more of the "natural landscape" was modified. The degree of modification increased proportionately to technological capabilities, changing values and population growth.

APPLICATION OF CULTURAL LANDSCAPES IN THE *NATURAL HISTORY OF NOVA SCOTIA*

The influence of culture on the landscape is reflected in the changes to its natural evolution. In the *Natural History of Nova Scotia*, Topics introduce the reader to the processes that create change in the landscape: formation and erosion of bedrock, glaciation, ocean currents, plant succession, etc. They also define the landscape features of which Nova Scotia is composed—drumlins, fields, coastal bays, forested uplands, etc.—and the elements such as plant and animals species. The systems that compose the landscape evolve naturally towards a steady successional state (see T10.2). Interruptions, such as fire, storms or other large-scale natural disasters, can radically alter the successional process. A mature system might now revert to an early-successional stage.

Ecologists define these changes as site history—what has happened to create the system that is there now. The cultural processes of land use are equally responsible for changing or maintaining a system in a certain successional stage. The obvious example is clear cutting a forest, which will generally return the system to a primary-succession stage. Human activity can also accelerate succession, for example, eutrophication of a lake (see T12.8). There are many variables involved when measuring the changes—geographical location, availability of seeds and nutrients, climate, etc. In *Volume 2, Theme Regions*, the association between physical environment and bi-

Plate T12.2.1: Windsor in two centuries. This similar view of Windsor from Ferry Hill shows how the landscape has changed since 1817. A reproduction of a watercolour painted by J.E. Woolford (*right*) depicts the military block house, docks and farmlands as the dominant cultural features. In 1995 (*facing page*) the block house is barely visible behind a residential and commercial built environment. Historical Plate: Nova Scotia Museum, Museum Services Division. Photo: A. Dauphinee otic communities changes according to where you are in the province and the history of the area. For instance, pine tends to be the colonizing species in oldfield regeneration in southwest Nova Scotia, while White Spruce is the typical colonizer in most of the rest of the province (see H5.2).

Cultural processes are thus tangible factors in the shaping of the landscape. Cultural components, like natural ones, can be organized as features and processes. For example, resource uses, such as forestry, fishing, mining, farming and park development, are processes. They contribute to the evolution of the landscape by influencing the natural processes. Resource uses can be categorized as industrial, recreational, commercial, institutional and residential patches and corridors or features in the landscape. Elements can be broken down into individual houses, people or introduced plants and animals. These features, elements and processes also have regional variations that relate to settlement patterns in the province and can be overlain on the *Theme Regions*.

CLASSIFYING CULTURAL ACTIVITY IN THE LANDSCAPE

On a large scale, it is possible to define cultural regions in Nova Scotia. These areas tend to be a reflection of historical settlement patterns, where distinct cultures left deep imprints in the landscape (see T12.1). We tend to identify certain areas with distinct cultures, and we recognize these cultural landscapes in our naming of areas or routes: the French Shore, the Ceilidh Trail, Glooscap Fault. Elements of these cultures are interpreted in historical settings, such as at Annapolis Royal, the Highland Village and Louisbourg. The heritage parks are a spatial documentation of cultural history and human interaction with resources. They indicate that distinct cultural landscapes can be defined and that cultural changes can be interpreted from the landscape patterns, that is, the matrix of patches and corridors. By interpreting the composition of the pieces over time, it would be possible to see how the landscapes have changed and to relate this to different types of resource use (see Plate T12.2.1).

It is more difficult to define cultural history in the landscape when history and ecology blend together into heterogeneous areas without distinct divisions. However, it is generally possible to distinguish between cultural features, such as buildings, roads and reservoirs, and natural ones, such as forests, streams and coastal bays. Using this method, the landscape can be defined by the ratio of natural to cultural (see above—Definition of Cultural Landscape). However, in some cases it is not easy to classify a feature as natural or cultural. For instance, a reservoir is very similar to a lake in many ways and a forest can be managed. Which is natural and which is cultural?

"One of the tasks of landscape ecology is to understand the relationships of these heterogeneous components [in the landscape] including man and his works."[2]

Ecology studies the transfer of energy through systems and defines ecosystems based on their function. In his book *Ecology And Our Endangered Life Support System,* [3] Eugene Odum proposes a landscape-ecology approach to categorizing ecosystems, based on the type of energy used to maintain their function.

ENERGY-BASED CLASSIFICATION OF ECOSYSTEMS

This classification system broadly divides the landscape into three environments—developed, cultivated and natural. Using Odum's model, these environments can also be categorized as fuel-powered (both renewable and nonrenewable fossil fuel and human power), subsidized solar-powered and solar-powered. Odum demonstrates his model at the ecosystem level because this unit is traditionally defined by energy transfer in ecology. However, the model is applicable to both the landscape and the habitat level, using the ratio method for defining a landscape. For example, a cluster of developed ecosystems would be a developed landscape, and most of the habitats would also be developed; that is, they also would depend on fuel power from human input to exist. The model can apply to any level as long as the approach is consistent.

Ecosystems that depend entirely or mostly on imported energy to function, such as urban centres, are developed or built environments. These systems tend to produce more waste than they can absorb. Cultivated systems include farmland and managed woodlots, which are partly solar-powered and partly dependent on imported fuel energy. These are generally resource-management areas. Self-supporting systems, such as the ocean or the Taiga forest in Cape Breton Highlands National Park, which depend primarily on solar power, are natural systems.

To apply this model scientifically, one would need criteria for measuring the energy type in each system. However, as a simplistic model, the three categories demonstrate that the landscape can be classified in a way that accounts for cultural and natural distinctions and their interaction. Also, the cultural landscape can be organized in much the same way that we organize the hierarchy of natural land—habitat–ecosystem–landscape—in the *Natural History of Nova Scotia*.

Natural systems provide life support and biodiversity; cultivated systems provide that and the production of resources; developed systems provide shelter. Sustainable approaches integrate these three categories in healthy landscapes. We need to determine the balance desired in Nova Scotia—the optimum amount of spatial and functional change. The optimum matrix sequence changes through time. It is important to have the landscapes classified so we know that they are changing and can measure that change for both humans and natural resources.

CULTURAL HABITATS

The document uses the habitat as a manageable unit of classification, to demonstrate how processes and elements function together. The habitat can usually be defined on aerial photographs or maps as distinct polygons. The following is an inventory of cultural habitats in Nova Scotia. The list is incomplete, serving as an example of the classification method. The habitats are categorized according to whether they are developed or cultivated. Notice that both categories contain both natural and cultural elements. The ratio of elements defines the structure or appearance of the habitat. The function is defined by the energy used to maintain it. This relates to the type of resource use involved. As soon as the activity is abandoned, such as an old quarry or naturally regenerating clear cut, the habitat is considered to be natural, because the primary energy input is solar. That is why the oldfield habitat (H.2) is included in the natural habitats. The natural habitats are defined in the Habitats section that follows in the Topics section of the *Natural History of Nova Scotia.*

CHARACTERISTICS OF CULTURAL HABITATS

The general characteristics of cultural habitats are as follows:

1 They are often unstable and, if not maintained by human activity, would be the first stage of succession towards a naturally occurring vegetation and habitat type (see T10.2). In very disturbed areas, this may be a long process.
2 The conditions that occur are special and can be tolerated by relatively few species, which may be present in large numbers.
3 The habitat may be occupied primarily by introduced species (see T12.10 and T12.11) as opposed to native species. These may be cultivated species, escaped species or species that are normally found only in association with human activities.
4 Primary production may range from very low in areas with low nutrient, light and moisture levels to high in areas with artificial nutrient

enrichment and adequate light and moisture levels.

5 The site may be degraded in an ecological sense by continued disturbance and the removal of nutrients through erosion and harvesting of crops.

DEVELOPED HABITATS

Buildings and Furnishings: These habitats are dominated by built structures requiring constant fossil-fuel-energy input. The habitats provided within domestic and industrial buildings provide food and shelter for a variety of fungi, arthropods, mammals and birds. These species mainly utilize stored food and organic materials in clothes and furnishings. Because of low light levels in buildings, there is normally low primary production, unless indoor plants are used. The animal species include those with long human associations, such as the house mouse and silverfish, as well as species that are parasitic on humans or domestic animals, like fleas and bed bugs. These species may be sufficiently abundant that they cause economic loss or become health hazards and need to be controlled as pests.

Disturbed Land (gravel pits, transportation routes, waste grounds): The active removal or disturbance of soil produces conditions intolerable for the majority of plant and animal species. The absence of soil results in dry, nutrient-poor conditions; the absence of vegetation, particularly trees, allows for extremes of temperatures and exposure to light and wind. Some hardy plant species are able to colonize this hostile environment, e.g., Coltsfoot and Plantain. Cultivated habitats, such as ponds and drainage ditches (see below), are often associated with transportation routes.

If the site is abandoned, a slow succession will eventually provide a more diverse and dense cover of mainly introduced plants. Eventually shade-intolerant trees such as Chokecherry, and Wire Birch, will become established on the site (see H6).

CULTIVATED HABITATS

Marine Docks and Pounds: The quality of the seawater may be affected by chemical or thermal pollution or concentrations of organic waste, and this may limit or enhance the occurrence of some species. The normal marine plankton, nekton and benthos communities prevail in the absence of these pollutants. On wharves, the appropriate pattern of intertidal zonation will be well defined on vertical structures. Submerged structures will have the same benthic community as rock bottoms (see H1.2 and H2.1).

Water Conduits: The seawater intakes and outfalls of thermal and tidal electricity-generating stations, industrial plants and sewage treatment plants will be colonized by benthic epifauna. As there is no light, plant life does not exist, and the animal species assemblage is mainly limited to particulate-feeding types, such as Blue Mussels and barnacles (see T11.17). These species may become sufficiently abundant to reduce water flows, and they need to be controlled by chlorination and other techniques. In fresh water, fouling by organisms is not a regular problem. Crustaceans and oligochaete worms, such as *Tubifex*, may occur (see T11.16).

Reservoirs and Canals: These are basically freshwater lake and stream habitats (H3) but subject to unnatural seasonal water-level changes. The most significant ecological change is hypolimnetic withdrawal or the removal of bottom water. The shallow-water (limnetic zone) flora and fauna are often poorly developed, but these habitats may be biologically active. Good examples are the dam and canal systems of Gaspereau River (Units 422 and 451) and Wreck Cove hydroelectric systems (District 210).

Ponds and Drainage Ditches: These are small bodies of water, often with marked seasonal variations in water level, having most water in the spring (vernal ponds). They may be subjected to nutrient enrichment or concentrations of road salt and herbicides and the margins are often trampled by cattle. These are basically pond habitats, subject to vegetation succession and progressive infilling (H3.4, H3.6). Roadside ponds created during highway construction often support large populations of amphibians due to the lack of aquatic predators (fish) and the warm temperatures, and have helped to disperse some species to areas where they were not previously found. Due to isolation and disturbance, aquatic invertebrate fauna may be poor. At one time, there were many ponds established for sawmills, but few now remain. There are, however, many farm ponds and impoundments on tidal marshes that provide important wildlife habitat (see T12.8). Some ponds are artificially stocked with fish (see T12.11).

Fields under Cultivation: The objective of agriculture is to control the nutrient, moisture and light resources of land to produce a desired crop species.

This process involves cultivation of the land, use of fertilizers, seeding, application of herbicides to control competitive plant species (weeds), application of fungicides and pesticides, control of moisture (such as dykelands) and harvesting. The main crop species is often accompanied by other hardy plant species, usually introductions, and the habitat may be used by various species of wildlife as a source of food and shelter. When abandoned, the successional process to oldfield (H.2), forest (H6) or tidal marsh (H2.6) begins. Dykelands in Nova Scotia are interesting examples of the change from natural to cultivated habitat and back again. The process that maintains the function and structure of a tidal marsh is one of the most uncontrollable forces that humans have to contend with. This is the twice-daily flooding of tidal areas (see T6.1). Managed dykeland quickly reverts to tidal marsh when the sea breaches the dykes that enclose the marsh. If these dykes are not constantly maintained, the vegetation will soon return to salt-tolerant species (see T12.7).

Orchard: The characteristics of this habitat are similar to those of fields under cultivation, but the species in the monoculture are trees. The ground flora is generally composed of grasses and introduced meadow plants. Domestic animals may be grazed amongst the trees and beehives are common. This habitat type is particularly common in the Annapolis Valley (Unit 610).

Pasture: Pasture is maintained grassland habitat used as a feeding area for cattle, horses, sheep and goats. Dry upland or wet lowland pasture will be used for the most suitable animals. This habitat needs to be maintained through grazing or removal of shrubs, otherwise it will rapidly revert to forest through the oldfield succession. Apart from the effects of a concentration of grazing animals, which include fertilization and compaction of the soil through trampling, the pasture habitat may be in relatively natural state and utilized by native plant and animal species like American Robin (see T11.3), as well as the introduced species.

BETWEEN CULTIVATED AND DEVELOPED

Parks, Gardens and Greenhouses: These are examples of sites with intensive human management and control of conditions. Shade, fertilization and moisture are manipulated to maintain growth of nonnative plant species. However, such habitats are susceptible to unwanted plants (weeds) and animal species, which need to be actively controlled. Furthermore, garden slugs, earwigs, sowbugs and other invertebrates are all introductions which thrive well in the conditions made available in this habitat. Control of pest species is often through the use of herbicides, fungicides and pesticides. Colonization by some plants, such as lichens, may be limited by air pollution in city centres.

Quarries: Active quarries, in which the rock face is continually being blasted and removed, provide a very sterile habitat. In formations where the rocks are fossiliferous, however, there is a constant supply of raw material exposed. Where a quarry is abandoned, it continues as a cliff habitat (H5.3), eventually becoming colonized by plants and animals according to the conditions of height, rock type and aspect (north-facing slopes tend to be cool and moist, south-facing slopes dry and hot). Progressive weathering and rock fall will result in the accumulation of a talus slope (H5.4).

Mines and Tunnels: Active mines and other tunnel structures often have carefully regulated conditions that do not favour colonization by plants and animals. The absence of light prohibits the growth of green plants. Following abandonment, the tunnel will change to a cave habitat (H5.5). Percolating water and decomposing timbers will result in the formation of a thin soil. This soil will become colonized by fungi and soil animals, particularly where there is enrichment with nutrients and organic material from the droppings and carcasses of animals using the tunnel as a hibernaculum. Old mines deep or long enough to have a stable temperature and humidity regime throughout the year are potential hibernacula for bats.

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Associated Topics
T3 Landscape Development, T6.1 Ocean Currents, T10.2 Successional Trends in Vegetation, T11.3 Open-habitat Birds, T11.16 Land and Freshwater Invertebrates, T11.17 Marine Invertebrates, T12.1 Colonization by People, T12.7 The Coast and Resources, T12.8 Fresh Water and Resources T12.10 Plants and Resources, T12.11 Animals and Resources

Associated Habitats
H1.2 Benthic, H2.1 Rocky Shore, H2.5 Tidal Marsh, H3 Fresh Water, H5.2 Oldfield, H5.3 Cliff and Banks, H5.4 Talus Slope, H5.5 Cave, H6 Forests

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T12.3 GEOLOGY AND RESOURCES

The diverse geology of Nova Scotia, which began to form over 1.2 billion years ago (see Figure T2.1.1), spans a wide range of rock types and has benefited its inhabitants ever since humans first entered the landscape. Local use of geologic resources by native cultures and early Europeans developed into extensive commercial exploration and export when the French and English settled here permanently. Many of Nova Scotia's contemporary urban areas were settled as the result of one form of mining venture or another.

The exploration and development industrial sector is still active in Nova Scotia and has expanded to include the offshore. In addition, fossils have become a significant resource for tourism and education. As with the other primary-resource sectors in Nova Scotia, the history of mining is evident in the landscape. "During the process of exploitation, all coalfields are inevitably modified and refashioned by mining activity. Even when virtually all this activity takes place underground ... the scale, longevity and ubiquity of the mines and their accompanying communities ensure a thoroughly altered landscape."[1]

What follows is a brief synopsis of how Nova Scotians have used land-based and offshore geologic resources. (Aggregate use is discussed in T12.4.)

HISTORICAL CONTEXT

Pre-European Contact

The Mi'kmaq and their ancestors acquired an impressive knowledge of the geology of their land by using rocks and minerals to develop one of the first technologies—the working of stone. Using multiple techniques and materials, they made tools, weapons and ornaments, and the rock faces themselves were a medium for their art. The most commonly used rocks were quartz varieties from the North Mountain area of Kings County (District 720), such as chert, chalcedony, jasper and agate. Ancestors of the Mi'kmaq exported materials all over the province and the eastern seaboard. (Archaeologists suggest that people came up from Maine and other parts of the Maritimes to the Scots Bay area of Nova Scotia on collecting trips.) Scots Bay was, in essence, a factory where materials were collected, and tools and weapons were roughed out and mass-produced. The active erosion here results in an abundance of materials suitable for flaking, such as chalcedony, jasper and agates. Harder igneous rocks were generally used to make implements that required a continuous cutting or grinding edge.

Native copper, associated with quartz, was also collected and worked into tools, weapons and ornaments. Cape d'Or, Cumberland County (District 710), is recognized as one of the more prominent copper-mining areas. Mineral pigments, such as iron oxide (red ochre) and black manganese, were extracted from rocks found in small, localized deposits around the province.

1600–1700: COPPER, IRON AND COAL

The commercial importance of minerals to Nova Scotia increased with the establishment of colonies in Acadia. Champlain believed that rich copper deposits were to be found in "Le Bassin de Mines."[2] Samples of copper and iron materials found at Cap d'Or and St. Marys Bay were taken back to France in the early 1600s as proof of the great prospects for colonization, in a pitch to raise money for permanent settlement in Port Royal.

Early mining history by colonials focused on the coalfields found in the Sydney basin (Unit 531) on Cape Breton Island. Smugglers mined the outcroppings along the shore and shipped coal to New England long before Cape Breton mineral grants were awarded by France in 1654.

1700–1800: COAL AND GYPSUM

Cape Breton near-surface coal was the first coal to be mined in Canada by regulated mining methods. The early mine operations and accompanying settlements were generally ephemeral, but, although the pits were small and short lived, they were numerous. Along with the many bootleg pits, the overall impact of surface mining on the landscape in the vicinity of the croplines was considerable.[1]

North America's first reports of gypsum, or plaster rock, mining occurred in Nova Scotia around 1770. Hants County farmers were the first to quarry gypsum in the Till Plain District (510) of the Carboniferous lowlands.

Around the same time, coal mining was recorded in Cumberland County at the "old French workings" in Joggins (Unit 522). More coal was discovered along the East River in Pictou County in 1798, and in less than ten years, a coal mine was established and began production.

1800–1900: SALT, IRON, COAL, GOLD, BARITE, COPPER, ANTIMONY, MANGANESE, LIMESTONE AND DOLOMITE, GYPSUM

Salt occurs in most of the Carboniferous deposits in Nova Scotia. The first mention of salt mining occurred in 1813 at Salt Springs, Pictou County (sub-Unit 582a). A few years later, in 1826, mineral rights were first issued, when the Crown granted Frederick, Duke of York, the right to all minerals in the province. Iron was mined in Annapolis County at the Nictaux-Torbrook deposit (sub-Unit 422b) in 1829. During the relatively short life of iron mining in Nova Scotia, four blast furnaces were operated. Iron production ceased in 1908.

The first mine shaft was sunk on the Sydney mine coal seam in 1830, beginning Cape Breton's history of underground coal mining. Mining operations became concentrated at a small number of large, deep and often submarine mines, resulting in more permanent impacts on the landscape.[1] Although strip-mining had a more immediate visual effect, it tended to be confined to the vicinity of the operation. The landscape changes related to underground mining extended beyond the operation periphery to permanent settlements and related industries. The operation itself generated large quantities of excavated rock, which were often disposed of on the shore and dispersed by wave and tide action.

The first authenticated discovery of gold was made in 1858 at Mooseland, Halifax County (sub-Unit 435a). Another discovery, in 1860, triggered Nova Scotia's first gold rush. Shortly after, there was a rash of gold discoveries in the Goldenville Formations associated with the Meguma rocks of the South and Eastern Shore areas. There were approximately sixty small working gold mines, including Tangier (Unit 834), The Ovens (Unit 832), Wine Harbour (Unit 842), Sherbrooke (sub-Unit 413b), and Waverley and Mount Uniacke in sub-Unit 413a. Gold ore was milled at thirty-four gold mills, twelve of which were powered by water.

In 1865, the earliest reported mining of barite in Canada occurred in Colchester County at the

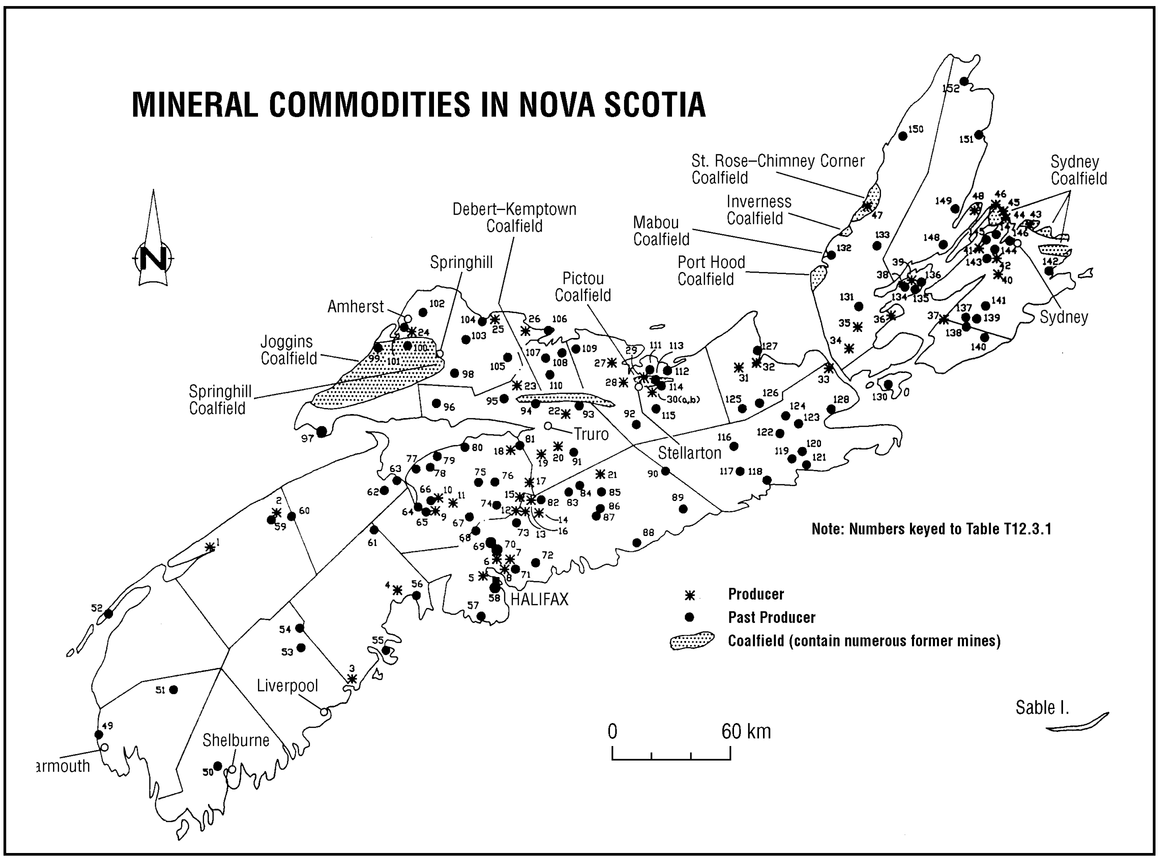

Figure T12.3.1: The distribution of producing mines and quarries as of September 1994. Past producers are also identified.
Compiled by: Land Use Group – Mines and Minerals Branch, Nova Scotia Department of Natural Resources.

T12.3
Geology and
Resources

	LOCATION (common deposit name)	COMMODITY
1	Parker Mountain, Annapolis County	Aggregate
2	Nictaux, Annapolis County	Building Stone
3	Middlewood, Lunenburg County	Aggregate
4	Chester Grant, Lunenburg County	Aggregate
5	Halifax, Halifax County	Aggregate
6	Waverley, Halifax County	Aggregate
7	Dartmouth, Halifax County	Aggregate
8	Dartmouth, Halifax County	Aggregate
9	Wentworth Creek, Hants County	Gypsum, Anhydrite
10	Miller Creek, Hants County	Gypsum
11	McKay Section, Hants County	Gypsum
12	Elmsdale, Hants County	Aggregate
13	Lantz, Halifax County	Clay
14	East Milford, Hants County	Gypsum
16	Shubenacadie, Halifax County	Clay
17	Milford Station, Hants County	Shale
17	South Maitland, Hants County	Limestone
19	Brookfield, Colchester County	Limestone
20	Upper Brookfield, Colchester County	Barite
21	Upper Musquodoboit, Halifax County	Limestone
22	Manganese Mines, Colchester County	Limestone
23	Folly Lake, Colchester County	Aggregate
24	Nappan, Cumberland County	Salt
25	Pugwash, Cumberland County	Salt
26	Wallace, Cumberland County	Building Stone
27	Hardwood Hill, Pictou County (MacKenzie Quarry)	Building Stone
28	Westville, Pictou County	Coal
29	New Glasgow, Pictou County	Shale
30a	McLellans Mountain, Pictou County	Aggregate
30b	McLellans Mountain, Pictou County	Aggregate
31	Brierly Brook, Antigonish County	Gypsum
32	Southside Antigonish Harbour, Antigonish County	Limestone
33	Aulds Cove, Guysborough County	Aggregate
34	Sugar Camp, Inverness County	Gypsum
35	Big Brook, Inverness County	Gypsum
36	Marble Mountain, Inverness County	Marble
37	Irish Cove, Richmond County	Limestone
38	Little Narrows, Victoria County	Anhydrite, Gypsum
39	Little Narrows, Victoria County	Gypsum
40	Glen Morrison, Cape Breton County	Limestone
41	Leitches Creek, Cape Breton County	Aggregate
42	Frenchvale, Cape Breton County	Aggregate
43	New Waterford, Cape Breton County (Phalen Colliery)	Coal
44	Point Aconi, Cape Breton County	Coal
45	Alder Point, Cape Breton County	Coal
46	Point Aconi, Cape Breton County (Prince Colliery)	Coal
47	St. Rose, Inverness County	Coal
48	Kellys Cove, Victoria County	Dolomite

Note: Only includes major aggregate producers. Former gold producers limited to production of more than 20 000 ounces.

Table T12.3.1: Location and commodity of the current producers.

Eureka Mine near Five Islands (Unit 710). Nova Scotia's first manganese mine opened in the Tenecape area of Hants County in 1876 (District 620). A copper mine on Cape Breton Island at Coxheath (sub-Unit 585b) created considerable surface and some underground development. Antimony was mined in Hants County at West Gore (sub-Unit 423a) in 1884. At the close of the nineteenth century, the Dominion Coal Company was formed in Cape Breton and began its significant role in the industrialization of the province.

Limestone and dolomite have been quarried continuously in Nova Scotia for over 100 years.[3] By 1875, several large-scale lime-burning businesses were established, including the one at Pugwash (sub-Unit 521a). Nova Scotia has very large gypsum reserves, which have been associated with a trend to develop large companies.

1900–PRESENT: COAL, GOLD, BARITE, TUNGSTEN, SALT, GYPSUM, LEAD, ZINC, COPPER, TIN

At the turn of the twentieth century, Nova Scotia experienced a period of growth and industrial expansion. Around 1900, Nova Scotia was Canada's leading mineral-producing province, particularly in coal and gold. Gold production in the province dwindled in the early part of the century with the Klondike gold rush, but a revival occurred in nearly all the old gold districts in the 1930s. Gold prospecting ceased again during World War II.

During the first two decades of the twentieth century, Nova Scotia produced most of the Canadian output of barite. Barite was mined almost continuously on Cape Breton Island from several deposits along the eastern shores of Lake Ainslie (Unit 584). In 1940, the Walton mine in Hants County (sub-Unit 511a), one of the largest single barite deposits in the world, first produced from an open-mine pit but was later converted to an underground operation. It closed in 1979.

Tungsten was mined at Moose River, Halifax County (sub-Unit 435a), between 1910 and 1918 and near Chester (sub-

District 460a) between 1927 and 1929. A small resurgence of tungsten mining occurred at the beginning of World War II.

Canada's first underground rock-salt mine opened at Malagash (sub-Unit 521a) in 1918. More salt was discovered in Cumberland County in 1931 when a petroleum-drilling program intersected a thick deposit of salt at Nappan (sub-Unit 521a). Commercial production of base-metal ores began in the present century, and copper-lead-zinc ore mines operated intermittently in response to metal markets.[3] Most of the ores were associated with Windsor Group rocks. Tin has only been produced in the latter part of this century, when a large operation opened near East Kemptville, Yarmouth County (Unit 411).

During the 1940s and 1950s mining production increased dramatically, and exploration and research expanded. In 1943, innovations in coal-mining technology were introduced to speed up production to meet demands of the war effort. The invention of gypsum wallboard in the early 1940s enabled significant changes in the construction industry. This event alone dramatically increased the production from Nova Scotia's gypsum mines. Plate T2.4.1 in Section T2 Geology, shows the extent of the gypsum operation at the East Milford Quarry in Halifax County (sub-Unit 511a).

Salt was discovered in the Pugwash area in 1953, during the drilling of a water well. Subsequent drilling found significant thicknesses of salt, which led to the development of the Pugwash Salt Mine in Cumberland County (sub-Unit 521a).

In 1958, a major coal-mining disaster occurred at Springhill, Cumberland County, which marked the end of major coal mining in the northern mainland. Other coal mines began to reduce production as the demand for coal declined, and with increased competition from cheaper, foreign oil, the coal industry fell into sharp decline. In 1966, the federal government established a new Crown agency, the Cape Breton Development Corporation (Devco). The corporation absorbed all remaining coal mines in the Sydney Coalfield and led

NO.	LOCATION (common deposit name)	COMMODITY
49	Chegoggin Point, Yarmouth County	Silica
50	Birchtown, Shelburne County	Building Stone
51	East Kemptville, Yarmouth County	Tin, Zinc, Copper, Silver
52	Little River, Digby County (Factory Bog)	Diatomite
53	Molega Lake, Queens and Lunenburg Counties	Gold
54	Brookfield Mines, Queens County	Gold, Silver
55	Indian Path, Lunenburg County	Tungsten
56	East River, Lunenburg County	Limestone
57	Terence Bay, Halifax County	Building Stone
58	Witherod Lake, Halifax County	Building Stone
59	Nictaux, Annapolis County	Building Stone
60	Torbrook, Annapolis County	Iron
61	Dean Chapter Lake, Lunenburg and Hants Counties	Manganese
62	White Rock, Kings County	Building Stone
63	Avonport, Kings County	Clay
64	Windsor, Hants County	Gypsum
65	Three Mile Plains, Hants County	Gypsum
66	Newport Station, Hants County	Gypsum
67	Mount Uniacke, Hants County	Gold
68	South Uniacke, Hants County	Gold
69	Beaverbank, Halifax County	Roofing Slate
70	Waverley, Halifax County	Gold
71	Montague Gold Mines, Halifax County	Gold
72	Lake Echo, Halifax County	Building Stone
73	Oldham, Halifax County	Gold
74	Renfrew, Hants County	Gold
75	West Gore, Hants County	Antimony, Gold
76	East Gore, Hants County	Roofing Slate
77	Kempt Shore, Hants County	Gypsum
78	Walton, Hants County	Barite, Copper, Lead, Zinc
79	Walton, Hants County	Gypsum
80	Tennycape, Hants County	Manganese
81	South Maitland, Hants County	Gypsum
82	Gays River, Colchester County	Lead, Zinc
83	Middle Musquodoboit, Halifax County	Clay
84	Elmsvale, Halifax County	Silica
85	Caribou Mines, Halifax County	Gold
86	Moose River Gold Mines, Halifax County	Gold, Tungsten
87	Stillwater, Halifax County	Tungsten
88	Tangier, Halifax County	Gold
89	Dufferin Mines, Halifax County (Salmon River)	Gold
90	Fifteen Mile Stream, Halifax County	Gold
91	Smithfield, Colchester County	Lead
92	Piper Lake, Pictou County	Iron
93	Manganese Mines, Colchester County	Manganese
94	Belmont, Colchester County	Silica
95	Londonderry, Colchester County	Iron
96	Five Islands, Colchester County	Barite
97	Cape d'Or, Cumberland County	Copper
98	Williamsdale, Cumberland County	Arsenic
99	Joggins, Cumberland County	Grindstones

Note: Only includes major aggregate producers. Former gold producers limited to production of more than 20 000 ounces.

Table T12.3.1: Location and commodity of the past producers *(continues on following page).*

NO.	LOCATION (common deposit name)	COMMODITY
100	Maccan, Cumberland County (Amos Blinkhorn Mine)	Copper, Gold
101	Nappan, Cumberland County	Gypsum
102	Amherst, Cumberland County	Building Stone
103	Oxford, Cumberland County (King Mine)	Copper
104	Pugwash, Cumberland County	Limestone
105	Wentworth, Cumberland County (Feeley Mine)	Copper
106	Malagash, Cumberland County	Salt
107	Oliver, Colchester County (Oliver Mine)	Copper
108	Balfron, Colchester County (Balfron Mine)	Copper
109	Black River, Colchester County (Black River Mine)	Copper
110	East New Annan, Colchester County	Diatomite
111	New Glasgow, Pictou County	Clay
112	Quarry Island, Pictou County	Grindstones
113	New Glasgow, Pictou County	Oil Shale
114	McLellans Brook, Pictou County	Oil Shale
115	Bridgeville, Pictou County	Iron
116	Glenelg, Guysborough County	Lead
117	Goldenville, Guysborough County	Gold
118	Wine Harbour, Guysborough County	Gold
119	Isaacs Harbour, Guysborough County	Gold
120	Seal Harbour, Guys. Co. (Upper Seal Harbour Gold District)	Gold
121	Seal Harbour, Guys. Co. (Lower Seal Harbour Gold District)	Gold
122	Forest Hill, Guysborough County	Gold
123	Erinville, Guysborough County	Iron
124	Erinville, Guysborough County	Building Stone
125	Copper Lake, Antigonish County	Copper
126	South River, Antigonish County	Dimension Stone
127	Lanark, Antigonish County	Gypsum
128	Manchester, Guysborough County	Iron
129	Queensport, Guysborough County	Dimension Stone
130	West Arichat, Richmond County	Gypsum
131	Melford, Inverness County	Silica Sand
132	Mabou Harbour, Inverness County	Gypsum
133	Scotsville, Inverness County	Barite
134	Jubilee, Victoria County	Lead, Zinc
135	Ottawa Brook, Victoria County	Gypsum
136	Iona, Victoria County	Gypsum
137	Enon Lake, Cape Breton County	Celestite
138	Enon Lake, Richmond County	Barite
139	McCuish Brook, Cape Breton County	Manganese
140	Stirling, Richmond County	Zinc, Lead, Copper, Silver, Gold
141	Silver Mine, Cape Breton County (Yava)	Lead
142	Catalone Lake, Cape Breton County	Dolomite
143	Coxheath Hills, Cape Breton County	Copper, Lead, Zinc, Silver, Gold
144	Frenchvale, Cape Breton County	Dolomite
145	Leitches Creek, Cape Breton County	Silica
146	Point Edward, Cape Breton County	Limestone
147	Scotch Lake, Cape Breton County	Dolomite
148	Baddeck Bay, Victoria County	Gypsum
149	St. Anns Bay, Victoria County	Gypsum
150	Chéticamp, Inverness County	Gypsum
151	Ingonish, Victoria County	Gypsum
152	Dingwall, Victoria County	Gypsum

Note: Only includes major aggregate producers. Former gold producers limited to production of more than 20 000 ounces.

Table T12.3.1: Location and commodity of the past producers *(continued from previous page).*

the coal industry toward renewed vitality. Federal-provincial regional development agreements subsequently made possible research and development that led to new discoveries of coal resources and to better reserve estimations of known deposits. This provided fundamental support for Nova Scotia's policy to rely more on indigenous energy resources and less on imported oil.

GEOLOGY AND RESOURCES TODAY

Significant changes over the last twenty years have influenced the mining and resource industries in many ways near the end of the twentieth century. Several new mines have started production, and there has been a resurgence in base-metal mining, as well as a small boom in gold exploration. A moratorium on uranium was brought down by the Governor-in-Council. The offshore-oil interest has fluctuated towards increased exploration and development. The provincial energy policy has turned to coal as a fuel source, and geothermal development is legislated under the Mineral Resources Act.[4] This resource use is discussed in more detail in the groundwater section of T12.8.

Figure and Table T12.3.1 shows the geographic distribution of mining activity onshore in Nova Scotia. Mining commodities include minerals and rocks and organic deposits. Refer to Figures T.2.1.4 and T3.4.3 for more information on the bedrock and surficial geology of Nova Scotia.

FOSSILS AS A RESOURCE IN NOVA SCOTIA

Fossils are traces of living organisms that have been naturally buried in sediments and subsequently permanently preserved (fossilized). As a result of its long and varied geological history, Nova Scotia has a good resource of fossiliferous formations that range from the Cambrian, where fossils are rare and altered by metamorphism, to the Quaternary, where whole assemblages of well-preserved plants and animals may be found. The

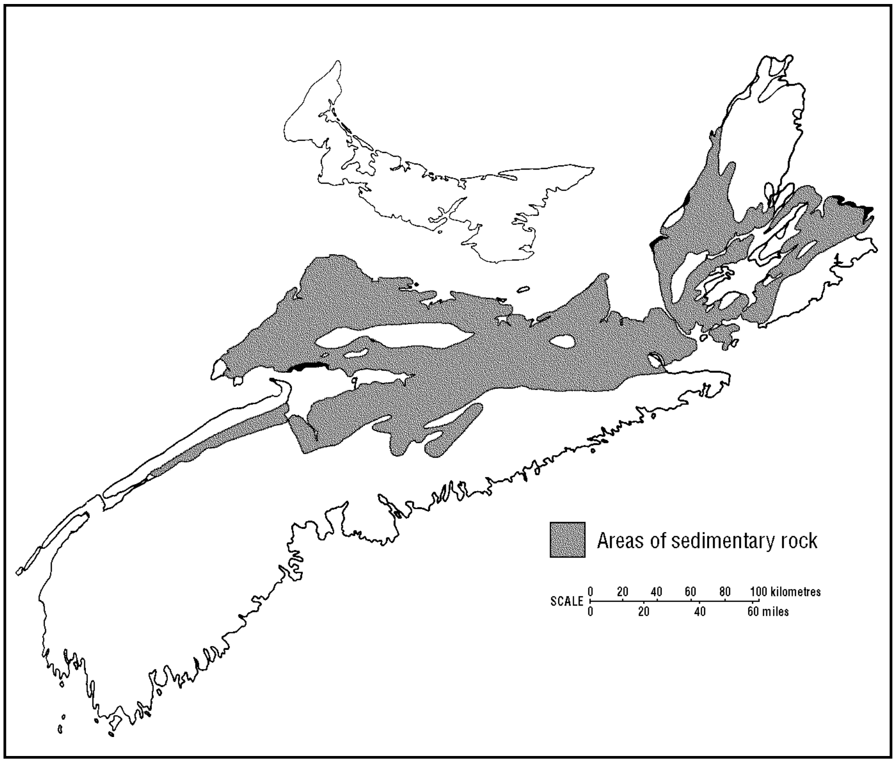

Figure T12.3.2: Distribution of sedimentary rocks in Nova Scotia with potential for fossil occurrences.

important fossiliferous formations in Nova Scotia are shown on Figure T12.3.2.

Fossils provide a record of the evolution of life on earth; they are used to correlate the ages of different formations or strata and to determine the environmental conditions in which sediments were deposited. Fossils, particularly microfossils such as foraminifera, have economic importance as zone fossils in hydrocarbon and other mineral-resource explorations. They are also an important educational and tourism resource. All fossils in Nova Scotia are legally protected. The fullest practical protection is afforded only at designated sites[5] (see *Volume 2, Theme Regions*).

OFFSHORE OIL AND NATURAL-GAS RESOURCES

This section presents an overview of existing discoveries and projects, as well as potential for (and possible effects of) future development of the Scotian Shelf (Region 900).

Hydrocarbon Potential of the Scotian Shelf

All of the conditions required for hydrocarbon occurrence can be found in the Scotian Shelf portion of the Scotian Basin. As of 1993, twenty-two significant hydrocarbon discoveries have been made there,[6] most of them close to Sable Island in District 930 (see Figure T12.3.3). Most hydrocarbon discoveries have occurred in deltaic sediments of the MicMac, Mississauga and Logan Canyon formations (see Figure T2.7.2 in T2.7 Offshore Geology). They indicate the presence of thermally mature to overmature source rocks and the probable thermal cracking of crude oil in the reservoir to simpler compounds.[7] More than 130 wells have been drilled and over 300 000 km of seismic data acquired.[8]

A number of good oil-prone source rocks have been identified. These may have been the source of the oil accumulations at the Sable Island, Cohasset, Panuke and Primrose discoveries.[10] Two of these discoveries (Cohasset and Panuke) form the Cohasset Project—Canada's first offshore project, which began production in June 1992.[11] This established that the small oilfields off Nova Scotia can be commercially viable. The Cohasset and Panuke fields are small by world standards; however, they can be worked efficiently owing to high flow rates, shallow water depths and the moderate climate of offshore Nova Scotia. The Canada–Nova Scotia Offshore Petroleum Board has approved the extension of the Cohasset commercial-discovery area to include the Balmoral field.

There is a high percentage of terrestrial organic matter in the Scotian Basin, which has contributed to the gas-prone nature of the thermally mature source rocks.[7] Most of the discovered natural-gas resource occurs in pools that range from 7 billion m^3 to more than 40 billion m^3 (0.25 trillion cu. ft. to over 1.4 trillion cu. ft.), with the major discoveries within a 40-km radius of Sable Island. In April 1992, the Department of Natural Resources commissioned a study designed to identify the most promising field development and market options for offshore natural gas. The study suggested that there

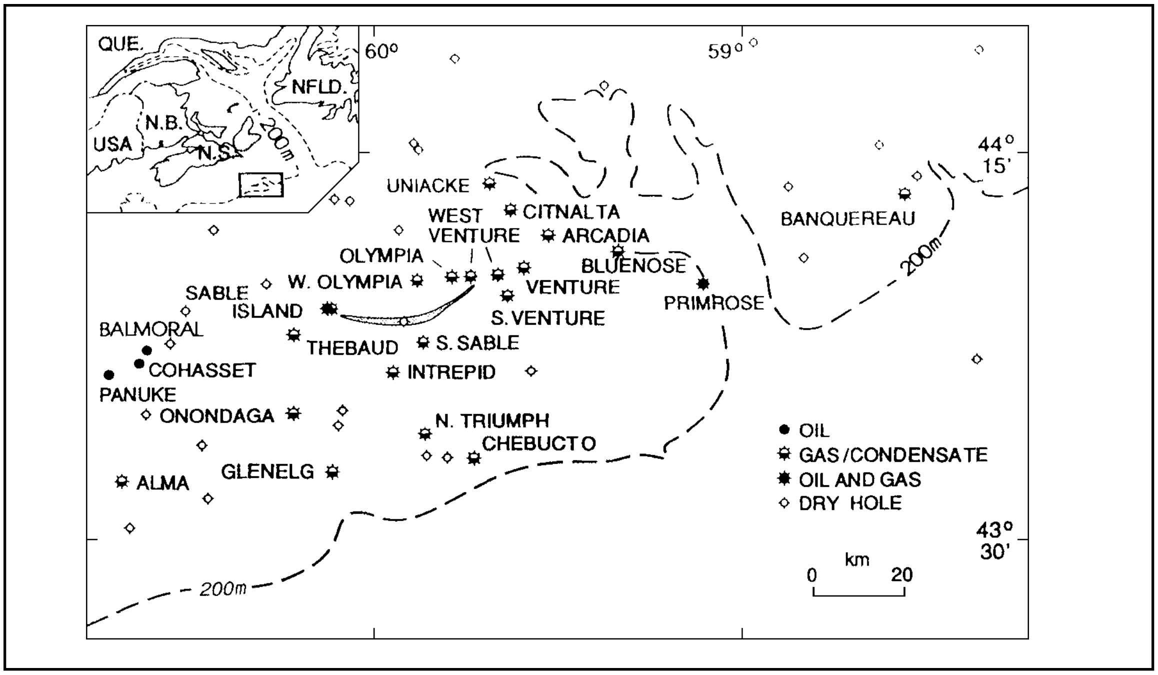

Figure T12.3.3: Hydrocarbon discoveries are concentrated on Sable Island Bank (sub-Unit 931e) and Banquereau (sub-Unit 931f). Adapted from McLean and Wade.[9]

may be economic merit in producing offshore gas after the year 2000.

Two other areas of the Scotian Basin have hydrocarbon potential worth noting. Georges Bank (sub-Unit 931a), located in the southwestern edge of the Nova Scotia offshore, is one of the world's richest fishing grounds. The fishery on Georges Bank contributes significantly to the provincial economy and is vital to the local economy of southwestern Nova Scotia. The physical environment of the bank and its complex currents are unique. As a result, the governments of Canada and Nova Scotia have determined that more information is needed before oil and gas activity may proceed on the bank. Legislation has been passed by both governments to prohibit any oil and gas activity on the bank until the year 2000.[8] Further study is planned during the intervening years, and a public-review panel will be established by 1996 to examine the issue thoroughly.

The second area is the Laurentian Sub-basin (see Figure T2.7.1 in T2.7), which was under moratorium pending a determination of the Canada–France international boundary for St. Pierre and Miquelon. The decision of the International Court of Arbitration on June 10, 1992, removed any uncertainty regarding the international boundary, and companies are again able to negotiate exploration rights.

ENVIRONMENTAL FACTORS OF DEVELOPMENT AND EXPLORATION

The composition of some geological formations may affect the quality of the natural environment and pose a threat to human health. For example, the chemistry of water often depends on the materials that it passes through. If an area is underlain by a lead deposit, well water may contain high amounts of lead. In Nova Scotia, dominant natural problems relating to the geology include water quality, water quantity, acid drainage, flooding (see T12.8), coastal erosion (see T7.1), karst topography (see T3.4), unstable slopes, radon emission and subsidence (due to underground mine workings or water extraction). These problems are often aggravated by human activity when surface activity disrupts subsurface equilibrium conditions. The acid-drainage problem in southwestern Nova Scotia is such an example (see T8.2 and T12.8).

Land-based Mining and Exploration

In his study on the landscape modification of the Sydney Coalfields, Millward highlights three major factors that determine the extent of the impacts: the length of time over which the reserves were mined, the scale and intensity of mining activity, and the length of time since mining ceased.[1] The way in which the metal or mineral occurs in nature determines the scale and intensity of the activity, including the amount and type of waste produced. The different phases of production also result in varying landscape modification. Exploration activities tend to be less intrusive than the extraction and development stages, as less infrastructure is associated with the immediate site and less time is involved. The type of mining can also determine the extent and duration of the communities and industries that develop around the mine site.

Past concerns centred on issues related to surface disturbance, such as land clearing, the cutting of seismic lines, the creation of pits, etc. More-recent impacts are less noticeable but more widespread, such as water drainage from disturbed sites resulting in erosion and stream and lake pollution. Still more subtle atmospheric effects include gas and dust emissions, which are now known to spread far from their source. The main environmental concerns challenging the mining industry, which are evident and often not so evident in the landscape, are listed below:[12, 13]

- surface disturbance during exploration, mine development and operational phases
- disposal of waste rock, low-grade ore and tailings, which react with air and water to generate acids and dissolved metals (acid mine drainage)
- disruption of surface and underground watercourses and the discharge of acid mine drainage into them
- generation of sulphur oxide gases during the smelting of sulphide ores and their discharge to the atmosphere, leading to acid rain
- release of carbon dioxide, ozone and other greenhouse gases from fuel combustion, blasting and mineral oxidation
- consumption of extremely large quantities of energy
- reclamation of intermittent or nonoperational mine and quarry sites and disposal of associated infrastructure

It is only in the last two decades that mine operators have been required to take environmental precautions. The Nova Scotia Department of the Environment[14] and the Department of Natural Resources[4] require permits and reclamation bonds in which operators agree to set aside money to guarantee that the site will be reclaimed once it is no longer in operation. Progressive reclamation is encouraged, to minimize disturbance. In more remote sites, ecological succession occurs once the site is stabilized. Nearer to populated areas, reclamation projects range from hydro-seeding to community-initiated development. In Point Aconi (Unit 531), the old coal mine became a recreational facility, including a ball diamond and cross-country ski area. At Stellarton (sub-Unit 582a), the reclamation project includes a park, recreational facilities and tree planting.

Offshore Exploration and Development

More than 130 wells have been drilled offshore in Nova Scotia with no documented effect on the marine ecosystem. There is, however, some evidence of indirect and direct links to changes in marine ecosystems, as well as implications for the fishing industry.[12] The environmental impacts of hydrocarbon spills relate mainly to drilling, shipping, and accidental and operational discharges. The drilling and production of oil is considered less of a concern offshore in Nova Scotia, because the resource is of a light grade that will evaporate from surface waters within twenty-four hours.[15]

Oil spills during marine shipping are potential sources of coastal and marine pollution. Short-term losses include damage to sea-bird populations.[16] Oil at the shore is especially damaging to wildlife and may even affect beach stability by coating sediments and changing their response to waves.[17] Sable Island is the breeding ground for Grey and Harbour seals, which are potentially susceptible to hydrocarbon development in that area.[18] The effect and movement of oil spills necessitate a thorough understanding of coastal and marine processes.[12] In the interest of mitigating the effects of marine spills, Nova Scotia has recently established a Marine Spill Response Centre in Halifax.

On the other hand, there is some indication that the infrastructure installed for hydrocarbon production provides habitats for marine species. The legs and braces of a platform serve as substrate for crustaceans and hiding places for fish.

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Associated Topics

T2.1 Introduction to the Geological History of Nova Scotia, T2.3 Granite in Nova Scotia, T2.4 The Carboniferous Basin, T2.7 Offshore Geology, T3.4 Terrestrial Glacial Deposits and Landscape Features, T3.5 Offshore Bottom Characteristics, T7.1 Modifying Forces, T8.2 Freshwater Environments. T12.4 Glacial Deposits and Resources, T12.8 Fresh Water and Resources.

Associated Habitats

H1.2 Benthic, H5.3 Cliff and Bank, H5.5 Cave

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T12.4 GLACIAL DEPOSITS AND RESOURCES

Glacial and post-glacial events in Nova Scotia (T3) have produced a wide variety of glacial deposits and features inland, along the coast and in the province's offshore waters. Glacial features, such as drumlins and eskers, have influenced settlement patterns by providing agricultural land, good sites for housing development and workable aggregate resources. Materials range from large till with cobbles or boulders to fine-grained sand deposits. Glaciation was also responsible for the large numbers of glacial lakes in Nova Scotia formed by erosion and damming by deposits that obstructed water flow (see T8.2).

The most important areas, from an economic standpoint, are the glacial-retreat and post-glacial deposits, which include ablation till, glacio-fluvial and alluvial deposits (see T3.4). These deposits are found throughout the entire province and constitute the main source of (nonquarry) aggregate material. Glacial till is also the basis of many of the soil formations in the province (see T12.9).

HISTORICAL CONTEXT

1700s

During the 1700s, there was an increased interest in colonization and development in Nova Scotia. Along the Atlantic Coast, there are few tidal marshes equivalent to those dyked by the Acadians in the Bay of Fundy and Northumberland Straits (see T12.7). To meet their need for food and shelter, the colonists cleared areas that had thick till and workable soil—the drumlin fields along the South Shore. These fields, which contain numerous rounded hills up to twenty acres in area, were glacially developed from slate bedrock, and their unconsolidated material provided good drainage for agriculture. In addition to the tree stumps, colonists had to remove stones from the till to permit ploughing. These stones were piled at the edge of fields and were often built into walls, which remain as evidence of farming, even though the land may since have regenerated to forest.

Apart from the cleared drumlins, the areas settled were agriculturally unproductive. Lunenburg (Unit 434) was established in 1753 as an agricultural community to support Halifax. Studies of the Lunenburg drumlin field indicate that the only land cleared and farmed was on the drumlins.[1]

Drumlins also supported excellent stands of pine, spruce, hemlock and hardwoods, which supplied lumber for local use by the colonists and for timber markets. These forests were burnt, and the ashes provided nutrients for hay, grain, turnip and potato crops, which in turn fed cattle, horses, sheep, hogs and people.

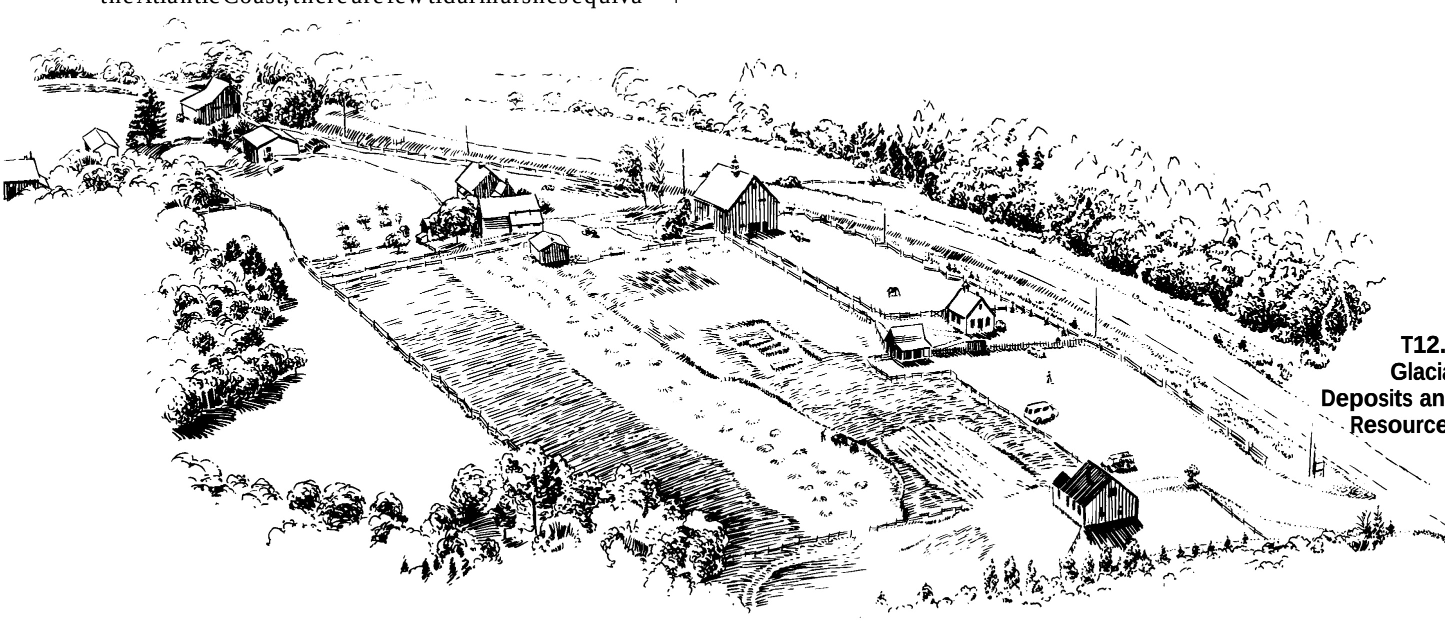

Figure T12.4.1: Ross Farm is a locally managed museum, part of the Nova Scotia Museum, restored to represent drumlin farming during the 1800s.

1800s
Drumlins were considered prime lands to accommodate the extensive grants issued in the 1800s. Once coastal areas were developed, settlers followed the drumlin fields inland, continuing to clear and farm. Ross Farm, near New Ross, Lunenburg County (Unit 434), is a classic example of a drumlin landscape community settled by soldiers discharged from the army and granted land in Nova Scotia around 1815 (see Figure T12.4.1).

Settlers in the 1800s also began farming river valleys, such as the Annapolis Valley (District 610), where the melting ice cap on the South Mountain left thick deposits of glacial-outwash materials on the valley floor.

Other deposits provided quarrying materials for building or repairing roads and buildings. “Barrow pits”, where accessible deposits were quarried casually by horse and wagon, were common from the late 1800s. The production of silica sand first occurred in 1908 at the Belmont operation, west of Truro (District 620).

1900–1950
In the 1900s, agricultural production dropped steadily on drumlin farms in various areas of the province, as urbanization changed food-import patterns and drew people from the country to the city. For example, in 1951, Queens County drumlin farms (Units 432 and 433) produced only half the hay and grain of ninety years previously, 1/3 as many hogs, 1/5 as many cattle, 1/10 as many sheep and only 1/23 as much milk.

As drumlin farms were abandoned, spruce and fir trees gradually spread across the unmanaged land. The oldfield habitat (H5.2) is often associated with abandoned farms on drumlins.

THE USE OF GLACIAL DEPOSITS TODAY

Forestry
Glacial-till areas still provide productive lands for forestry. The tops of drumlins have the best site conditions for hardwood forests and have lasting value for hardwood production and parkland areas, for example, provincial park reserves and Kejimkujik National Park.

People are using abandoned agricultural lands for Christmas-tree farming. Monocultures of pine and Balsam Fir are conspicuous on drumlins in southwest Nova Scotia, particularly around the Bridgewater area (Unit 433).

Development
Drumlins are often prime sites for housing development, as they provide good soil for on-site sewage, good drainage and, often, attractive views for potential buyers. Many of the island and coastal headlands of the South Shore (Unit 832) and Halifax area (Unit 833) are drumlins coveted as prime real estate.

Recreation
District 830, characterized by beaches and islands, abuts the drumlin areas of Lunenburg County. Where drumlins are attacked by the sea, they provide the primary sources of sediment for our sand beaches (see T7.3). Interference with the natural process of reworking sediments can degrade beaches valued for their recreational potential (see T12.7).

Beach Mining
Beach mining is tied to the accessibility of material and has historically occurred where roads and rail lines cross beaches and sand dunes (see T12.7). Prior to the mid-1950s, beaches and inshore coastal areas were the principal source of sand and gravel in Nova Scotia. The mining of aggregates from the beach face, dunes and bluffs is considered to have been one of the most damaging activities to beach development in the province.[2] The removal of sand and gravel affects the deposition of materials downstream as the source of materials decreases. Other changes can occur where the extensive removal of aggregates exposes the backshore to increased wave action on dunes and to the subsequent erosion and flooding of backshore habitats in severe storms, e.g., Lawrencetown Beach, Halifax County (Unit 833), and Glace Bay (Unit 531).The beach at Cow Bay, Halifax County (Unit 833), was quarried for sand and gravel between 1954 and 1966. This effectively obliterated part of the spit-system beach, which had not recovered as of 1988.

During the 1960s, growing public concern about degradation of beaches eventually resulted in prohibition of the removal of beach material under the Beaches Protection Act of 1975. This piece of legislation, although aimed at the protection of a resource, has been instrumental in maintaining part of Nova Scotia’s coastal landscapes.

Quarrying
Nova Scotia has many important deposits of materials that provide key ingredients to a host of construction materials and secondary products. The most useful mineral-aggregate deposits, such as sand and gravel, are composed of the more durable rocks, including granites and quartzites. These deposits

are restricted to the flanks of the Avalon Uplands (Region 300) and the northern slopes of the Region 400—the Atlantic interior (see T2.2).

Kames and eskers are a major source of sand and gravel in the province. Four deposits are commercially exploited around Sydney (Unit 531), Folly Lake (Unit 311 and Gays River (sub-Unit 511a) in Colchester County, and Yarmouth (Unit 831).[3] Many smaller operations are located throughout the province (see plate T12.4.1). This resource is used for road building, sewage projects, commercial-site preparation, parking lots, residential construction (including foundation preparation and drainage) and backfill.

Apart from glacial deposits, sand and gravel may also be found in ice-contact deposits, glacial deposits, modern-stream alluvium, weathered bedrock and marine deposits.

Glacio-fluvial clays are another economically viable resource in Nova Scotia. The Lantz clay pit in Hants County (sub-Unit 511a) is a local industry supporting Shaw Bricks and Lorenzen Pottery. Many of the houses in the area are built of red brick.

In Nova Scotia, the extent to which production can be supported by onshore materials is limited. An example of this limiting factor occurred in the 1980s, during the proposed Bay of Fundy damming project, when it was determined that Nova Scotia's deposits could not provide the necessary quantities of materials.

OFFSHORE METALLIC AND INDUSTRIAL-MINERAL POTENTIAL

The surficial geology of the continental shelf contains extensive deposits of sand and gravel, which were formed by marine reworking of glacial drift (see T 3.5). This untapped resource offers significant potential for an offshore sand-and-gravel industry in the future, particularly if social pressures continue to reduce access to and development potential of land-based quarry sites.

Placer Gold Deposits

Placers are concentrations of gold or other heavy minerals often associated with sand and gravel deposits. The gold was eroded from Meguma bedrock by glacial processes and deposited in tills on the continental shelf. The tills have been reworked, particularly during the last marine transgression, by marine processes, and the gold is concentrated into placers located in gravel lag deposits or in bedrock joints. Known placer deposits are typically located

Plate T12.4.1: Sand-and gravel-quarry near Wolfville, (sub-Unit 511a). This aerial view shows the depth of the deposit in relation to the surrounding trees and the different sizes of the material excavated. Photo: R. Merrick.

T12.4
Glacial
Deposits and
Resources

where the gold-bearing anticlines of Meguma bedrock extend onto the continental shelf, e.g., The Ovens, Lunenburg County (Unit 832), and the Country Harbour vicinity, Guysborough County, (Unit 842).

Sand and Gravel

Sand and gravel deposits on the continental shelf cover Georges Bank, Browns Bank, LaHave Bank, Emerald Bank, Sable Island Bank, Banquereau (Unit 931), Middle Bank, Canso Bank, Misaine Bank and Scatarie Bank (Unit 921). The deposits, up to 50 m thick, consist of fine-to-coarse, well-sorted sand, grading to rounded gravels.[4]

There are also smaller local deposits of sand and gravel that may have potential for development, e.g., a sand-wave field at Scots Bay off Cape Split, Kings County (District 720/Unit 912)[5].

Environmental Concerns

The main environmental concerns regarding marine mining off Nova Scotia are the impacts on traditional fishing grounds and on coastal erosion. Fisheries concerns relate to direct destruction of fish stocks or spawn, destruction of habitat at any stage in the life cycle or interference with fishing-vessel navigation. Coastal erosion problems may be caused by the interruption of sediment supply to beaches, which can cause or exacerbate coastal erosion.

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Associated Topics

T2.2 The Avalon and Meguma Zones, T2.7 Offshore Geology, T3.4 Terrestrial Glacial Deposits and Landscape Features, T3.5 Offshore Bottom Characteristics, T7.1 Modifying Forces, T7.3 Coastal Landforms, T8.2 Freshwater Environments, T12.3 Geology and Resources, T12.7 The Coast and Resources, T12.9 Soil and Resources

Associated Habitats

H2.2 Boulder/Cobble Shore, H2.3 Sandy Shore, H5.2 Oldfield, H5.3 Cliff and Bank

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T12.5 CLIMATE AND RESOURCES

The climatic regions of the province (see Figure T5.2.1) play a role in determining Nova Scotia's resource base for agriculture, fishing, forestry, recreation and tourism. Climate affects the growth, composition and distribution of biotic communities (see T10.3), surface water and the water budget (see T8.1) and the development of soils (see T9.1, T9.3). In addition, there is a relationship between climate and the ocean.

Our settlement trends, the types of activities we choose and the technology used to accomplish them relate to climate and the availability of resources. Technologies such as solar and wind power recognize the potential of climate as a resource.

The climate of an area changes naturally in short-term fluctuations and over extended periods of time. These changes can be measured by the variations from average conditions. Recently, documented changes in global climatic trends have caused concern that some human activities may be rapidly modifying the composition of the earth's atmosphere and changing global, and possibly local, climate. In order to determine the extent of possible impacts of modern climatic trends, scientists are studying the correlation between post-glacial climatic change (see T4.1) and current global climatic changes.[1]

This Topic begins with consideration of the effects of climate on agriculture, as an example of the connection between climatic variables and industry. The second section outlines technologies related to climate. The Topic concludes with a discussion of issues related to global climate change.

CLIMATE AND AGRICULTURE

Both day-to-day weather and the long-term climate in general have a significant effect on the agriculture industry in the province. Farmers face many problems: crops limited by insufficient heat; a short frost-free season; sparse snow cover and extreme minimum winter temperatures; dry spells in mid-summer and prolonged rainy periods in the spring and fall; and periodic lack of sunshine.

Temperature affects plant processes mainly by controlling the rate of development. The concept of growing degree-days or heat units assumes that plant growth is directly related to the average temperature. There are certain minimum temperatures below which plants do not develop. For perennial crops, a threshold temperature of 5°C is most valid, while for tender, heat-loving plants, such as beans and corn, a base temperature of 10°C is more appropriate. Thus, growth and reproduction of any plant is proportional to temperatures above the base temperature. When temperatures are low, development is slow. This is a major factor determining which crops can grow in Nova Scotia and also how quickly a specific crop will develop.

The lack of heat units is further complicated by a relatively short frost-free season. Many crops are extremely sensitive to temperatures below 0°C and thus require seeding–through–harvest to take place between the last spring frost and the first fall frost. As a result, the heat units to develop the crop to maturity must be sufficient during this frost-free period to ensure an acceptable yield.

The coastal effect on Nova Scotia's weather results in an excess of 1300 mm of precipitation per year, of which over three-fourths is rain, in many locations in the province. Snow tends to act as a buffer and to insulate crops and their root systems; however, with too much rain and not enough snow, many perennial fruit crops are left exposed to extremely cold minimum temperatures throughout the winter months. This results in permanent injury to the plants and, in recent years, has had a significant effect on blueberries, strawberries, apples and grapes, as well as on some forage species.

Although not commonly recognized, frequent dry spells can occur throughout the summer, placing many crops under water stress. To alleviate this, farmers are turning to irrigation as a valuable management tool to guarantee optimum yields.

Wet spells, mainly during the spring and fall months, are common in Nova Scotia. Although timely rain is quite beneficial, too much early rain can delay many seeding and other field-related operations, while, on the other hand, too much rain in the fall can delay the harvest.

As in other temperate regions, variability of the weather in Nova Scotia can also affect the operations of other resource-based industries. Forestry, fishing, tourism and engineering activities tend to be seasonal but may be interrupted by exceptional conditions or "unseasonable weather". For example, skiing and other winter sports in lowland and coastal areas may be restricted owing to lack of snow. Outdoor activities in summer, such as festivals and general beach recreation, may be limited by cold or wet weather. Organizers can use historic weather data to predict the most suitable date for their event, but this is not always reliable.

SOLAR AND WIND ENERGY

As well as influencing the resources in Nova Scotia, our climate is, in itself, a resource. Sun and wind are both potential energy sources, and various technologies have been developed to exploit them. There is little scientific documentation on the possible effects these technologies may have on the landscape; however, certain natural requirements are necessary to make them efficient.

Solar Energy

Solar energy is most appropriately used in heating buildings and water. Nova Scotia's relatively temperate climate and availability of winter sun make the province one of the best areas in Canada for taking advantage of solar energy. Although there is considerable variability in the amount of available sunlight in different parts of the province, Halifax solar data can be used as an example of just how much solar energy is available in Nova Scotia. Halifax has 1900 hours of bright sunlight per year, slightly over five hours a day, and its average intensity on the sloped roof of a typical Nova Scotia house is 2803 kilowatt hours per square metre per year. The sunlight on 8 m^2 is enough to provide all the space heating for such a house.[2] It is also worth noting that sunlight does not have to be bright in order for it to be useful. Diffuse sunlight provides forty per cent of all solar gain to a south-facing sloped window in Nova Scotia.[2] Microclimate conditions are more important to effective solar energy use than regional differences.

Integration of solar technology into the design of commercial, industrial and institutional buildings can also reduce traditional energy costs. A key solar element in such buildings is the use of natural lighting, because lighting costs are often the largest single energy cost in many large buildings.

One solar technology that is just beginning to become cost-effective is photovoltaics (PV), which uses photo cells to produce electricity directly from sunlight. To date, PV has had mainly niche uses, such as for remote telecommunication relays, marine beacons (the Canadian Coast Guard is a major user of PV) and remote cottages. However, rapid technological development is bringing PV costs down; so much that in some areas in the world, large-scale PV generation facilities feed competitively priced electricity directly into regional electrical grids. This use of solar energy will probably grow substantially in the next few years. Solar energy thus may become a major energy source in Nova Scotia.

Historically, little conscious use has been made of solar energy in Nova Scotia, with the exception of traditional building elements, such as greenhouses, sun porches, solariums and south-facing windows. However, spurred by the oil crisis in the 1970s, there was considerable experimentation with the use of solar energy, primarily for space heating and mainly in single-family dwellings, but also in a few agricultural applications, such as heating barns and drying crops. Government support in the 1970s and early 1980s encouraged considerable growth in solar technology; in the 1990s, environmental concerns have been responsible for a rekindling of interest.

Wind Energy

Windmills were used in Nova Scotia in the 1800s for pumping water and for powering sawmills. They were usually squat, wooden structures resembling the classic Dutch windmill.[3] Today, a number of modern designs of wind turbines are available for generating electricity from the wind. A wind-power generator must have a battery system to take over during extended periods of light or calm winds.

The landscapes best suited for generating wind energy are flat and treeless; each tower requires 1–1.2 ha. Higher areas where the wind funnels through mountain passes are also appropriate. The optimal wind conditions are steady, constant streams averaging 21 km per hour. In winter, the increased demand for heating in Nova Scotia coincides with increased wind; however, freezing rain can be a problem.

The height of the towers and lines can be a hazard to migrating birds. Flyways are generally 90–105 m high, and, although height of towers is site specific, they can be as short as 30 m high, and the power lines can be buried.

Test sites in Wreck Cove in Cape Breton (sub-Unit 552c) and Minudie Marsh in Cumberland County (Unit 532) are determining profiles on wind speed, roughness, direction, temperatures and gust conditions.

GLOBAL CLIMATIC CHANGES

Some of the results of climatic change appear beneficial at first glance. Many people would welcome less-severe winters with the resultant reduced fuel bills. Less frost would mean a longer growing season. However, there will be effects on ecosystems that are not necessarily positive. In some cases, species cannot evolve fast enough. Nova Scotia's geographic orientation as a peninsula increases the potential for species' isolation or extinction. The typical boreal habitats and their species of much of the province would eventually be replaced by temperate habitats and their species.[4] Pests and diseases that cannot survive our current climate could in future present problems to agriculture and forestry sectors. Although the nature and extent of impacts on the biosphere that result from human activity altering the composition of the atmosphere cannot be predicted with a high degree of confidence, people must be aware that changes will occur. Climatic changes are also causing concern within the fishing[5] and forestry industries,[6] as well as having potential effects on freshwater resources.[7]

Global Warming

Global warming is considered to be a result of an imbalance in the natural carbon cycle caused by the burning of fossil fuels, deforestation, agricultural practices and industrial activities. These contribute to an increase in levels of carbon dioxide, methane and nitrous oxide. These compounds have existed in the atmosphere for millions of years and have helped to maintain the temperature of the earth at a level that permits life as we know it, by means of a phenomenon called the greenhouse effect. Outgoing infrared radiation from the earth's surface is partly absorbed by these greenhouse gases and reradiated back down towards the surface. The greenhouse gases are starting to accumulate at such a rate that scientists are predicting changes in the earth's climates.

To try to forecast the nature and magnitude of climate change, scientists have used very powerful computers to simulate future climates, using what are referred to as general-circulation models. The results indicate that, for a doubling of the carbon dioxide in the atmosphere, the average temperature of the earth will increase in the order of 3.5°C, with increases being lowest near the equator and highest at high latitudes. To date, these models cannot predict accurately changes in climate on the scale of counties or even provinces the size of Nova Scotia, but the results are still useful.

Increasing temperatures are expected to cause the top layer of the oceans to expand, resulting in higher sea levels, threatening coastal wetlands and estuaries with inundation. Increased melt of the Greenland glaciers could decrease the temperature of the Labrador Current, causing local cooling along portions of the east coast of Canada, rather than the warming predicted for further inland.

Air Quality

The most common air pollutants are sulphur dioxide, nitrogen dioxide, carbon monoxide, suspended particulate matter, ozone and total reduced sulphur. At certain concentrations in the air, each can have an effect by itself, or they may contribute to other air-quality problems. Routine monitoring of air quality is done for one or more of these pollutants, depending on location; therefore, a little more is known about them than about other classes of pollutants. There are six additional families of toxic air pollutants: polycyclic aromatic hydrocarbons, volatile organic compounds, dioxins and furans, metals, polychlorinated biphenyls and pesticides. Even though standards exist for a few toxic air pollutants, very little is known about their sources, concentrations and effects.

Acid Precipitation

Emissions of sulphur dioxide, and to a lesser extent nitrogen oxides, cause acid precipitation, the first widely recognized air-pollution problem that can be caused by distant sources. In fact, most of the acid precipitation that occurs in Nova Scotia is caused by sources in the Ohio River valley, Ontario, Quebec and the eastern United States. Emissions from local sources have some impact on the province but may also contribute to an acid-precipitation problem in sensitive areas downwind of Nova Scotia, for example, Newfoundland. As a result of agreements between the federal government and the provinces and between Canada and the United States, reductions in emissions have already occurred and will continue to occur. The most sensitive areas of Nova Scotia, however, may not show much improvement (see T7.2).

Ground-level Ozone

Formed by chemical reactions between volatile organic compounds and nitrogen oxides in the presence of sunlight, ground-level ozone is also referred to as urban smog. It can cause serious respiratory problems, affect plant growth and deteriorate artificial materials such as rubber. Ground-level ozone usually originates in urban areas, but in Nova Scotia, ozone is largely imported from other regions, as shown by the relatively high levels measured at Kejimkujik National Park (Region 400).[8]

Ozone-layer Depletion

In the stratosphere, a layer 50 km above the earth's surface, ozone is also found in very low concentrations. If all this ozone could be confined to a layer at the surface of the earth, it would be only 3 mm thick. This small amount of ozone is beneficial rather than harmful, because it filters out much of the damaging ultraviolet radiation from the sun. The emission of chlorofluorocarbons (CFCs) and, to a lesser extent, other compounds is causing depletion of this ozone layer, reducing its ability to shield us from harmful ultraviolet radiation. CFCs, which are artificial products used in fire extinguishers, refrigeration and air-conditioning units, foam products and as solvents in the electronics industry, are gradually being eliminated. Although there is no evidence that the depletion of stratospheric ozone has had measurable effects on ecosystems, the possibility of damage increases with ozone losses.[9] By the end of 1995, legislation will prevent the manufacturing, importation and use of CFCs in many nations of the world.

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Associated Topics

T4.1 Post-glacial Climatic Change, T5.1 The Dynamics of Nova Scotia's Climate, T5.2 Nova Scotia's Climate, T8.1 Freshwater Hydrology, T9.1 Soil-forming Factors, T9.3 Biological Environment, T10.3 Vegetation and the Environment

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T12.6 THE OCEAN AND RESOURCES

Nova Scotia's marine waters play a major role in the province's economy and lifestyle. Our interaction with coastal and offshore waters and the resources they support has shaped many aspects of Nova Scotia's landscape and human-settlement patterns, while providing food, tidal energy and recreation.

HISTORICAL CONTEXT

Pre-European Settlement

Prior to European colonization of Nova Scotia, coastal and offshore waters provided transportation routes and abundant food sources for the Mi'kmaq. Camps were often located in coastal areas where the Mi'kmaq subsisted on various types of marine life, including cod.

> *According to one account, written in 1863, travelling long distances on open waters in their canoes was never without worry for the Mi'kmaq, as a type of large fish (killer whale) sometimes attacked their boats. The Mi'kmaq adopted the preventive practice of placing tree boughs at the stern; these smelled of the land and drove the fish away.*[1]

Coastal waters provided resources for most of their needs and also brought the Mi'kmaq into contact with European fishermen in the 1500s. Exploratory voyages by sea in the late 1400s had spread word of the resources available in the New World. For more than a century, the prospect of a sea route to Asia and the potentials of the New World encouraged most exploration. The fishery drew thousands of men and hundreds of boats across the Atlantic each year (see T12.11). Knowledge of the configuration and resources of northeastern North America was spread across Europe, and the fishermen's accounts often surpassed the detail of the official exploration records.[2]

The practice of sending ships to fish offshore banks (Region 900), salting the cod in their holds and returning to Europe without landing is thought to have been developed by 1550.[2] In spring and summer, offshore currents brought floe ice (see T6.1) and icebergs offshore. The European fishermen were not used to these conditions, and they found shelter in the numerous harbours.

> *In the early 1600s, the Governor of Acadia remarked that the sea was "paved with salmon" and other species. At times, fish were so plentiful that they impeded the passage of ships; according to John Cabot, cod could be captured by simply lowering wicker baskets over the side of a boat.*[3]

The first fishermen did not establish permanent settlements. As the industry grew more competitive and disputes over land between the French and English developed, more permanent bases were established to support the fishing industry and to stake claim on territory. Many semipermanent settlements developed along the Atlantic coast and offshore islands as overwintering stations with make-shift dwellings. These lengthened the period of residence but did not change the migratory character of the fishing community.

Louisbourg, and then Halifax, developed from military strategies during the conflicts between the French and the English. As territorial disputes were settled, many of the coastal communities were linked by sea, with boat services providing transportation and trading routes.

1800s

In the early to mid-1800s, boat services existed between Halifax and Arichat, Lunenburg, Shelburne, Liverpool and Yarmouth, as well as to New England and Great Britain. In addition, Pictou was connected by boat to Prince Edward Island, and Fundy coastal communities were connected to New Brunswick, while Sydney had an established link with St. John's, Newfoundland.

Transatlantic migrations were also occurring at this time, requiring the transport of people and goods. This was tied in with the shipbuilding industry in Nova Scotia (see T12.10). The sailing-ship industry flourished between 1820 and 1880. At first, North American timber was sought to build ships and masts; gradually, however, vessels built in Nova Scotia were used in the international trade. Schooner captains generally waited for the outgoing tidal currents to carry them from port. Several hundred kilometres from shore, mariners encounter the Gulf Stream, a river of water flowing up to 25 m/s and used for centuries to assist ships travelling to Europe from Nova Scotia. Trade increased with steam power in the late 1880s, when Nova Scotia was trading with Great Britain, New England and the West Indies.[4]

1900s

The sea continued to provide a livelihood for many people into the twentieth century.[5] However, by the 1920s, the Maritime region had lost control of the major industries. Halifax and Saint John remained ocean-shipping cities; however, they faced increasing competition from Montreal and the eastern seaboard. Halifax retained its focus as a centre for Nova Scotia fishing trade but had limited success in developing a winter port-to-rail trade. "Despite its magnificent natural harbour, Halifax was not well sited to become a major port."[5]

The railway changed the trading patterns, and as central Canada opened up in the 1900s and new technology changed the fishing industry, the Maritimes' position in the world market diminished. By 1925, ten steam trawlers were operating in Nova Scotia waters, effectively reducing the numbers of small boats and local industry. During the World Wars, Halifax was revitalized as a central port and harbour. Its position as a military base continues today.

Coastal waters have long affected human-habitation patterns. Most of Nova Scotia's population lives within 20 km of the coast, reflecting both the marine heritage of the province and the desirability of the coastal zone as a place in which to live and work, with the fishery often serving as the predominant resource.

THE OCEAN AND RESOURCES TODAY

The Offshore Fishery

Many of Nova Scotia's productive fishing grounds exist owing to the presence of nutrient-rich water and associated phytoplankton blooms, produced by an oceanographic phenomenon known as "upwelling" (see T6.1), which brings cold nutrient-rich waters upwards to replace warmer surface water. Most upwellings are wind generated, but in the Bay of Fundy (Units 912, 913) they are caused by the tides. The conditions in this area sustain a breeding ground for whales and the most affluent commercial fishery on the country's east coast.[6] While the fishery is an economic mainstay in Nova Scotia, it also exerts the single largest human pressure on the Canadian marine ecosystem (see T12.11).

Harbours

Deepwater harbours are also an important resource, as Halifax (Unit 833) and Port Hawkesbury (District 860) attest; these are among the largest deepwater ice-free ports in the world. The viability of several of Nova Scotia's resource industries (pulp and paper products, gypsum, aggregates) is closely tied to the accessibility of marine transportation. Today, as in the past, the shipping industry and transport by water are very important to the economy of the province. Bilge and oil discharge related to marine transportation is considered a threat to marine animals (see T12.11).

Discharge

Human impact on coastal waters in Nova Scotia has been significant. Both coastal waters and marine life are influenced by industrial discharge, oil spills, municipal sewage and storm-water runoff, runoff from agricultural and urban areas, ocean dumping, long-range atmospheric transport, and persistent litter and debris. Some of these contaminants can degrade coastal waters; their impact is commonly measured in terms of biochemical oxygen demand (BOD) and total suspended solids (TSS). BOD results from the decomposition of organic waste and can affect aquatic life by reducing the oxygen content of the water. TSS, which includes sand, grit and other nonbiodegradable materials and human fecal matter, can alter benthic habitat and, in the latter case, cause fecal coliform contamination. These types of stresses in marine ecosystems have resulted in shellfish closures. In 1970, 104 areas were closed to shellfish harvesting; in the early 1990s, 236 were closed.[7] Poor water quality has also limited the expansion of aquaculture operations at various coastal sites.[8]

In March 1995, the media reported that surveys of Britain's shorelines revealed increasing amounts of plastic bottles and other debris derived from eastern North America. A detailed product analysis showed that about one-third of this debris originated in Atlantic Canada, drawing attention to the fact that the way we abuse our own marine waters is part of a global problem.

The effect of industrial discharge on Nova Scotia's ocean waters is most evident in several areas. Cape Breton's coal mines discharge their wastewater and runoff directly into the ocean.[9] The high sulphur content of the coal results in highly acidic wastewater and higher solubility of metals, which in turn can lead to bioaccumulation of metals in benthic fauna.[10] The waters of the Northumberland Strait receive the effluent of Boat Harbour, once a Pictou Landing tidal lagoon that now serves as a reservoir for pulpmill wastes, which have been responsible for fish kills and impacts on the estuary.

Despite human impact on coastal and offshore waters, nature is resilient, and most ecosystems will recover over time, given the right conditions. This is exemplified by one of Canada's early major oil spills, which occurred in 1970, when the tanker *Arrow* ran aground in Chedabucto Bay, resulting in a spill of 15,000 t in Nova Scotian waters. Shoreline analysis at one particular site, twenty years later, reveals that oil can still be found in sediments and may persist for another decade.[10,11] However, the coastal waters and marine life recovered quite rapidly, according to studies undertaken by the Bedford Institute of Oceanography. Much of the oil in the bay disappeared quickly after the disaster, and, although thousands of clams and seabirds died, fish and lobster did not, and the clams made a quick comeback.

Estuaries

Estuaries, as sheltered and productive coastal areas, have for centuries been preferred sites for human settlement and development. They tend to be used for disposal of wastes, are freely modified for shipping or agricultural purposes and have generally been neglected both from conservational and scientific points of view. Some of the capability of estuarine ecosystems to handle detritus has enabled them to cope with the human wastes that have been deposited as a consequence of this activity. However, as human populations have grown, the quantity of waste has reached the point where even these environments are unable to sustain the input.

Organic wastes, such as untreated sewage, consume the oxygen essential for animal life, and when tidal mixing is small, anaerobic conditions may persist for long periods. In estuaries that are mixed more thoroughly by tides, the capacity to handle extra organic matter is much greater. The wastes from our society also contain a variety of toxic metals, manufactured organic compounds, oils, radionuclides, etc., that are harmful in high concentrations to living things. Because estuaries tend to act as traps, these toxic materials can accumulate, often in association with the fine grades of sediment deposited on tidal flats. These may remain within the system for long periods and represent a major threat to water quality.

Nova Scotia's abundant bays and estuaries have become the focus for a burgeoning aquaculture industry involving salmon, mussels, clams, oysters and scallops. The naturally high productivity, coupled with good tidal flushing and protection from heavy seas, makes many estuaries ideal locations for aquaculture. For this industry to persist (and particularly if filter-feeding species are to be grown), high water quality must be maintained. More than any other factor, the potential of aquaculture has focused attention on the state of Nova Scotia's estuaries. The aquaculture industry needs clean waters in which to operate, and this industry has been the most prominent factor in focusing attention on the state of Nova Scotia's estuaries and on the need to protect, and in many cases rehabilitate, estuarine environments.

Causeways and Bridges

Physical restructuring of coastal environments through the construction of causeways and bridges has also put pressure on marine environments, altering the flow of waters and sediments and interrupting migration, spawning runs and larval transport of fish and invertebrates (see T12.7). In Nova Scotia, construction of the Canso Causeway changed the numbers and types of bottom-dwelling species in the Strait of Canso. A smaller causeway at Barrington Passage cut off the summer mackerel migration and affected lobster habitat.[9] The construction of the Annapolis Tidal Power Station on the Annapolis River, which generates 20 MW of electricity for 12,500 homes, has changed current patterns and caused river erosion upstream. Human, fish and bird populations, dependent on the river and associated coastal ecosystems, have been affected by this development.

Recreation and Tourism

The ocean and coastline of Nova Scotia provide a number of important resources for recreation, including general beach recreation, coastal cruising, deep-sea fishing, scuba diving and bird-watching. More recently, other activities such as whale watching, sea kayaking, surfboarding and windsurfing have shown significant development, particularly in specific areas of Nova Scotia where the best opportunities occur. Examples include Humpback and other whale watching at Brier Island, Digby County (District 810, Unit 912), and surfing at Lawrencetown

Beach, Halifax County (Units 833, 911). Halifax is the finishing point of the biennial Marblehead-to-Halifax yacht race.

Many of these activities form the basic components of new ventures in ecotourism or adventure tourism. They provide new economic opportunities for coastal communities directly and indirectly through the provision of accommodations, specialized outfitting and other services.

OFFSHORE PROTECTED AREAS

The current plight of many economically important fish species and vulnerable pelagic mammals, birds and turtles has drawn attention to the need for protected areas offshore. International initiatives and coordinated activity are required to care for species that do not recognize national boundaries and that generally undertake long seasonal migrations. However, the ineffectiveness of international agreements makes active protection in national jurisdictions essential. For example, the Leatherback Turtle, which migrates to feed as far north as the Cabot Strait in Canadian waters, lays its eggs on sand beaches of Florida and the Gulf of Mexico. Pelagic or oceanic seabirds, such as the Greater Shearwater, commonly feed in Nova Scotia's offshore waters in the summer, as they range far from where they breed. These species are vulnerable to marine pollution (see T12.3) when in Nova Scotia's waters, but the main concern is for the protection of their distant breeding areas.

In Nova Scotia waters, there is a general need for the conservation of pelagic and benthic habitats in areas that support populations of vulnerable species, e.g., the Right Whale. Although species may be protected individually, protection of the habitat on which they depend is the best approach to conservation. The Gulf of Maine Action Plan provides opportunities for this approach.[12] The Action Plan evolved from an international agreement to conserve for sustainable resource use the marine environment of the Gulf of Maine—the water between Cape Cod and Cape Sable Island—and the abutting terrestrial watersheds that drain into the Bay of Fundy and the Gulf of Maine. The agreement was drawn up in 1989 by the bordering states and provinces. The population of Bottlenose Whales that inhabits The Gully, northeast of Sable Island (Districts 930 and 940), requires conservation of its habitat as the best approach to protection. The establishment of a protected area for this purpose has been proposed.[13] Establishing protected areas offshore can be an essential tool in the conservation of economically important fish species through habitat management. The application of the *Natural History of Nova Scotia* theme-regions approach may prove to be useful in the establishment of offshore marine protected areas.[14]

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Associated Topics

T6 The Ocean, T11.7 Seabirds and Birds of Marine Habitats, T11.12 Marine Mammals, T11.14 Marine Fishes, T11.15 Amphibians and Reptiles, T12.3 Geology and Resources, T12.7 The Coast and Resources, T12.10 Plants and Resources, T12.11 Animals and Resources

Associated Habitats

H1.1 Open Water, H1.2 Benthic, H2.4 Mud Flat, H2.5 Tidal Marsh

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T12.7 THE COAST AND RESOURCES

Nova Scotia's coastlines are constantly shifting in a dynamic process of erosion and deposition called shoreline migration (see T7.1). The rates of change vary considerably, depending on exposure to wind and wave action, the presence of glacial deposits, the types of substrate and exposed bedrock, vegetation cover and the flow of water through the landscape on a seasonal basis. In addition to these natural processes, people have created their own dynamics and rates of change to coastal environments (see T7.2) and habitats (see H2).

Historical and cultural development in Nova Scotia is dominated by links to the sea, causing the majority of the population to be concentrated along the coastlines.[1] In addition, the coastlines offer a wide variety of natural and scenic resources. Exploitation of these resources can be in conflict with natural coastal processes and put pressure on these ecosystems. Most negative impacts result from a lack of understanding of coastal processes and the delicate balance of coastal ecosystems due to the effects of extreme climatic conditions.

HISTORICAL CONTEXT

Pre-European Contact

Sea-level fluctuations (see T3.3) and eroding coastlines have obscured most archaeological evidence that people inhabited Nova Scotia's coastlines prior to 3,000 years ago. Post-glacial climate changes (see T4.1) suggest that resources were different from those here today. Large middens dating between 2,000 and 3,000 years ago suggest that people during this period lived along the coast where shellfish could be exploited.

Early Mi'kmaq people chose campsites along the coast, based on the availability of fresh spring water and firewood and a place to beach canoes. They chose places with escape routes in case of attack, such as peninsulas or islands, and high ground, where they could keep a lookout for enemies and for food species, such as porpoise. Clear coastal water was preferred to the turbulence and mud of the inner Bay of Fundy, and streams running into the ocean needed to be small enough to accommodate a fishing weir.

Plate T12.7.1: Dykeland at Grand Pré, Kings Co. (District 610), formed by the dyking and draining of tidal marsh. An upland field in the foreground leads to Grand Pré National Historic Site, commemorating Acadian heritage. Minas Basin and Blomidon (Unit 720) are seen in the distance. Photo: A. Wilson.

In the summer, they chose areas with a stiff breeze, to keep blackflies away. During the rest of the year, shelter from the wind was important. In winter, hibernating eels were fished under the ice in estuaries.

European Settlement

The first Europeans to settle permanently in Nova Scotia dyked the extensive tidal marshes along the Bay of Fundy coastline. The Acadians created the first dykelands at Port Royal (Unit 610) in the 1630s. They dyked the upper marsh (see H2.5) first, developing a few hectares at a time and gradually extending the agricultural land toward the outer edge of the marsh.[2] When all available marsh had been dyked along the Annapolis estuary, settlement spread around the Bay of Fundy to areas where dykeland production could occur. The Acadians did not generally clear upland areas along the coast, as their basic needs were met through dyking the tidal marshes.

Dyking modified the natural marsh production and converted the tidal marshes to agricultural land. Dykelands were created by the construction of banks to keep the flood water from a low-lying area that would normally be inundated. Fresh water drained from the marshes at low tide through a culvert, referred to as an *aboiteau*, and natural vegetation was removed. Figure T12.10.1 illustrates species composition and landscape features of a tidal marsh before and after dyking.

The dykelands required maintenance to prevent them from returning to the natural successional tendencies of tidal-marsh vegetation (see H2.5). New Englanders who settled the vacant lands after the expulsion of the Acadians (see T12.1) found the marshes flooded with salt water by a severe storm that had damaged the dykes and aboiteaux.[2]

New Englanders cleared the coastal uplands for farming, but they continued to use dykelands for hay and pasture, and marsh mud was dug for fertilizer for their upland farms. Immigrants also cleared much of the coastal forests and drumlin headlands along the Atlantic Coast (Region 800), exposing the unconsolidated materials to increased erosion. By the early 1800s, immigrants to Nova Scotia had recovered most of the original Acadian dykelands as well as reclaimed new areas of tidal marsh.

Sediment from logging and farming provided marsh grass with a foothold to develop some of the extensive tidal marshes found on the Nova Scotia eastern shore: e.g., Chezzetcook, Petpeswick, Three Fathom Harbour (Unit 833).

By the mid-nineteenth century, settlements were scattered around the coast and along the main river valleys stretching inland. The interior of Cape Breton was as frequently settled as the coastline, owing to the ease of access afforded by Bras d'Or Lake. Islands were often used as summer fishing stations and processing plants. In coastal areas too rugged for agriculture, fishermen supplemented their income with sheep farming. Sheep often lived in a semiwild state, feeding on kelp and seaweed. In 1907, 400–500 sheep were reported to be living on Tusket Island, Yarmouth County (Unit 831), and in Guysborough County, 1,000 sheep grazed the 65 km of coast between Ecum Secum (Unit 834) and Port Bickerton (Unit 842).[3]

During the nineteenth century, hay was an important crop needed to maintain the horse-powered logging and mining industry. By the early 1900s, large tracts of coastal marshes, such as at Tantramar and Minudie in Cumberland County (Units 523 and 532), were devoted to the production of hay.

By the late 1930s, the hay market had all but ceased as a result of fossil-fuel technology. The dykes fell into disrepair, and much of the land was reclaimed by the sea. In 1948, the Marshland Rehabilitation Act was enacted to promote the creation and maintenance of dykelands. Over twenty years, using modern technology, 18,000 ha of tidal farmland were protected in Nova Scotia.[2] Tidal dams were constructed on the Avon, Annapolis and Tantramar rivers.

Chezzetcook Inlet, Halifax County, experienced a second era of siltation and marsh development in the 1940s and 1950s, when construction of a railway and causeway led to siltation and build-up of mud deposits. Except for marshes in the Bay of Fundy, where high tides contribute the sediment needed to start marsh development, many of Nova Scotia's tidal marshes have probably arisen since the first European settlement.

THE COAST AND RESOURCES TODAY

Agriculture

Agriculture along the Atlantic Coast (Region 800) occurs mostly on drumlins and drumlin islands cleared during the 1800s and 1900s (see T12.4).

Sheep farming still occurs on some islands and along the Atlantic coastline.

Along the Northumberland (Unit 521) and Bay of Fundy Coasts (Regions 600 and 700), dykelands are still maintained for the production of hay, forage, pasture and some grain and vegetables.[2] Water from the uplands collects in low-lying areas, creating a band of freshwater wetlands and shallow lakes, often surrounded by bog. These areas provide habitats for a variety of wild animals and plants. The largest expanse of maintained dykeland is found in the Tantramar Marshes (Unit 523). Without maintenance, these dykelands and others in Nova Scotia would revert to tidal marsh.[4]

Dredging

The maintenance of fishing harbours is an ongoing task, particularly along the west coast of Cape Breton, where the dynamics of the exposed shoreline create constant deposition in the channels: e.g., Inverness (sub-Unit 551a) and Judique (Unit 522). Dredging can accelerate the erosion of beaches and cliffs by reducing the littoral-sediment supply. Munroes Island, Pictou County, at the entrance to Caribou Harbour (sub-Unit 521a), has been reduced considerably by dredging. Dredging also increases sedimentation in tidal lagoons and inlets, increasing turbidity in the waters. Materials dredged from the channels are deposited in designated offshore dumping areas. The levels of toxins in these dredged materials and their possible ecological effects are often undetermined.

Coast-protection Structures and Harbour Defences

Jetties and breakwaters built on beaches and in estuaries may affect the development of coastal systems. Local beaches have built throughout the province by accumulation of sand behind wharves and jetties. For example, a jetty at the mouth of a river near Rissers Beach, Lunenburg County, (Unit 832), has caused the build-up of a beach-and-dune system, which now depends on the maintenance of the jetty. A similar situation is occurring at Mabou Harbour, Inverness County, (sub-Unit 551a), where the beach is enlarging, owing to the interception of northward-moving sand by a breakwater. The opposite occurs at Inverness Beach, where jetties trap southward-moving sand and direct it into a lagoon, which has to be dredged periodically.[1]

Causeway Construction

Causeways intercept wave dynamics, causing bank erosion downstream and excessive deposition upstream. Causeways can also alter current flows and interrupt fish- and invertebrate-breeding cycles. The construction of the Canso Causeway changed the numbers and types of benthic species in the Strait of Canso (sub-Unit 583a and Unit 860).[5] The Windsor Causeway, built across the Avon River in the late 1960s, has arrested the macrotidal movement of sediments in the Bay of Fundy (Unit 511). The increased sedimentation has caused an extensive mud-flat development, which is being colonized by salt-marsh grass. A causeway to Caribou Island (sub-Unit 521a), built in 1922, increased the progradation process at Waterside Beach in Pictou, allowing subtidal deposits to build a series of beach ridges.[6] Causeway construction at Barrington (Unit 841) has dramatically increased sand accumulation on the opposite side of Barrington Bay. The causeway has cut off the summer mackerel migration and has also affected lobster habitat.[7]

Beach Quarrying

Beach quarrying (see T12.4) is tied to the accessibility of material and has historically occurred where roads and rail lines cross beaches and sand dunes.

Transportation routes along dunes and across beaches can affect dune stability, and succession and can block drainage channels. Culverts under the roads are constantly subject to blocking by sand and gravel, which results in flooding upstream and in the backwaters, affecting water quality of the backwater and increasing erosion along the stream banks.

Coastal Development

There is increasing pressure for shorefront development in Nova Scotia, particularly for seasonal dwellings and tourism facilities. The population density on the Atlantic coast of Canada increased about ten per cent between 1971 and 1986.[5] This type of population growth can increase stress on marine and coastal ecosystems.

On-site waste-disposal systems require minimum lot sizes and soil depth for approval. Soil-deprived coastal barrens are often subject to blasting and infill, drastically altering ecological communities. Constructing foundations in dunes undermines the system's stability.

Recreation

Recreation is a year-round activity along the coasts of Nova Scotia, and some activities—for example, use of all-terrain vehicles (ATVs), horseback riding and camping—can be destructive to coastal habitats, mostly owing to soil erosion along trails. Management depends on active participation from special user groups. For example, at Conrad's Beach Provincial Park, Halifax County, (Unit 833), local bird-watchers help protect Piping Plover breeding areas, and horseback riders and hikers are directed away from from the nesting areas by boardwalks and interpretive signs.

Conservation

Comprehensive programs have been developed in response to dune erosion and beach-habitat degradation. Various conservation methods employ flexible devices, such as snow fencing and revegetation. These methods are used in conjunction with limiting human access to sensitive areas. This includes restricting vehicle access, building boardwalks and providing public education, such as the Piping Plover program (see T12.11). Boardwalks, such as at Clam Harbour Beach Provincial Park (Unit 833), allow access while maintaining the ecological integrity of the dunes and coastal barrens.

The international importance of coastal wetlands to migrating waterfowl populations has resulted in the creation of conservation programs to protect wildlife wetland habitats at various sites throughout the province, including Minas Basin, Chignecto and the outer estuary of Musquodoboit Harbour. Some of the dykeland in the Bay of Fundy has been reflooded under programs designed to create habitat for wetland wildlife. Marsh-reclamation projects are found in the Amherst area (Unit 523) and in the Belleisle Marsh in the Annapolis Valley (District 610).

To date (1993), approaches to managing coastal pressures have been largely uncoordinated, as a result of fragmented jurisdictional responsibilities for marine and coastal resources. Coastal-zone management is of prime concern, however, and programs are emerging to encourage economic development that includes environmental protection and conservation. Management concerns in Nova Scotia are reflected in *Coastal 2000*.[8] The consultation paper offers a framework for strategic planning at the community level in Nova Scotia.

Associated Topics

T3.3 Glaciation, Deglaciation and Sea-level Changes, T4.1 Post-glacial Climatic Change, T7.1 Modifying Forces, T7.2 Coastal Environments, T12.1 Colonization by People, T12.4 Glacial Deposits and Resources, T12.9 Soil and Resources, T12.10 Plants and Resources, T12.11 Animals and Resources

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Associated Habitats

H2 Coastal

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T12.8 FRESH WATER AND RESOURCES

"As a resource, fresh water is a vital requirement for agriculture, industry, power generation, recreational activity, drinking and aesthetic enjoyment." Fresh water also supports wildlife and ecosystems and is a major component of Nova Scotia's landscapes. Possibly, it is because fresh water from Nova Scotia's lakes, rivers, wetlands and groundwater reserves is so plentiful that it is taken for granted as a commodity. "As a result, some of our uses of water interfere with others."[1]

Numerous direct and indirect activities have altered the province's aquatic ecosystems, and, although the changes are not always readily seen in the landscape, the effects are apparent in species diversity and in water-quality studies.

The Minister's Task Force on Clean Water recommends developing a water-resource management strategy for Nova Scotia to mitigate the effects of the conflicting interests related to freshwater use in the province. Such a strategy would necessitate an understanding of how aquatic systems function and how they respond to human influence.[2]

HISTORICAL CONTEXT

Before European Contact

The long tradition of water use in Nova Scotia dates back to early transportation routes. Practically everywhere that there are navigable rivers in the province they were used, combining canoeing and portage. The Mi'kmaq navigated inland waters that were probably originally used by Paleo-Indian cultures. An encampment dating to 5,000 years before the present was discovered at the southern end of Kejimkujik Lake where the Mersey River leaves the lake (sub-Unit 412a). Archaeologists conjecture that the site was a seasonal eel-harvesting site used by people who had travelled up the Mersey from encampments along the coast.[3] This part of the river is believed to have been used for eel fishing for 5,000 years.

Eel weirs tended to be sited where natural obstacles, such as ledges or debris, could be supplemented by boulders so that the stream current was formed into a "V" shape.

Plate T12.8.1: The water-powered grist mill at Balmoral Mills is built on falls on Balmoral Brook, a tributary of Waughs River, Colchester County (sub-Unit 521a). The mill, preserved by the Nova Scotia Museum, is one of the last examples of many built in Nova Scotia in the nineteenth century. Photo: R. Merrick

Sticks and other debris were added to force the eels into the centre of the V.

Early cultures and the Mi'kmaq usually located their camps near springs that supplied an abundant source of fresh water.

1600s and 1700s

Early European accounts of spring spawning runs on streams described the fish as being so abundant that "everything swarms with them." This subsistence economy was soon supplanted by a commercial economy, which eventually resulted in the overfishing of certain species, such as salmon. By the late 1700s, colonists and Mi'kmaq were involved in commercial exploitation of rivers by trading their salmon catch with dealers along the coast. For Mi'kmaq as well as nonnative fishermen, success was determined by proximity to good fishing areas, the availability of various species and ecological constraints.

Inland waterways provided transportation routes for Europeans and Mi'kmaq involved in trade and later for military purposes. The river systems that flowed down to the coasts were the most obvious corridors connecting coastal settlements with the interior of the province. The initial impetus for moving inland was to get access to new timberlands as coastal forests were depleted. For example, in the late 1700s, there were several mills near the mouth of the Mersey River. Operations moved upstream as lumber grew scarce around Liverpool. There were no roads, so the river provided the main transportation routes for the lumbering operations. Settlements such as South Brookfield, Queens County, (Unit 433), were established along these transportation routes. By travelling inland up rivers, settlers discovered good farmland in the drumlin fields of southwest Nova Scotia (see T12.4).

Even after roads were established, some of the early settlers continued to use the rivers for transportation. Enterprising people used the waterways to advantage. For example, one settler in South Brookfield combined boatbuilding with agriculture and transported his goods to market down the Medway in boats he had built, which he then sold after unloading the produce.

The earliest documented canoe trip across the province occurred in 1686 from Annapolis Royal to Liverpool. Seven Frenchmen and two Mi'kmaq guides navigated the inland waterways and portage routes in six days.[4] At about the same time, people were looking to link the two coasts of the province by road from Nictaux to Liverpool.

Extensive changes to freshwater habitats began in the eighteenth and nineteenth centuries, when colonists dammed Nova Scotia's rivers and streams for water-powered gristmills and the sawmills of the burgeoning timber industry.

The Acadians operated water-powered sawmills in Nova Scotia in the 1600s, and settlers continued to use this method as lumbering operations expanded in the 1700s. Both the Roseway and the Jordan rivers in southwest Nova Scotia became sites for Loyalist sawmills. Financial incentives were offered by the government to encourage the construction of mills, resulting in forty-seven new sawmills between 1783 and 1787.[5]

1800s and 1900s

In the 1800s, hunters and fishers travelled waterways for recreation, using early settlers and Mi'kmaq as guides. Canoe routes continued to be the way to access hunting and fishing grounds into the twentieth century.[6] The influx of sportsmen led eventually to the establishment of permanent hunting and fishing lodges along some of the main rivers.

Rivers continued to be used for the transportation of goods and lumber during the 1800s. During a small gold rush in southwest Nova Scotia in 1884, for example, the Medway system was used to transport men and goods to the Molega Mine (Unit 432). Log drives tended to occur in the spring, when the water was highest. The quantities of logs damaged stream-bank habitats and left extensive quantities of organic debris, which settled to the bottom of rivers, smothering organisms in bottom habitats. This also caused anoxic conditions in the sediments and, in extreme cases, could cause oxygen deficiencies to the ecosystem. Breaking down great amounts of organic material requires oxygen normally available to other biota.

Frozen waterways have always fostered recreational activities and resource industries. In the latter half of the nineteenth century, before the invention of refrigeration, the ice industry was important. The Halifax area had two ice companies in operation, at Williams Lake and Lake Micmac, supplying ice blocks to markets. The Dartmouth Lakes boasted some of the first hockey games in Canada in the eighteenth century, when British garrison teams adapted a form of skateless hockey played by the Mi'kmaq.

By the mid-1800s 1,400 sawmills were in operation in Nova Scotia. Water was the main choice of power generating for the mills (see Plate T12.8.1). Liverpool was an example of a settlement founded on the prospect of natural resources, including the Mersey River. "Its river, down which large quantities of timber are floated with the spring freshets, and the fisheries ... are the main source of its wealth."[6]

The sawmill operations often made watercourses inaccessible for spawning fish, which consequently suffered population declines. Although legislation requiring fish passes was enacted in 1786 in Nova Scotia, it was rarely implemented.[7] As elsewhere in the province, salmon had once been plentiful in the Sackville River at the head of Bedford Basin, but in 1856 Captain Campbell Hardy wrote, "The Sackville River offers no sport to speak of now for the sawmills and their obstructive dams have quite cut off the fish from their spawning grounds." Mill refuse contributed to water-quality changes in Nova Scotia, and this dumping practice continued on some rivers well into the 1930s.[8]

In the 1920s, pulp-and-paper companies built dams on the Mersey River, flooding the area and creating Lake Rossignol (sub-Unit 412a). Although fish ladders were built, very few fish would go up them. For local Mi'kmaq guides, this affected their best guiding businesses—salmon fishing and moose hunting. Erosion around Lake Rossignol has exposed many sites of archaeological significance, which may be seen when water levels are low.

In his 1873 account of the first settlers of Colchester County, Nova Scotia, Thomas Miller wrote:
"The first settlers of Stewiacke had many difficulties to contend against. On September 8, 1792, there was the great freshet which carried away a large part of their wheat which was standing in stook in the field. Many of their houses stood on the interval and were in danger of being carried away. Many made rafts of boards from the floors of their homes and pushed off for higher land, while those who had canoes were busy saving the people first and afterwards the cattle and sheep. After this they very prudently built more of their houses on the uplands."[9]

T12.8 Fresh Water and Resources

FRESH WATER AND RESOURCES TODAY

Watershed Management

The province is traversed by a multitude of watercourses of all sizes that provide drainage to the sea. In Nova Scotia, forty-four primary watershed-drainage areas (see T8.1.2) have been identified for management and monitoring. Land use in watershed areas can greatly affect the water quality of municipal drinking water. In most cases, municipalities drawing water have little control over the watershed lands that are often located in another municipality, and as a result water contamination may occur because of land-use activities incompatible with the production of safe drinking water. The clearing of land for agriculture, mining, forestry and highway construction affects Nova Scotia's freshwater environments. Impacts can be minimized by following established ecological guidelines or leaving uncut greenbelts by watercourses (see T12.9, T12.10). Eutrophication can occur from agricultural runoff, domestic sewage, siltation and other human activities. Degradation can also occur through the destruction of wetlands because of infilling, reclamation as farmland and as such other activities, developing subdivisions for homes and cottages.

Floodplains

Floodplains have tended to be popular places to build because the land is flat and the soil deep. Developments, such as housing projects, have often been built without considering the potential flood levels of most floodplains. Construction activities, in many cases, have decreased the capacity of the floodplain land to retain water and, therefore, have intensified the effects of flooding and drought. By ignoring the natural function of the floodplain (see T8.2), developers are at risk from the inevitable periodic floodings that have caused considerable property damage in the past. To avoid flooding, developers have often built up the land with fill, to raise the level of the property. This reduces the area available to contain flood water and can lead to increased upstream and downstream flood damage. The Little Sackville River floodplain[10] and the Truro floodplain[11] (adjacent to the Salmon and North rivers) are just two of the areas where serious flooding has taken place.

In 1978, the federal and provincial governments entered into an agreement aimed at reducing potential flood damage by discouraging unwise use of flood-prone land. The agreements provide for the identification, mapping and study of serious-flood–risk areas throughout the province. This flood-risk mapping program has proven to be valuable for municipal land-use policies as well as in the review of major projects that were scheduled to be constructed through floodplains, e.g., the North River Bridge, TransCanada Highway.[12]

A flood-risk area is defined as land that is subject to severe flooding on the average once in 100 years (i.e., there is a one per cent chance of the land being flooded in any given year to a particular elevation—the 100-year elevation). A smaller area, designated

Plate T12.8.2: A watercolour of the Sackville River floodplain in 1817 by John Elliott Woolford. The view from Sackville shows the floodplain area prior to development. This area now contains the Bedford Place mall. Historical plate: N.S. Museum, Museum Services Division.

as the floodway, is the part of the floodplain subject to more frequent flooding. In this zone, flooding occurs on average once every twenty years (i.e., there is a five per cent chance of flooding in a given year to a particular elevation—the twenty-year elevation. The designated floodway fringe lies between the floodway and the outer limit of the flood-risk area. Within this fringe area, any new building or alteration of an existing building requires appropriate flood-proofing measures if it is to receive federal or provincial assistance.

Damming

Rivers in Nova Scotia have been dammed to convert the energy potential of water into electrical power at thirty-two power sites around the province. The drawdown and flooding associated with large-scale dam construction can alter both terrestrial and aquatic ecosystems, including changes in habitat for plants and animals that require fast-flowing water and changes in water quality. Reservoir water levels are usually maintained at the optimum required for hydroelectric production and do not always coincide with the requirements of fish migration or waterfowl breeding. Flooded forests near sites often die; however, they then provide nesting sites for heron colonies, which favour the standing deadwood and stumps. Dams can affect spawning and fish migration patterns (see T12.11).

Wetlands

Until recently, the ecological role of wetlands has been poorly studied. As an intermediate between freshwater and terrestrial habitats, wetlands were often infilled to create more “useful” land. This infilling interrupts surface and subsurface flow of water and can seriously affect the water-table level during dry periods. There are several programs in Nova Scotia that focus on the construction and protection of wetlands as wildlife habitat and as retention and filtration ponds. These artificially created systems are part of the more than 33,000 inventoried wetlands in the province (see T8.3).

Water Supply

Forty-eight of the fifty-six surface water supplies and nineteen of the twenty-five groundwater supplies contributing to municipal water systems have significant, identifiable water-quality problems. Some contaminants occur naturally; these include iron and manganese, which add colour and affect the taste, and hydrogen sulphide, which gives an unpleasant smell. Arsenic pollution of groundwater has been associated with abandoned gold mines at several locations. Other natural contaminants are radon, various salts, compounds from organic decomposition and silt entering waterways in excessive amounts as a result of such activities as forestry, land clearing and construction. Other contaminants resulting from human activity include acid precipitation, sewage, industrial effluent, dry-cleaning fluids, road salt, oil, pest-control products and agricultural runoff. Hog manure now produced in the Annapolis Valley is equivalent to the sewage discharge of a city of 250 000 people.

The Nova Scotia Department of Municipal Affairs has prepared a list by county that shows the type of water supply used by each municipality (i.e., surface water and/or groundwater).

Groundwater

Groundwater constitutes only six per cent of the total volume of fresh water used throughout the province; however, it is still important to many residents. This is particularly evident in Cumberland County and in the Annapolis Valley, where groundwater is the primary source of municipal water supplies.

The greatest human use of fresh water is for various household needs. Approximately half of the domestic water used in the province is drawn from lakes and streams that are part of our surface-water resource. Approximately fifty per cent of the population use wells that tap the groundwater resource. The average household uses 150 to 250 gallons of water per day, of which only four per cent is consumed by drinking and cooking. [13]

The primary aquifers in the province are found in sand and gravel deposits (the Annapolis and Margaree valleys) and in sandstone and gypsum areas, mainly in Colchester and Cumberland Counties and in parts of Cape Breton. In these areas, which have relatively little surface water, wells are the primary source of domestic-water supply.

Overpumping of the groundwater resource can reduce well yields and lower water levels. In coastal areas, there have been incidents of saltwater intrusions into groundwater supplies from overpumping by fish plants. Interference with water wells can also decrease the natural groundwater discharge to rivers and streams during drought periods, affecting water supplies, wildlife and recreational and other uses.

The waters of Spa Springs, Annapolis County, (District 610), were reputed to possess healing properties, which attracted many visitors to that area in the eighteenth century. Today, the community is renowned for its bottled mineral water. The major dissolved mineral in the groundwater is gypsum, which is attributed to the gypsum lenses found in the late Triassic silt stones and shales of the Blomidon Formation.

Recently, groundwater has been used for geothermal-energy production in Nova Scotia. The groundwater in hard-rock districts will rise approximately 1°C for every 30 m depth. Carboniferous bedrock has a higher geothermal gradient potential, a phenomenon exhibited by the water temperatures in the abandoned coal mines in the Carboniferous lowlands (Region 500). In Springhill (Unit 581), there are five water-filled seams, the deepest of which extends at a 32° angle for approximately 4 km. The water circulates rapidly, with temperatures reaching up to 21°C. The geothermal industry at Springhill has prompted other studies on the potential of using the heated groundwater in abandoned mine sites. [14, 15 16]

Acidification of Fresh Water

Much of Nova Scotia's surface water in naturally mildly acidic; however, increased acidity levels resulting from human activities have been a source of concern in the province.

Runoff from quarries, highway construction and urban development displaying low-pH levels is generally referred to as acid drainage. Acid drainage is caused by the chemical and biological oxidation of sulphur-rich minerals. Construction activities contribute to acidified waters in southern Nova Scotia, because the blasting exposes pyritic slate bedrock of the Halifax Formation to the atmosphere, leaching aluminum, heavy metals and acid in water runoff to streams and lakes. The Halifax Formation is found throughout the southern mainland, extending from Yarmouth to Canso. With such widespread occurrence, mineralized slates are difficult to avoid. In fact, many towns and villages and a whole network of highways are situated on top of these rocks.

Freshwater acidity is also an issue in southwestern Nova Scotia, where the nature of the bedrock and shallow overburden contribute little to the buffering capacity for runoff (see T8.2). Slowly decomposing

> *One of the most cited examples of the effect of acid drainage resulted from construction activity at the Halifax International Airport. Runway and taxiway construction, excavations of slate for buildings and the stockpiling of slate material set off a chain reaction that initiated and promoted the generation of acid drainage. The production of acid related to these activities was determined to be responsible for major fish kills, the closure of a fish hatchery, the disruption of water supplies and the lowering of water quality in lakes and streams. In addition, a variety of heavy metals were found in drainage water.*

organic materials, such as peat moss, can also create acid conditions in lakes.

Wildlife in aquatic ecosystems is especially sensitive to acidic deposition. As water in rivers and lakes becomes more acidic, the eggs of aquatic organisms are less likely to hatch and mature, while fish in all stages of their life cycle are vulnerable. The species that are most sensitive to acidity, including many species of fish, insects, crustaceans and molluscs, are eventually eliminated. The impoverished aquatic ecosystem that follows may be unable to supply the nutritional needs of waterfowl at breeding time; for example, calcium is required for the formation of eggshells, and protein demands are high for growing chicks. Increased acidity also causes aluminum, cadmium, lead and other potentially toxic metals to be more soluble and to be “mobilized” into the water. Methylmercury in fish from acidic lakes may reach concentrations that can interfere with reproduction in mink, loons and other predators. Cadmium is taken up by vascular plants and then accumulates in the livers and kidneys of herbivores, such as Moose, at levels that pose a risk to human consumers.

Salmon populations have declined in Nova Scotia because acidified waters have caused the loss of one-third of Nova Scotia’s available salmon habitat since 1950.[17] This environmental stress has extirpated salmon in thirteen Nova Scotia rivers. Even if acid deposition could be stopped and the habitat allowed to purge itself, short-term natural recovery of these salmon stocks is no longer possible. Given their sensitivities to acidic waters, salmon are now designated as environmental-indicator species whose population numbers are used to monitor the state of Nova Scotia’s freshwater ecosystems. In order to preserve native salmon stocks genetically suited to individual Nova Scotia rivers, the provincial government has instituted a conservation program to protect a particular salmon stock for genetic-salvage purposes. Each winter, a portion of the frozen East River near Chester is limed, to counteract the effect of the spring melt whereby ice and snow discharge their accumulated water, creating a surge in river acidification detrimental to spawning salmon in the critical stages of their life cycle. This has led to a dramatic increase in juvenile salmon in a 500-m^2 area of the river.

On a more optimistic note, reduction of emissions has been shown to lead to a gradual recovery of lake ecosystems. In 1992, an Environment Canada study concluded that seventeen lakes in southwestern Nova Scotia had shown significant improvement. During the eight-year study, sulphate deposits had declined in six Nova Scotia lakes and alkalinity rose in thirteen lakes, which is another indicator of declining acid-precipitation deposits.

Recreation

Swimming, boating and canoeing are popular freshwater-recreation activities. Cottage development along the edges of lakes is also popular and can cause problems in the ecosystem if waste-disposal regulations are not adhered to.

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Associated Topics

T2.3 Granite in Nova Scotia, T2.4 The Carboniferous Basin, T6.4 Estuaries, T8.1 Freshwater Hydrology, T8.2 Freshwater Environments, T8.3 Freshwater Wetlands, T12.3 Geology and Resources, T12.9 Soil and Resources, T12.11 Animals and Resources

Associated Habitats

H3.1–H3.6 Fresh Water, H4.1–H4.4 Fresh Water Wetlands

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T12.9 SOIL AND RESOURCES

The soil regions of Nova Scotia are irregular, uneven and reflective of the complex physical and human environments within the province. Distribution, types and quantities of soil influence the availability of plant and animal resources (see T12.10 and T12.11), determine agricultural development and settlement patterns, and contribute to commercial development. For example, early settlers depended on their ability to grow food to support communities involved in the fishery. More recently, soils have helped to determine how we develop housing on nonserviced land.

Human activities are influenced by the availability of soils and also influence the structure, fertility and composition of soils. Some activities, like agriculture, can be directly related to the use of soils as a resource. Other activities, such as land clearing for development, affect soils indirectly.

The relationship is characteristic of the ways through which humans interact with the environment, responding to potentials, recognizing limits and adapting the environment to suit human needs.[1] Human activities have, in turn, changed soil distribution and fertility. Although soil conservation is not as big an issue as in the Prairie provinces, guidelines have been developed to reduce soil degradation in Nova Scotia.

HISTORICAL CONTEXT

1600s and 1700s

Europeans used the soils of tidal marshes for agriculture during the 1600s and early 1700s. The soils were stone- free and rich in organic materials and nutrients. The tidal marshes were dyked (see T12.7), drained and planted—a process that leached salt and other minerals from the soil. After the salt had been leached out of the soils, the remaining mixture of silt, sand, clay and water was very productive for crop growth. Ploughing changed the stratified structure of the original marsh soil. (Soils in the Bay of Fundy are classified today as Acadian soils.) Acadian agricultural practices required no manure, as the fertility of these engineered farmlands was maintained by periodically allowing tides to flood the drained marshland, which could add 2–3 cm of nutrient-rich sediments to dykeland soils. Before the marshes were dyked, water transport deposited the deepest, richest soils adjacent to the sea and along rivers. With drainage patterns altered, water from upland areas now tends to collect in the low-lying, inland dyked environs, resulting in a band of freshwater wetlands and shallow lakes, often surrounded by sphagnum bog.

> *The soil of ... Nova Scotia ... is various, being in some parts very rough and barren; in others exceeding pleasant and fertile, as ... round the Bay of Fundy, and on the rivers which fall into it.*
> *Robert Rogers.* A Concise Account of North America. London, 1765

As settlement in Nova Scotia grew, there was a need for increased agriculture support to the fishing, lumbering and shipbuilding industries. Most areas capable of supporting agriculture were eventually settled, although some marginal areas were cultivated only briefly.[2] The main environmental criteria determining settlement were topography, climate and soils, although soil was the most important factor. Isolated from Europe, settlers depended on the ability to grow food to support colonial development.

1800s

In the first quarter of the 1800s, Loyalists settled and farmed land abutting navigable river in areas rich with alluvial soils or land previously farmed by Acadians. By the mid-nineteenth century, settlement patterns corresponded to the bays and inlets around the coast and to the main river valleys stretching inland. The interior of Cape Breton, however, was as well settled as the coastline, owing to the ease of access via the Bras d'Or Lakes.

Drumlins, with their deep till soils, were extensively cleared of stones and trees and farmed, first along the southwest Atlantic Coast and then inland (see T12.4). The soil on the drumlins continued to influence settlement patterns, as they provided islands of fertility in a sea of relatively poor and shallow soils. There was little pioneer settlement after 1850, although land clearance continued in more favoured areas.

In 1912, Fernow[3] calculated that 18.4 per cent of the Nova Scotia land base was occupied by farms. By

1958, 10.1 per cent was farmed. In the late 1970s, 6.8 per cent of Nova Scotia was farmed land.[4] Much of the farmland abandoned during this time has returned to forest through succession dominated by White Spruce or White Pine (see H5.2).

THE USE AND INFLUENCE OF SOILS TODAY

Soil Capability

Interpretive soil-classification systems are ratings based on an intended use, the Canada Land Inventory (CLI) for Agriculture being one example. Soil is classified as suitable for agriculture and other purposes through its relation to geographic location and economic accessibility.

The CLI is a seven-class system where Class 1 is the best and Class 7 the worst. "Best" is defined as the ability to successfully grow a wide range of commercial crops. As the range of crops becomes narrower, more inputs are required or yields become poorer or less reliable, the class is poorer. There are thirteen subclasses, denoted by letter, to describe the kind of limitation present. The best soils in Nova Scotia are Class 2; because of adverse climate, denoted 2C.[5] Common soil limitations in the province are shallow rooting depth (D), stoniness (P), adverse topography (T), wetness (W), lack of moisture (M) and low fertility (F). About 375,000 ha (seven per cent) of the province has potential for general agriculture as defined by Classes 2 and 3.

Other interpretive classifications are based on growing a single crop, like Alfalfa, or are for a single use, like septic filter fields. These classifications follow similar rules to CLI, but the criteria and class limits change, depending on critical values specific to the intended use.

Agriculture

Glacial scouring has left many areas of Nova Scotia with marginal- to poor-capability soils for agriculture.[2] Commercially viable soils are generally restricted to lowlands underlain by post-Devonian sedimentary bedrock, such as the Annapolis Valley (District 610) and the Gulf shore lowlands of Region 500. The Annapolis Valley is Nova Scotia's most productive farming area with fertile soils based on glacial-fluvial deposits in the river valley. The drumlin fields on the South and Western Shore (District 430)

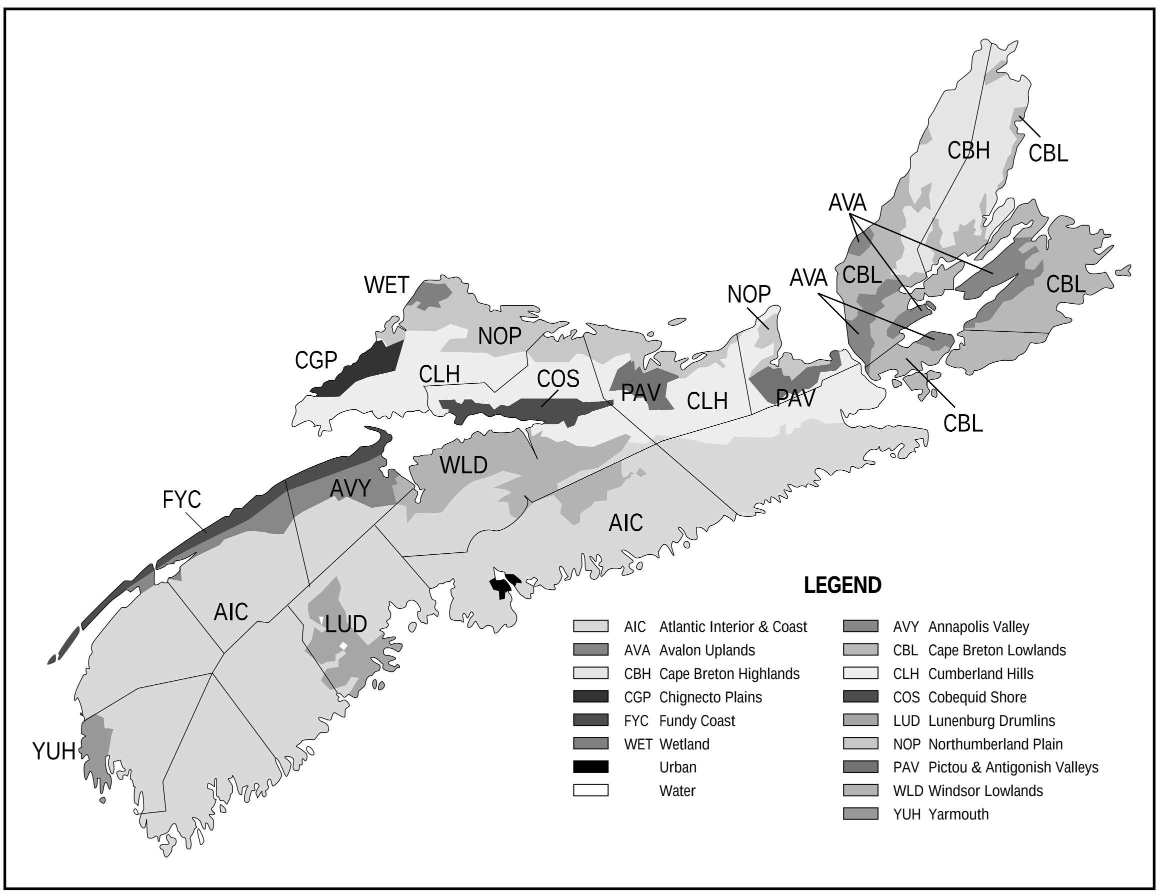

Figure T12.9.1. Agricultural Resource Areas of Nova Scotia

T12.9 Soil and Resources

AGRICULTURAL RESOURCE AREA		HECTARES (000)	SOILS (DOMINANT SOIL SERIES)	SLOPE	CLIMATE*	CLI(Agr)
CODE	NAME (DISTRICT/UNIT)					
AIC	Atlantic Interior and Coast (400, 800)	3258	Well-drained, stony, sandy loams and sandy loams (Halifax, Bridgewater)	4–9%	D,E,H	7: stones, fertility, bedrock
AVA	Avalon Uplands (300)	794	Well-drained, stony, sandy loams (Thom, Wyvern, Kirkmount)	4–15%	B	7: stones, fertility, bedrock, slope
AVY	Annapolis Valley (610)	135	Rapidly drained sands, well-drained sandy loams and gravelly sandy loams (Cornwallis, Woodville, Morristown)	4–9%	F	2–4: fertility, drought
CBH	Cape Breton Highlands (200)	379	Well-drained, stony, sandy loams (unnamed soils)	16–30%	C	7: stones, fertility, bedrock, slope
CBL	Cape Breton Lowlands (510, 520, 530, 550, 560, 580)	325	Imperfectly drained, gravelly, sandy loams and loams (Millbrook, Westbrook, Springhill, Queens)	4–15%	B,D	3–4: wetness
CGP	Chignecto Plains (532)	53	Well-drained, stony, sandy loams (Shulie)	4–9%	B	7: stones, fertility, bedrock
CLH	Cumberland Hills (581)	162	Moderately well-to-imperfectly drained sandy loams and gravelly sandy loams (Westbrook, Debert, Hansford, Pugwash)	4–9%	B	3–4: stones, slope
COS	Cobequid Shore (620)	61	Well-to-imperfectly drained, loamy sands, sandy loams and loams (Truro, Woodville, Debert, Queens)	4–9%	G	2–3: fertility
FYC	Fundy Coast (720)	89	Well-to-imperfectly drained sandy loams and gravelly sandy loams (Rossway, Glenmont)	4–9%	G	7, 2–4: stones, bedrock, slope
LUD	Lunenburg Drumlins (434)	199	Well-drained sandy loams (Bridgewater)	4–15%	E	3–4,7: stones, slope, wetness
NOP	Northumberland Plain (521)	374	Imperfectly drained, sandy loams and loams (Debert, Queens)	4–9%	A	2–4: wetness
PAV	Pictou & Antigonish Valleys (580)	93	Well-to-imperfectly drained, gravelly, sandy loams and loams (Westbrook, Millbrook)	4–9%	B	3–4,7: stones, slope
URB	Urban	13	N/A			
WAT	Water	45	N/A			
WET	Wetland (520, 540)	60	Poorly drained sandy loams and loams (Masstown, Kingsville)	<3%	D,B	5–7: wetness
WLD	Windsor Lowlands (511)	265	Imperfectly drained loams (Queens)	4–9%	D	3–4: wetness
YUH	Yarmouth (820)	28	Imperfectly drained gravelly sandy loams (Springhill)	4–15%	H	4–5,7: wetness

Table T12.9.1 Summary of Agricultural Resource Areas in Nova Scotia

also support soils suitable for commercial exploitation (see T12.4). There is little land that might possibly be suited for agriculture that is not farmed or developed. About three-fourths of the farmland in Nova Scotia has a permanent crop cover. Table T12.9.1 summarizes the distribution and soil types in agricultural areas in the province in the 1990s. See T5.2 for a summary of the dominant climate conditions in different parts of the province.

DEVELOPMENT

The generalized distribution of soils and farming activity (Figure T12.9.1) serves as an indicator of the potential of the environment to support human settlement. Settlement within Nova Scotia is characterized by a pattern of concentration and linear dispersal. Urban regions are areas of population concentration, for example, the Halifax-Dartmouth Metro Area. In Nova Scotia, population concentration is focused in areas of relatively low soil quality, such as Halifax. At the same time, linear settlement patterns, with some clustering, are notable for coastal areas and for agricultural regions.[6, 7] Overall, outside of the more substantial urban regions, population densities are low. Higher-quality soils for agriculture allow for slightly higher densities of land occupation. Consequently, the Annapolis Valley (District 610) is more densely inhabited than the highlands (Region 200).

Human interaction with the environment can affect the quality of the environment, including soils. Settlement patterns represent a level of permanent human presence in a region and are an associated indicator of environmental threat. In Nova Scotia, urban development does not appear to be a substantial threat to soil quality. Where density of occupation is coupled with a highly altered landscape (e.g., the agricultural landscape), the potential for soil degradation is greater.[8]

SOIL DEGRADATION

Soil degradation results from the acceleration, by humans, of naturally occurring processes. Soil degradation processes in Nova Scotia include erosion by wind and water, acidification, compaction, contamination and the loss of organic matter.

Erosion

Erosion occurs when soil loses its stability after being stripped of vegetation (see plate T12.9.2). Erosion by water can occur on row-cropped land, highway construction projects and as a result of forest-access roads and clearing trails. Water erosion is greatest on steep land and on soils with slow infiltration rates.

Stream-bank erosion can be accelerated by increasing water-flow rates through a channel as a result of land clearing in the watershed area, e.g., forestry practices (see T12.10). Surface erosion is site-specific and can occur wherever soil is exposed by construction, forestry, clearing, etc.

Wind erosion relates to texture and absence of ground cover. In Nova Scotia, it is an issue only on exposed sandy soils, such as sandy areas in the Annapolis Valley and coastal sand dunes (see T12.7 and H2.6).

There are soil conservation guidelines in Nova Scotia that relate to forestry, construction and agriculture activities.

Acidification

Acid rain is not a soil-acidification problem for most farmers in the province, because they have to apply large quantities of lime to counteract natural acidity. The low buffering capacity of soils, however, makes acid rain a concern for large areas of uncultivated and forested lands in the province, where liming is not a common practice (see T12.8).

When soil pH varies from near neutral, many nutrients become unavailable to plants, while others can be released in toxic amounts. Newly cleared land in Nova Scotia requires 15–30 tonnes of lime per hectare to raise the topsoil pH to near neutral. The initial treatment is carried out in several stages; not all the lime is added at once. About 500 kg per hectare of lime is required annually to maintain the pH.

Compaction

Nova Scotia soils tend to be moist throughout most of the year, making them resistant to wind erosion but susceptible to compaction. Most soils in Nova Scotia have a naturally compact layer starting at 40–60 cm below the surface. Activities that increase overburden, such as filling, construction and walking, aggravate soil compaction, impeding root growth.

Hardpan is a term commonly used to refer to hardened or cemented layers in the soil profile that impede drainage or rooting. There are various theories as to what causes the cementation of soils; however, in Nova Scotia, the main focus has been on how to mix the layers to improve drainage for agriculture. See Figure T9.2.1k, which shows the changes that occur in a typical Cornwallis soil profile before and after cultivation.

Contamination

Soil contamination can occur as a result of toxic spills, excessive use of chemicals, tar ponds, industrial-waste dumps and buried fuel tanks.

Loss of Organic Matter and Nutrients

Soils in Nova Scotia have a low organic-matter content at the surface. Agriculture can add organic content. Loss of organic matter is of concern on annually cultivated land and in clear-cuts. Little is known about the effect of human activities on the biological environment (see T9.3) of soils.

Nutrient loss can also occur from soil-leaching processes and harvesting methods in forestry, which remove tree limbs and foliage as well as logs from cut-over sites, thereby preventing this discarded biomass from decaying and enriching soils. This process can be further accelerated by intensive harvesting techniques. Loss of soil nutrient leads to lower forest productivity.

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Associated Topics

T5.2 Nova Scotia's Climate, T9.2 Soil Classification, T9.3 Biological Environments, T12.4 Glacial Deposits and Resources, T12.7 The Coast and Resources, T12.8 Fresh Water and Resources, T12.10 Plants and Resources, T12.11 Animals and Resources

Associated Habitats

H2.6 Dune System, H5.2 Oldfield

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Plate T12.9.2: Soil erosion during highway construction in Nova Scotia in the early 1970s. Exposed soil becomes compacted by rain and baked by the sun. Consequently, little rain soaks in and most runs off rapidly, cutting deep gullies and carrying quantities of silt into streams and rivers. Photo: R. Merrick.

T12.10 PLANTS AND RESOURCES

Nova Scotia's native plants and their use by humans have been a major factor in shaping cultural customs, landscape features and the provincial economy. In addition, the many wild and cultivated plants growing in Nova Scotia today that are exotic, introduced species have also played a part in the province's history.

HISTORICAL CONTEXT

Before European Contact

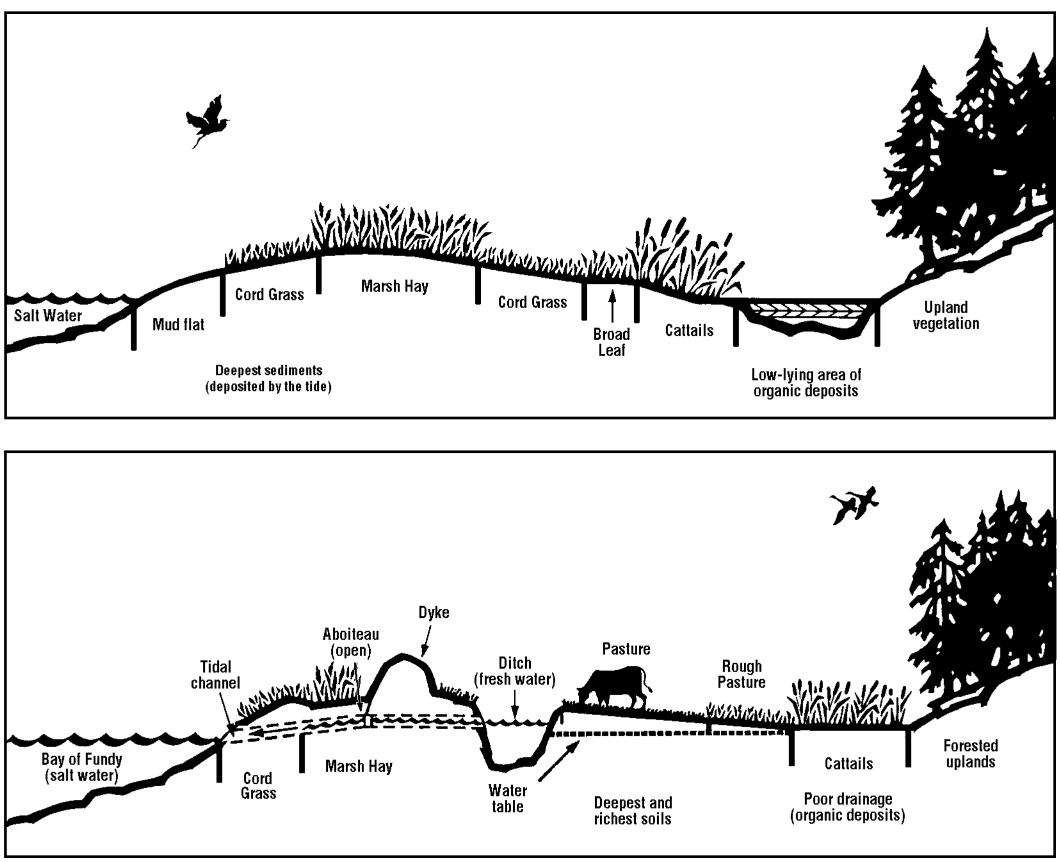
The use of Nova Scotia's native plants is a part of the cultural history of first peoples in the province. The Mi'kmaq used the bark, roots and wood of trees to make birchbark canoes, shelters and utensils, and tapped maples for syrup. Barren, forest and aquatic-habitat species were extensively used for food and medicine. Plant species were an essential part of their hunting-gathering culture; however, the human population was relatively small and the use of plants is not thought to have had significant effect on habitat composition and species distribution. (Mi'kmaq people maintain traditional uses of plants for food and medicine.)

> *Native people made a significant contribution to early colonial medicine. For example, in the 1600s, they introduced French settlers to spruce tea as a treatment for scurvy.*

1600s and 1700s: Coastal Plants

The first Europeans settled mainly along the coasts of Nova Scotia and used plants found in coastal habitats. The French dyked the extensive tidal marshes (see H2.5) along the Northumberland Strait and Bay of Fundy. The process of creating farmland by dyking removed the natural vegetation typical of tidal-marsh communities (see Figure T12.10.1). Salt

Figure T12.10.1: Changes in species composition and landscape features in undyked (a) and dyked (b) salt marsh in the Inner Bay of Fundy (Unit 913). Adapted from Howell et al.[1]



T12.10 Plants and Resources

Plate T12.10.1: Land conversion near Pictou in 1817. This Woolford watercolour shows the extensive hardwood forest in the West River valley (sub-Unit 521a) being cut and the stumps removed prior to cultivation. The native forest vegetation is replaced by an introduced herbaceous vegetation associated with agriculture. Historical plate: N.S. Museum, Museum Services Division.

marsh grasses, particularly Marsh Hay (*Spartina patens*) (see T10.5), were cut and used as hay. (See T12.7 and T12.9 for more information on dyking.) As settlement expanded, marine Eelgrass beds were harvested and used as insulation in Maritime homes, both inside walls and outside buildings for use as winter "banking".

Following the deportation of the Acadians by the British in 1755, land clearing began in earnest. Large stands of old-growth forests were cut along navigable rivers to accommodate the influx of New Englanders in the 1760s. This was followed by the clearing and burning of large tracts of forests along the coast and inland.

1600 and 1700: Forestry

Nova Scotia's forests have been subjected to a longer span of activity by Europeans than any in North America (see T10.1, T10.2). Forests provided the fuel, the construction materials, the export staples and the pastures on which the settlement frontier was founded. Timber was the colony's chief export after fish, providing cash income to many settlers. In the early era of forestry, stands were highgraded for the best lumber and trees suitable for ship masts (see T12.6). The Broad Arrow Policy of 1728 reserved by law large pine trees for use as masts and spars for the Crown. Hemlocks were often cut and stripped of their bark for use in tanneries, while the tree bole was left behind to rot. These practices continued for many years and were later followed by clear-cutting methods when the demand for pulpwood increased. Prior to this, inferior and unmerchantable trees were left standing and so provided much of the genetic stock required for regrowth.

In the late 1700s, uncontrollable fires threatened Liverpool. In the wake of such repeated fires, large areas of pioneer hardwoods, such as aspen and birch, sprang up, especially in the eastern counties, only to give way to even-aged stands of spruce and fir.

1800 and 1900: Forestry

Nova Scotia's forests have been cut over for 300 years, but intensive forestry operations have occurred during the past 150 years. Many of our forests have been cut over three times (see Plate T12.10.1).

Timber was exported, and a considerable amount was used for the booming shipbuilding industry of the mid-1800s. At this time, 1 400 sawmills were in operation, the majority of which were powered by water.[2] In some areas, concern was expressed over the effects of sawmill dams, log drives and sawdust pollution on freshwater fish (see T12.8). Between 1800 and 1818, annual exports of Nova Scotia fir and oak timber alone rose from 604 to 28 082 shiploads. While the lumber trade fueled the economy, the land was transformed; by 1837–38, the original-growth pine was already exhausted.[3]

With the old stands gone, successive forests were exploited for pulp-and-paper production, a process that was invented in 1839 by Charles Fenerty of Upper Sackville. Over time, this new use has created significant impact on the landscape, as many mixed forests have been transformed by forestry practices into large stands of even-aged softwoods.

At the beginning of the twentieth century, Dr. B.E. Fernow, in his survey of Nova Scotia forests, undertaken for the Commission of Conservation concluded that the province's forests were being cut at a rate exceeding their ability to regrow.[4] The opening in 1928 of the Bowater Mersey Ltd. paper mill in southwestern Nova Scotia greatly increased the impact of forest harvesting as a change agent for Nova Scotia's forests (see T10.1). In the early and mid-1960s Nova Scotia Forest Industries and Scott Maritime Ltd. mills opened in the central and eastern regions, continuing to accelerate the process of species composition and distribution change.

Introduced fungi and insects wrought other changes (see T11.16). White Pine Blister Rust, imported on nursery stock in the 1900s, degraded the few remaining White Pine stands. In the 1930s, stands of beech, once a fairly abundant component of the ancient Acadian forest, were severely depleted by beech bark disease, which entered via Halifax around 1890. Balsam Woolly Aphid, arriving from Europe some time before 1910, slowly stunted the growth of many Eastern fir stands. Finally, a native insect, the Spruce Budworm, proved to be a most powerful influence, consuming at fairly regular intervals whole tracts of overmature spruce and fir, so that they reverted to immature stands, which in turn became fodder for the same insect a few decades later. The natural increase of fir after forest harvesting and of White Spruce after farm abandonment have exacerbated this problem.

Barren Species

The lowbush blueberry (*Vaccinium augustifolum*) has long been picked for its fruit and has commonly grown on abandoned farmlands or disturbed habitats—often where forest fires have left many acres of barren land. Burning blueberry barrens with flash fires was a practice that came into use over a long period of time, beginning in Nova Scotia in the late 1890s. The intent was to prune plants to improve their growth. However, by 1904, fire-ranger reports confirmed that burning for the cultivation of blueberries had become widely practised and, indeed, somewhat of a problem, since it resulted in the loss of many valuable acres of timber. This was particularly true in southwestern Nova Scotia. Some areas, notably the drier granitic sites of the western counties, were permanently degraded by fire to heathland and rock barren, as nutrient-poor soils and climatic conditions inhibited future forest growth (see H5.1).

By the 1940s, sufficient knowledge had been gathered and laws passed to make the practice of periodic blueberry bush-burning a viable and safe system of cultivation. In Cumberland County, forest fires in the 1920s left large areas of blueberries growing in abundance, and people began to exploit this newly found source of wealth.[5]

Bog Species

The commercial cranberry industry also has a long history in Nova Scotia. Experiments in the cultivation of this berry began in 1871, when William MacNeil, of Annapolis County, planted a small area on the edge of a peat bog. By the late 1800s, cartloads of cranberries were being shipped to Boston, Montreal and Britain. Interest in cranberry production was renewed in the 1960s, and old cranberry bogs were brought back into operation. Commercial cranberry farms now operate in several parts of the province.

Coastal and Marine Plants

The extensive logging and farming (see T12.9) occurring as a result of increased settlement in Nova Scotia created sediment banks along the coast and in estuaries. The sediments were colonized by marsh grasses and eventually developed into tidal marshes (see T12.7). Historical records show a similar pattern all along the Atlantic coast of North America, where many streams that once were clear and free of sediments and river systems that were once navigable have been filled by sediments and developed into marshes.

The harvesting of Irish Moss from the ocean bottom started as a cottage industry in the 1930s. Prior to 1940 it was collected in the Antigonish area. Harvesting intensified during the Second World War, when traditional sources of supply from Europe and Japan were no longer available to the United States.

Traditionally, rockweed was used as an agricultural fertilizer and soil conditioner. In the past thirty years, it has been used for the production of alginate (a food additive that stiffens products such as ice cream and milkshakes), seaweed meal to condition soils and a fertilizer that is applied to leaves. Commercial exploitation began in the early 1960s in southwestern Nova Scotia.

PLANTS AND RESOURCES TODAY

Forestry

Over the years, most of the old-growth forest types (see H6 Introduction), dominated by White Pine, Red Spruce, Eastern Hemlock, Sugar Maple and Yellow Birch, have given way to early-successional stands dominated by Balsam Fir, Red Maple, aspen and White Birch (see T10.2). The overall structure and composition of the current forest and associated plant communities bears little resemblance to those of 200 years ago.

From a forestry perspective, the forests of Nova Scotia are capable of yielding significantly more than current yields from existing mature stands. Only in the last couple of decades has the government introduced initiatives to restore our forests to a more productive and healthy state and to meet the challenge of sustainable forestry. The Department of Natural Resources indicates that, at current levels of management, industrial harvest based mainly on the softwood species could be increased by more than fifty per cent by the year 2025.[6]

While the forestry sector in Nova Scotia is dominated by pulp-and-paper manufacturing, many other products are produced, including sawlogs and lumber, Christmas trees, maple syrup, firewood, poles and pilings. Forest products comprise thirty per cent of provincial exports.[7]

Technology

Prior to mechanization, forestry was a more labour-intensive industry than it is now. By the early 1970s, large forestry companies were replacing the pulp cutter with mechanized harvesting and massive clear-cutting, considered by industry to be the most economically viable harvesting method.[7] Major environmental impacts have occurred as a result of forestry activities such as clear-cutting, and, although ninety per cent of Canada's forests are clear-cut, questions remain surrounding the long-term ecological sustainability of this practice. It has been argued that partial or selective cutting practices are preferable.

Insecticides and Pesticides

Chemical weeding practices, such as herbicide spraying, are used to destroy the fast-growing hardwoods, like birch and maple, that are the first to appear on clear-cut areas and compete with regenerating softwood species. Bt (*Bacillus thuringiensis*), a bacterium lethal to Spruce Budworm, has been used as a biological agent to control budworm outbreaks in the province. The impacts of insecticide and herbicide use in forestry are of potential significance and have generated debate over possible environmental effects on terrestrial and aquatic systems and human health.[8]

Genetic Degradation

The impact of forest activities that is hardest to quantify is genetic degradation. That this has occurred seems almost certain, considering the extent of highgrading at every stage of forest exploitation in the past—first the best pine was taken for masting timber, then the best pine and spruce for select deal logs and finally the best softwood stands for prime lumber and pulpwood. The effect has been to leave inferior specimens as breeding stock. Thus, the long-lived, shade-tolerant pine, Sugar Maple, Yellow Birch, Hemlock and Red Spruce, which were the main components in the original forest, have been degraded.

Erosion

Erosion has occurred on many clear-cut watersheds, resulting in a degradation of water quality and fish habitat, and loss of soil and some soil nutrients (see T12.9). The effects of erosion are greatly decreased by following established environmental guidelines for forest harvest, including the use of uncut woodland buffer strips or greenbelts to protect streambanks from disturbance and the careful planning and construction of roads, especially road stream crossings, with culverts placed to allow the passage of fish.[9] Loss of soil nutrients can also occur as a result of leaching (see T12.9).

Wildlife

Wildlife habitats can also be affected by forestry. In general, the use of larger clear-cuts (greater than 10–15 hectares) produces greater effects than smaller ones, particularly if the latter are spaced so as to produce a mosaic of habitats. As long as suitable winter range conditions remain, species such as White-tailed Deer, Moose and Snowshoe Hare benefit from some forest-harvest practices, largely owing to the production of browse on regenerating clear-cuts. Particular forest birds may be either positively or negatively affected, depending on their ecological requirements. Freshwater fish habitats have been greatly affected by the harvesting of some watersheds, which has resulted in erosion, siltation and increased water temperature; however, leaving uncut greenbelts alongside streams alleviates this.[10]

Over two-thirds of the forests in the province are privately owned, a consequence of early colonial policies that liberally dispensed land grants to attract settlers, leaving less than thirty per cent for Crown land. This private-sector ownership comprises small-woodlot owners, who possess fifty per cent of forest land, and forestry and lumber companies, who own an additional twenty-one per cent. Although forestry and lumber companies also lease Crown land, eighty per cent of the total harvest comes from privately owned lands. Slightly less than three per cent of the forest is vested in the two national parks, Kejimkujik and Cape Breton Highlands.

In addition to their importance to the economy, Nova Scotia's forest lands are immensely important to a wide variety of people who use them for such activities as hiking, bird-watching, boating, camping and hunting.

Blueberry Harvesting

Although blueberries are now grown commercially in many parts of Nova Scotia, 75 per cent of the cultivation takes place in Cumberland County. The many millions of kilograms of blueberries produced each year have transformed the blueberry into one of the most important horticultural crops in the province.

Barren areas that have resulted from forest fires or cutting support natural growth of lowbush blueberry. These areas are regularly burned to stimulate growth and to deter natural succession (see Plate T12.10.2).

Plants of Coastal and Marine Habitats

Irish Moss, Dulse and Knotted Wrack or Rockweed are harvested from tidal or shallow subtidal zones (see T10.9 and H1.2) with mechanical or manually operated rakes or cutting devices.

In the southern Gulf of St. Lawrence (Unit 914), Irish Moss is harvested by dragging rakes along the ocean floor behind boats. Off southwestern Nova Scotia (Unit 911), harvesting is carried out by handraking from small dories. Carrageenin, which is extracted from the moss, is used as a jelling, emulsifying and stabilizing agent in foods, drugs, paints, etc. The three Maritime provinces account for about three-quarters of the world's supply of Irish Moss.

Plate T12.10.2: Blueberry fields near Folly Mountain (Unit 311). Photo: R.Lloyd

Rockweed is also harvested in southwestern Nova Scotia and is processed into alginic products. Dulse, which is gathered around the province, is dried and eaten by humans.

Proper spacing of the tines on the harvesting rakes permits the holdfast to remain attached to the rocks and allows the plant to continue growing. Ice remaining in areas such as the Northumberland Strait in late spring can affect harvesting by scraping the bottom and removing plants. Irish Moss beds are slow to recover from damage caused by dragging or ice, as new plants re-establish from spores. The National Research Council of Canada has developed a fast-growing strain of Irish Moss for aquaculture in seawater tanks. Rockweed requires two to five years to recover from harvesting, depending on the degree of harvesting and local productivity. The development of rockweed harvesting in the 1980s has resulted in competition for access to local resources, local overharvesting and the breakdown of harvesting strategies.

The gathering of Irish Moss is considered a fishing activity since it is harvested from the sea, primarily by lobster fishermen during the closed season.

INTRODUCED PLANTS

Approximately 400 new species of vascular plants have been reported since about 1800. Introduced plants are, for the most part, related to human activities. When anthropogenic habitats revert to natural ones, shading by native shrubs and trees eliminates most introduced flora or at least restricts their numbers to naturally maintained, open, disturbed ground, such as that bordering rivers and streams and at the landward margin of coastal cobble beaches. Fields left fallow are covered first with grasses and weeds, but within a few years, alders and White Spruce take hold in sufficiently moist sites (see H 5.2), or lichens and grasses in sandy, rocky or otherwise drier sites.

Introduced plants are here to stay. The more permanent ones are said to be "naturalized", that is, originally coming from a foreign area but now thoroughly established. Imperfectly naturalized plants are described as "adventives". But, whether naturalized or adventive, introduced species will continue to be with us for as long as there are humans to clear away shading trees and shrubs and to maintain areas of open, disturbed ground.

Weeds

The most commonly encountered introduced plants are the weeds, a convenient grouping of the more aggressive species that grow where people do not want them. Most weedy species were not introduced intentionally. A major source of continuing introduction from earliest settlement times up to the beginnings of this century was impure agricultural seed. The advent of modern seed-screening techniques, inspection programs and strict import regulation is relatively recent. Previous to this, seeds from crop plants in Europe gathered for export included the seeds of whatever weeds were growing in the same fields.

Weeds were also introduced in packing material consisting of dense masses of dried vegetation or dunnage, in animal foodstuffs and in straw bedding. Alien plants and other associated organisms (see T12.11) were also unintentionally introduced in ship ballast unloaded on Nova Scotia's shores. One Nova Scotia ballast dump site was beside Steele's Pond by Point Pleasant Park, Halifax. Here, intrepid Nova Scotia naturalist John Erskine and his botanist son, David Erskine, collected a number of exotic rarities included in the second edition of *The Flora of Nova Scotia*. The Northumberland Straits area, with old ballast dumps at Pictou and elsewhere, includes the sites for a number of well-established introductions, many still more or less limited, however, to this part of the Gulf of St. Lawrence. Introduced into this region, for instance, are two species of *Atriplex*, a genus of mostly salt-loving plants. One *Atriplex* species has become an integral component of the local salt vegetation; the other is widely scattered on most sandy beaches bordering the Gulf of St. Lawrence.

Most of the noxious weeds were introduced from Europe into regions of North America that, like Nova Scotia, were originally covered by forest. When humans first began to clear the forests and till the soil, they provided an environment particularly well-suited to these inhabitants of unshaded, naturally disturbed ground. Weeds quickly took to colonizing the freshly exposed unsettled soils. The most successful species were those whose original environment matched most nearly their new one. Native woodland species, accustomed to a moist, rich cover of humus, higher humidity, reduced sunlight and other factors associated with a woodland environment, were unable to persist very long after the land had been cleared.

Weeds have grown in cultivated land for so long that they have become particularly well adapted to managed environments. This is believed to be one reason why introduced weeds tend to be more aggressive and persistent than most native species. Another reason is that in travelling abroad, plants often left behind many of their natural adversaries such as insects that fed upon them. Tansy Ragwort is a cattle-poisoning weed particularly abundant in Pictou County and northeastwards into Cape Breton. Larvae of the European Cinnabar Moth feed exclusively on ragwort in its homeland, but none arrived with their foodplant. Some years ago, the Cinnabar Moth was purposely introduced into northern Nova Scotia, where it is now helping limit the spread of ragwort (see T12.10).

As well as competing with cultivated plants, a large number of weeds act hosts for fungi, bacteria and viruses, causing diseases that are transferred to crop plants. Some of the disease-causing organisms attack both the crop plants and closely related weeds. In other cases, a number of parasitic fungi that attack crop plants spend part of their life cycle on botanically unrelated weed hosts. A well-known example is the fungus that causes Black Stem-rust of wheat, oats and barley. Part of its life cycle is spent on the European Barberry. From infected barberry leaves, the fungus produces spores that infect wheat and the other two cereals.

Some introduced plants, such as Daphne and Poison Hemlock, while uncommon, are deadly poisonous; the bright-red berries of Nightshade, a ubiquitous climbing city weed, although only mildly poisonous, seem especially attractive to children. Ragweed pollen is the major cause of late summer and autumnal hayfever in eastern North America. The plant itself, introduced from western parts of the continent, is now particularly widespread along roadsides in Kings and Annapolis counties.

Not long after they were established in eastern North America, introduced weeds were presented with two new ideal habitats: railways and roadsides. The weeds were quick to occupy the newly disturbed open ground, which also provided them with convenient corridors for westward travel. Later, these same routes were to facilitate the eastward spread of weedy native species from western grassland regions. Such natural agents as wind, water and wildlife continue to help disseminate those weeds first brought here by humans.

T12.10
Plants and
Resources

Cultivated Species

Most cultivated plants, such as Horse-chestnuts and lindens and many garden flowers, require more or less constant tending to persist. Given a head start, they may outstrip their competitors or else, as in many lawns, coexist with native plants. More often, though, cultivated plants need help to survive and flourish.

Many garden species brought from abroad and cultivated early in Nova Scotia, escaped cultivation and are now known as “garden escapes”. Some spread widely; others stubbornly persisted, often spreading vegetatively by underground stems. One of the best-known examples is Japanese Knotweed. Originally from Asia, it was introduced into Great Britain as an ornamental; from there it probably came into Nova Scotia and other parts of eastern North America. Heather is another persisting introduced plant occurring in scattered localities throughout the province.

Lupines were introduced from western North America and now grow well along roadsides. Likewise, Black-eyed Susan, a native of the central United States, grows along highway margins. Other widespread ornamentals include Moneywort, Bellflower, Muskmallow, Ground-ivy, Goutweed, Queen-of-the-meadow, and the succulents stonecrop and Live-forever.

About 100 years ago, “wild” heather in Point Pleasant Park was investigated by Dalhousie botanist George Lawson. He found it spreading from an old garden where it had earlier been planted. He reported his findings in the Proceedings of the Nova Scotian Institute of Science. *Park authorities, however, prefer the more romantic myth that the heather originated from seeds shaken from the mattress ticking of Scottish soldiers who encamped in the park after arriving from Scotland.*

Some garden species can coexist with with native species in unmanaged habitats. For example, European Columbine grows in rich wooded intervale soils along with native wildflowers.

Herbs also escaped cultivation. Wild Caraway is the most frequent escape, occurring most commonly around fishing villages. The mints, peppermint and spearmint, are scattered around the province but remain very local in places where they were previously cultivated. A few plants, cultivated as vegetables, such as Wild Parsnip and Chicory, are common in some parts of the province. Drug plants such as Celandine, Wormwood, Comfrey and Tansy can be found persisting in areas where they were formerly planted. Forage crops, some still cultivated, are common escapes found in fields and roadsides. These include legumes such as the White and Yellow Sweet-clover, and numerous European grasses, the best known of which is Timothy, now well established in North America.

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T12.11 ANIMALS AND RESOURCES

Human dependence on other animals is part of the web of life. A reliance on animal populations was instrumental in shaping Mi'kmaq and colonial cultures. To a degree, this still holds true today, as the commercial fishery continues to shape the life and sustenance of many of the province's coastal communities. Our reliance on animal species has influenced populations and diversity, changed habitat structure and, ultimately, contributed to the modification of landscapes in Nova Scotia.

It is possible to link changes in animal communities to the combination of harvesting and conservation practices that comprise wildlife management. It is much more difficult, however, to connect species-population trends directly to other consumptive activities, such as forestry, agriculture and development. In addition, there are many natural factors that affect population dynamics.

The following outlines significant activities that have had documented influences on terrestrial- and aquatic-animal communities in Nova Scotia. A discussion on the historical use of animals as a resource is followed by contemporary activities related to specific groups or species of animals. The Topic concludes with a section on animal species introduced to Nova Scotia after European contact. See T4.3, Colonization by Animals, for information on post-glacial migrations of species into the province.

In the 1990s, the term "wildlife" was officially broadened by environment officials to include all nondomesticated, wild-living organisms, including invertebrates, all plants, and bacteria.[1] Traditionally, "wildlife" referred to the fish, mammal and bird classes. This is the interpretation that is used in this text, bearing in mind the ecological roles that are played by bacteria, algae, fungi and invertebrates as part of ecosystems in the landscape.

HISTORICAL CONTEXT

Prehistory to European Contact

Animals have played a basic sustenance role in human cultures in Nova Scotia for approximately 10 000 years. Blood on stone tools found at the Debert archaeological site indicates that early people hunted Caribou and other large mammals adapted to migration and tundra-like environments. After glaciation, the tundra changed to dense boreal forests that could not have supported large mammals, thus confining food-gathering and hunting activities to the ocean and shore areas (see T3.3 and T4). Shell middens dating to the Ceramic Period (2500–500 BP) indicate that marine species were a substantial part of diets at that time.

European Contact to the 1800s

Mi'kmaq cultures hunted land and marine mammals and fish for sustenance and some trading until the late sixteenth century, when traditional activities began to change in response to contact with the Europeans. The commercial focus and subsequent trading and market hunting affected some animal populations to the extent that species such as the Sea Mink became extinct. Animal populations and diversity were also influenced by loss of habitat resulting from increased forest fires and land clearing.[2]

Hunting as a sport emerged gradually as hunting for food became less a part of everyday life. In 1794, the first game law made it unlawful to kill partridge and some species of ducks at certain times of the year.[3] In the mid-1800s, a small group of sportsmen and soldiers of the British garrison formed the Nova Scotia Game Society, resulting in the first hunting season to limit the taking of Moose. Beginning in 1874, a three-year closed season to help build up the Moose herd was introduced with the appointment of the first game wardens. During the later half of the nineteenth century, when sport hunting became popular in Nova Scotia, the Mi'kmaq, with their much-revered knowledge of wildlife and wilderness areas,[2] proved indispensable as guides. The contemporary history of hunting, trapping and fishing in the province was very much influenced by the creation of the Department of Lands and Forests in 1926, which began to monitor animal populations and set up conservation programs.

Commercial exploitation of marine mammals began in the 1500s, when Basque fishermen hunted large numbers of whales in the Gulf of St. Lawrence (Unit 914). Other marine mammals, such as the Atlantic Walrus or "Sea Cow", were hunted to the point of extinction. French settlers hunted them for their oil and ivory, and by the late 1700s, they had vanished.

As early as the 1500s, fishermen were harvesting cod to be salted and dried for overseas markets. The cod fishery shaped the colonization of Nova Scotia, serving as its basic commodity for international trade (see T12.6). Many people settled to fish—or if they settled for other reasons, they soon turned to fishing as a living. Fishing methods changed as twentieth-century technology replaced canoes, tall ships and schooners with motor-driven trawlers and long-liners. This change allowed fishermen access to offshore fishing grounds. Fishing was usually seasonal, and fishing bases were on cove heads and islands where fish could be salted before returning home when the catch was full or the season ended (see Plate T12.11.1). As truck transport, paved roads and refrigeration became common, the curing process of the salt dry cod was largely overtaken by the demand for fresh and frozen fillets, and the traditional character of the fishery was transformed to meet modern marketplace needs.

1900s

Whaling operations have, over the years, severely reduced populations of several species, including the Right, Humpback, Sei, Sperm, Blue and Fin. After centuries of exploitation off our shores, the Northern Right Whale is now listed as an endangered species by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (see T11.18). Widespread pressure led to international agreements to stop whaling, and in the early 1970s, Canada banned whaling in its waters, shutting down a whaling station in Blandford, Nova Scotia.

Harp and Hooded seals were the focus of a hunt for many years until 1987, when the annual seal hunt in eastern Canadian waters was closed to large vessels.[4] A bounty system in response to fishery concerns was in operation from 1927 to 1976 and was effective in reducing populations of Harbour Seals. The Grey Seal is the most important host for the sealworm parasite which effects groundfish; however, government bounties have been ineffective in culling their populations.

In 1977, Canada declared a 200-mile economic zone (see map insert in *Volume 2, Theme Regions*), in an effort to prevent overfishing and depletion of the fish stocks by foreign fleets in the northwest Atlantic. This raised expectations that the fishery would finally be on a sound basis, but events proved other-

Plate T12.11.1: Split cod drying on wooden racks. These structures were a typical landscape feature of the makeshift communities set up seasonally on coastal headlands and offshore islands. The camps provided a place to process the fish while allowing fishermen continuous access to the inshore fishery. This picture was taken in the 1970s—the end of an era in the cod fishery. Photo: R. Merrick.

wise, as the effects of advanced fishing technology, overfishing practices, inadequate management and possible environmental factors (weather and oceanographic) contributed to a collapse in cod stocks by the early 1990s. The result was severely cut cod quotas and the institution of fishing moratoriums in Atlantic Canada to allow cod populations to recover.

ANIMALS AND RESOURCES TODAY

Habitat Modification

Habitat modification through human land use has altered wildlife population numbers and distribution patterns. Agriculture, forestry, road corridors and settlements have all created an increase in "edge" habitat, where forests meet clearings. This has been accompanied by an increase of shrub and sapling habitats in the early stages of forest succession. While it has not been good for the Fisher, Marten, Southern Flying Squirrel or birds requiring mature forest habitats, many species have benefited: e.g., mice, squirrels, chipmunks and other small mammals that find an abundance of nuts and fruit in these settings. Hares, Moose and deer also thrive in woodland margins, where browse is plentiful.[5] As well, birds using these "edge" habitats have increased more than any other group, as exemplified by the Robin, Song Sparrow, Alder Flycatcher and Common Yellowthroat. Since many mature hardwood forests have been replaced by solid coniferous stands, there has also been an increase in birds that prefer this habitat, especially budworm followers, such as Bay-breasted and Cape May warblers.[6] Apart from altered habitats, wildlife must contend with pressures generated by agricultural and forestry practices, chemical pesticides, toxic contaminants, acidic waters and increased human disturbance in wilderness areas made accessible by logging roads, power-line corridors and all-terrain vehicles.

Habitat Conservation and Management

To protect habitats and wildlife, the Department of Natural Resources and the Canadian Wildlife Service administer sanctuaries, wildlife management areas and ecological reserves. Hunting, fishing and forestry are either prohibited or controlled in these areas. The largest provincial game sanctuaries and wildlife management areas at Waverley (Unit 453), Liscomb (sub-Unit 413b), Tobeatic (sub-Units 412a/440a) and Chignecto (Unit 532) comprise both private and Crown land. Conflicting land uses in the Tobeatic and in Liscomb have led to the initiation of integrated resource management proposals, which include wildlife habitat management and game harvest controls.

T12.11 Animals and Resources

Some conservation and management practices focus on single species conservation. Migratory waterfowl habitats have been protected by coastal wetlands conservation sites throughout the province including the Chignecto and Musquodoboit wetlands. Workers in Piping Plover conservation programs post signs asking beach visitors and all-terrain vehicle drivers to stay close to the water's edge so that human disturbances will not continue to cause plover nest failures on our beaches. There is growing involvement from private landowners in stewardship programs.

"Eco-tourism"

Many people come into contact with Nova Scotia wildlife through recreational activities such as whale-watching, bird watching, hiking and camping. This burgeoning industry in the province is shaping the value we award wildlife and "wilderness" areas and will require better records and management of habitat to achieve sustainable use.

Hunting

Thirteen per cent of Nova Scotians today are hunters, interested in "game" species ranging from Moose, White-tailed Deer, Black Bear and Snowshoe Hare to migratory birds, such as waterfowl, the Common Snipe and woodcock. Nova Scotia's Wildlife Act regulates hunting and sport fishing through mandatory license stipulations. In the 1980s, approximately 91,000 deer licenses were issued annually, with an average yearly provincial kill of 46,000 deer.[7] Wildlife biologists monitor "game" species populations to determine distribution and density throughout Nova Scotia. Traditional relationships to the land remain important to Mi'kmaq culture. In the 1980s, the Mi'kmaq asserted their traditional Moose-hunting rights and won a Supreme Court victory, which upheld their 1752 treaty rights.

According to the results of a 1981 government survey on the value attached to wildlife by Canadians, nearly ninety-six per cent of Nova Scotians participate in some wildlife activity—hunting, fishing, trapping, watching birds, photographing wildlife, reading outdoor and nature books and magazines, or viewing films and television programs on wildlife themes.[8] Viewed as a resource, animal wildlife provides a wide range of social and economic benefits to Nova Scotians.

Plate T12.11.2: Square-net fishery for Gaspereau on the Gaspereau River in Kings County (sub-Unit 422b) is an example of traditional knowledge applied to sustainable exploitation of a species. Harvesting Gaspereau is a seasonal occupation, occurring when the anadromous species (see T11.13) travel from the sea to freshwater lakes to spawn. Photo: R. Merrick.

Freshwater Fishing

The freshwater fishery of Nova Scotia has evolved from solely subsistence or commercial use to an increasingly recreational one with an estimated 102,000 anglers. Logging roads and all-terrain vehicles have opened up formerly inaccessible wilderness areas for recreational fishing. The most popular species are, in ranking order, the three trout species (Brown, Speckled or Brook, and Rainbow), Atlantic Salmon and Smallmouth Bass. Five provincial fishing districts have been established by the Nova Scotia Department of Fisheries to manage inland-fishing activities.[9] Three sport fish—Brook Trout, Atlantic Salmon and Black Bass—are protected by seasons and/or bag limits under the Fisheries Act.[10]

In areas where the underlying geology is predominately sedimentary rock and thick glacial tills, slow-moving gradient streams provide for greater fish production. The Tusket, Medway, Mersey, LaHave, St. Marys, Shubenacadie, Stewiacke, Cornwallis and Annapolis rivers are examples of relatively high-productivity streams. The continuation of freshwater fishing in Nova Scotia is very much dependent on the quality and quantity of freshwater habitats (see Pate T12.11.2).

Stocking:
Close to two dozen Nova Scotia rivers receive almost half a million salmon smolts each year in federal government efforts to enhance salmon populations.[11] As well, provincial programs stock Nova Scotia waterways with close to 100 000 Speckled and Rainbow trout annually. (See “Introduced Species” below.)

Acidification of Fresh Waters:
The number of fish species in Nova Scotia lakes surveyed since 1960 has been positively correlated with pH and lake surface area.[12] The pH levels of lakes from which acid-intolerant species (e.g., Brook Trout and White Perch) had disappeared were significantly lower than those of lakes that still supported populations of those species. It has been estimated that approximately seventeen per cent of all fish populations in Nova Scotia lakes before 1960 had become extinct due to acidification. By 1983, this estimate rose to thirty-two per cent of fish populations in lakes with pH below 5.9. (See T12.8 for more information on activities contributing to acidification of fresh water and its effect on Atlantic Salmon.)

Damming:
In addition to atmospheric pollution, a major cause of salmon-habitat destruction in Nova Scotia rivers since 1870 has been construction of dams for mills and hydroelectric power.[13] Rivers in the province with hydroelectric dams impassable to fish include the Nictaux, the Mersey and the Indian (Halifax County). Rivers with significant fish passage problems caused by dams include the Gaspereaux, the Black and the East (Sheet Harbour). There are policies regulating the passage of migratory fish species in the federal Fisheries Act.

Inshore and Offshore Fishery
Cod is still one of the most important species in the Nova Scotia fishery; however, the commercial catch is diversified, consisting of over two dozen varieties of fish. Almost 60 per cent of the groundfish catch is frozen, about 25 per cent is salted (mainly cod) and less than 10 per cent is sold as fresh fish.[14] The inshore fishery undertaken from many ports around the province, and the offshore fishery conducted by deep-sea vessels, are equally important.

There are 44 fishing districts in the province’s waters and various types of fisheries that reflect different species. However, there are three main commercial fish groups: groundfish, pelagic and invertebrates (molluscs and crustaceans). (Refer to T11.14 and T11.17 for natural-history information on the various groups and species.) Harvesting occurs with fixed gear (baited long lines, lobster traps, gill nets), which remains stationary on the sea bottom, or mobile gear (trawlers, draggers and seiners), which moves through the water to capture fish.

Groundfish Resources:
Groundfish are mainly harvested with otter trawls, baited hooks or gill nets, either inshore or offshore depending on the species. Except for the Northumberland Strait area (Unit 914), where hake and winter flounder are the dominant species, cod has made up the significant tonnage of groundfish landings. Haddock and pollock are also valuable catches, particularly in the Bay of Fundy (Unit 912) and its approaches and on banks of southwestern Nova Scotia (District 930).[8]

Pelagic Fish Resources:
The pelagic fishery includes open ocean species and estuarine species. Herring and mackerel dominate the pelagic group and are caught fairly close to shore with fish traps, gill nets and herring weirs or offshore by the purse seine. Most swordfish vessels operate out of southwestern Nova Scotia, while tuna are caught mainly in the waters off Antigonish (Unit 914) and Guysborough (Unit 911) counties, as well as in St. Margarets Bay (sub-District 460a). Estuarine species, such as salmon and gaspereau, feed near the surface and are harvested with gill nets, purse seines or fish traps.[8] A marine recreational fishery harvests mainly sharks in large bays around the coast.

Mollusc and Crustacean Resources:
The mollusc and crustacean fishery includes bivalve molluscs (scallops, oysters and mussels) and crustaceans (lobsters and crabs). Scallops are landed in numerous ports in the province with scallop draggers. The main beds, however, are found offshore, on the Canadian side of Georges Bank (sub-Unit 931a), in the Bay of Fundy (Unit 912) and approaches, and in the Northumberland Strait (Unit 914).[8]

Aquaculture

Since the late 1970s, aquaculture has been moving from pilot scale to commercial production, harvesting mussels, oysters, Atlantic Salmon, and Rainbow and Speckled trout, with other resource species in development. Aquaculture operations are located in bays, inlets and estuaries in different parts of the province; however, their development is directly related to the availability of suitable sites, including an assurance of high-quality water.

Environmental Concerns in the Marine Fishery:

The modern fishing methods favoured for the different fish groups are the subject of controversy. The debate centres around the effects of the technologies on the ecology of marine systems and the ability of the fishery to sustain itself. Concern over the potentially destructive effects of trawlers and draggers on seabeds has initiated recent studies that suggest that disturbed seabeds suffer a reduction in bottom fauna[15] that may hurt the survival rate of young fish.[16] Protection of the habitat for fish is a major element in a sustainable fishery.

The effects of the fishery on other species is also important. Fishery wastes (mainly discarded by-catch and offal) are exploited by behaviourally flexible large gulls, which have evolved as shoreline foragers. This food supplement has fueled their increase, and now they are so numerous that they are reducing the reproductive success of, and preying on, other seabird species that share their breeding islands. Terns, eiders and puffins are the species most affected by gulls in Nova Scotia. As mussel culture takes over more of the bays and inlets traditionally used by eiders for feeding and rearing their young, there is an increasing intolerance of wild populations of eiders, which feed on mussels. This conflict can only increase and will undoubtedly limit eider populations.

Catastrophic oil spills are well known as killers of pelagic and coastal seabirds (see T12.3), but these events are less important mortality factors than the chronic oil pollution of the seas from marine traffic. Ships pump oily bilge waters into the sea and tankers discharge tank washings. These operational discharges of oil are the most important environmental threat to pelagic seabirds.

Introduced Species

The introduction of exotic animals can cause the displacement of native animals and pest infestations, diseases and parasites. Species are often introduced without the accompanying diseases, parasites and predators that kept their populations in check. They can multiply rapidly and gain the reputation of being pests.

Most introductions are inadvertent, a side-effect of transporting people or goods, particularly plant and animal products. The first introductions almost certainly arrived with the first Europeans. Wildlife management has also resulted in the introduction of several species to Nova Scotia, including nonnative animals and the reintroductions of former resident species.

Birds:

Five introduced bird species have become established in Nova Scotia. Two were introduced as game birds: the Grey Partridge and Ring-necked Pheasant. The Grey Partridge is restricted to agricultural areas in the central mainland, principally the eastern Annapolis Valley (District 610) and the north shore of Minas Basin (Districts 620 and 710). Ring-necked Pheasants are widespread in the central and western mainland.

The other three species became established through deliberate releases or accidental escape, possibly both. The Rock Dove is widespread in agricultural, suburban and urban areas throughout the province. The European Starling and House Sparrow, both cavity nesters, are found in all but extensively forested areas. These two are the only introduced species that compete directly with native cavity-nesting birds—the Tree Swallow, Eastern Bluebird and Purple Martin.

The Peregrine Falcon, extirpated from the Maritimes in the 1950s, has been successfully reintroduced in Nova Scotia.[17] Five other species, all game birds, have been introduced in this century but have not become established. (See Erskine[6] for details of breeding distribution and status of introduced birds.)

Mammals:

Eight mammal species have been introduced to Nova Scotia and five are presently established. The status of one is unknown.

Horses were first introduced to Sable Island (District 890) in 1738,[18] and their wild descendants are still present. Wild Boar from Europe were introduced and have become feral in a fenced private preserve on Roberts Island, Yarmouth County (Unit 831), where they are hunted by the owner and his guests. Stocking of White-tailed Deer, a former resident species, occurred in the late 1800s and early 1900s, although some deer migrated naturally from New Brunswick.[19] They were not present when Europeans first arrived, but their bones have been found in shell middens dating to about 1000 years before present. Moose were reintroduced on the Cape Breton Highlands (Region 200) from Alberta in 1947 and the American Marten to Kejimkujik National Park (Region 400) in 1986. The Arctic Hare was introduced to Scatarie Island (District 870) in 1975. A population did become established, but it is not known if it is still there. Other species introductions occurred when completion of the Canso Causeway in 1955 allowed the Bobcat to migrate to Cape Breton Island.

Reintroductions and transplants of beaver were begun in 1933, those of fishers in the 1940s and 1960s. The Grey Squirrel has been repeatedly introduced, most recently to the Halifax Public Gardens (sub-Unit 451a) in 1992, but has never become established. The nearest wild population is around Fredericton, N.B.

Three rodents of the family Muridae have become cosmopolitan pests. The Black Rat has probably been established at one time or another in all Nova Scotia seaports but has not been able to persist for long, partly because it is too cold here, and partly because it can not compete with the Brown Rat. The population that existed in Halifax died out or was exterminated before 1861.[20] The Brown Rat is widespread in urban and agricultural areas and at open landfill sites, as is the House Mouse. Coyotes are the most recent new species resident and have invaded on their own, encouraged by human land-use practices.

Fish:

Five freshwater fish species were introduced around the turn of the century to stock streams and lakes: the Lake Whitefish, Brown Trout, Rainbow Trout, Smallmouth Bass and Chain Pickerel.[21] The relatively small size of Nova Scotia's lakes allows these aggressive game fish to compete for food and space with native species. It is estimated that the pickerel and bass can eliminate native predators in five generations. Goldfish, released accidentally, have become a problem in some areas where they compete with minnow species. Two anadromous species, the Coho and Chinook salmons, were introduced more recently as escapes from aquaculture operations.

Amphibians and Reptiles:

The Red-eared Slider (turtle), although not legally sold in Nova Scotia, continues to turn up in local ponds, particularly in parks. It can survive our winters in hibernation but so far has not reproduced. They are generally released pets and considered a pest species, as they eat salamander larvae and tadpoles.

Invertebrates:

In Nova Scotia, as elsewhere, the vast majority of introduced animals are invertebrates, largely insects. Most of them end up as pests of some kind. In Nova Scotia, species such as the Winter Moth, Larch Casebearer, aphids, scale insects and sawflies are notorious for damage to trees and shrubs (see T10.1 and T11.16).

Many invertebrate species have been introduced in ships' dry ballast, by the importation of plants for agriculture and horticulture and by transshipment of goods since at least the seventeenth century. These species arrived as land was cleared for agriculture and development, activities that caused the destruction of native habitats and their associated soils, and the decline of native species. The province's history of human settlement and its geographic isolation have resulted in the highest ratio of introduced invertebrate species to native species in Canada. For example, there are nine species of slug recorded from Nova Scotia of which six are definitely introduced. Some of the slugs are very aggressive and colonize native habitats directly or through the course of succession, while others have remained close to the point of introduction. The native slug species of the family Philomicidae are now restricted to undisturbed forest habitats. More than twenty per cent of all terrestrial mollusc species of Nova Scotia are introduced.

Earthworms, ground beetles, click beetles, cellar bugs, centipedes and millipedes are introduced species commonly found in gardens. Familiar urban invertebrates include cockroaches, bedbugs, carpet beetles, flour beetles, clothes moths, flour moths, earwigs, fleas, lice, houseflies and book lice.

The only reported introduced freshwater invertebrate is the Chinese Mystery Snail. It was introduced with aquatic plants to ponds in Yarmouth, Halifax and Lower Sackville as early as 1950. The snails have not yet spread widely in the province. Marine invertebrates include the Green Crab, originally introduced from Europe, which has been spreading northwards from Cape Cod since about 1900. It reached the Minas Basin in the late 1950s (1958–60) has since reached Halifax and has spread northwards along the Eastern Shore and into the Northumberland Strait. The Awning Clam occurs along the central Atlantic coast of Nova Scotia and elsewhere only in New England, possibly moved between the two areas by humans. European Oysters brought to Nova Scotia for aquaculture production have been raised in quarantine conditions to avoid the introduction of diseases. The snail *Ovatella myosotis*, which occurs in tidal marshes from Nova Scotia to the West Indies, is understood to have been introduced from Europe in historic times.[22]

Associated Topics

T3.3 Glaciation, Deglaciation and Sea-level Changes, T4.3 Post-glacial Colonization by Animals, T11.2–T11.7 Birds, T11.10 Ungulates, T11.12 Marine Mammals, T11.13 Freshwater Fishes, T11.14 Marine Fishes, T11.17 Marine Invertebrates, T11.18 Rare and Endangered Animals, T12.3 Geology and Resources, T12.8 Fresh Water and Resources

Associated Habitats

H1 Offshore, H3 Fresh-Water, H6 Forests

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T12.12 RECREATIONAL RESOURCES

Recreation may be broadly defined as all forms of leisure activity that provide relaxation and enjoyment. It includes both active and passive pursuits and may be undertaken indoors or outdoors, in urban or rural settings. Sports are included if they require little skill or organization and lack a strong competitive element.

The focus here is on rural or countryside recreation, rather than activities undertaken in towns or cities. The latter are important but seldom relate to the capabilities of the natural environment—they usually occur indoors or in artificial outdoor settings such as playing fields or softball diamonds. (Even in the countryside, however, many recreational activities use artificial facilities and may be located with more thought to consumer demand than to the land's natural capabilities.) Clawson and Knetsch,[1] the authorities on outdoor recreation, divide activities into user oriented (e.g., theme parks, go-karting, golf), intermediate (e.g., skiing, camping, picnicking) and resource oriented (e.g., beach activities, angling, hiking, canoeing, nature study). Even activities in the latter group often require some investment to develop the resource, such as a boat ramp, a scenic lookoff, a road or trail. It is important, therefore, to differentiate between the potential of an area or site for recreational use—its carrying capacity of capability for sustained use—and the current or actual degree of development and use for recreation.

Degree of use, whether potential or actual, is measured in terms of visitor-days (use by one visitor for a portion of one day constitutes a visitor-day). Some activities by their nature lead to intensive use, either because they are facility oriented (e.g., gold panning, downhill skiing) or oriented to a localized natural resource (e.g., a beach). Other activities, usually those that are more resource oriented, require and generate dispersed use (e.g., hiking, canoeing, cross-country skiing, hunting, wilderness camping). Again, it should be recognized that most outdoor activities are seasonal, so that a particular environment will support varying degrees of use in each season.

CLASSIFICATION

For Nova Scotia, by far the most important assessment of recreational resources is the Canada Land Inventory (CLI),[2] conducted in the late 1960s and early 1970s by the Nova Scotia Department of Lands and Forests and the federal Department of Energy, Mines and Resources. Land capability for recreation was surveyed and mapped in detail, with ratings ranging from class 1 (very high natural capability to sustain one or more recreational activities of an intensive nature) to class 7 (practically no natural capability for any popular types of recreational activity). The 1: 50,000 manuscript maps were generalized and published at a scale of 1: 250,000, covering Nova Scotia in seven sheets.

Factors increasing or inhibiting recreational capability in the CLI scheme relate to the land in its natural or modified state and, thus, include human influences such as road access, current land use and presence of historic or prehistoric sites. The factors may be grouped under the headings of climate, topography, water features, natural vegetation and/or human land use, wildlife, human or cultural features and, as a composite of all the rest, scenery. Some factors operate primarily at the broad regional scale (e.g., climate), others vary over shorter distances (e.g., topography, land use), and still others are highly localized (e.g., beaches, rivers, scenic lookoffs, historic sites). As mentioned, intensive recreation is often concentrated on such localized features.

The accompanying map is a generalized version of the CLI maps. Though the CLI maps do not classify water bodies, Figure T12.12.1 suggests larger lake surfaces and sheltered coastal areas that have above-average capability.

Rivers

Rivers shown have high capability for fishing and canoeing, but low capability for boating and cottage use. Since fishing and canoeing are dispersed activities, these rivers almost all fall in class 4 (capability to sustain moderate annual use). The named rivers are class 4 along most or all of their length, while others, such as the Shubenacadie, Stewiacke and Musquodoboit, attain class 4 only in sections. Only one river in the province, the Northeast Margaree, has a lengthy stretch in capability class 3. The en-

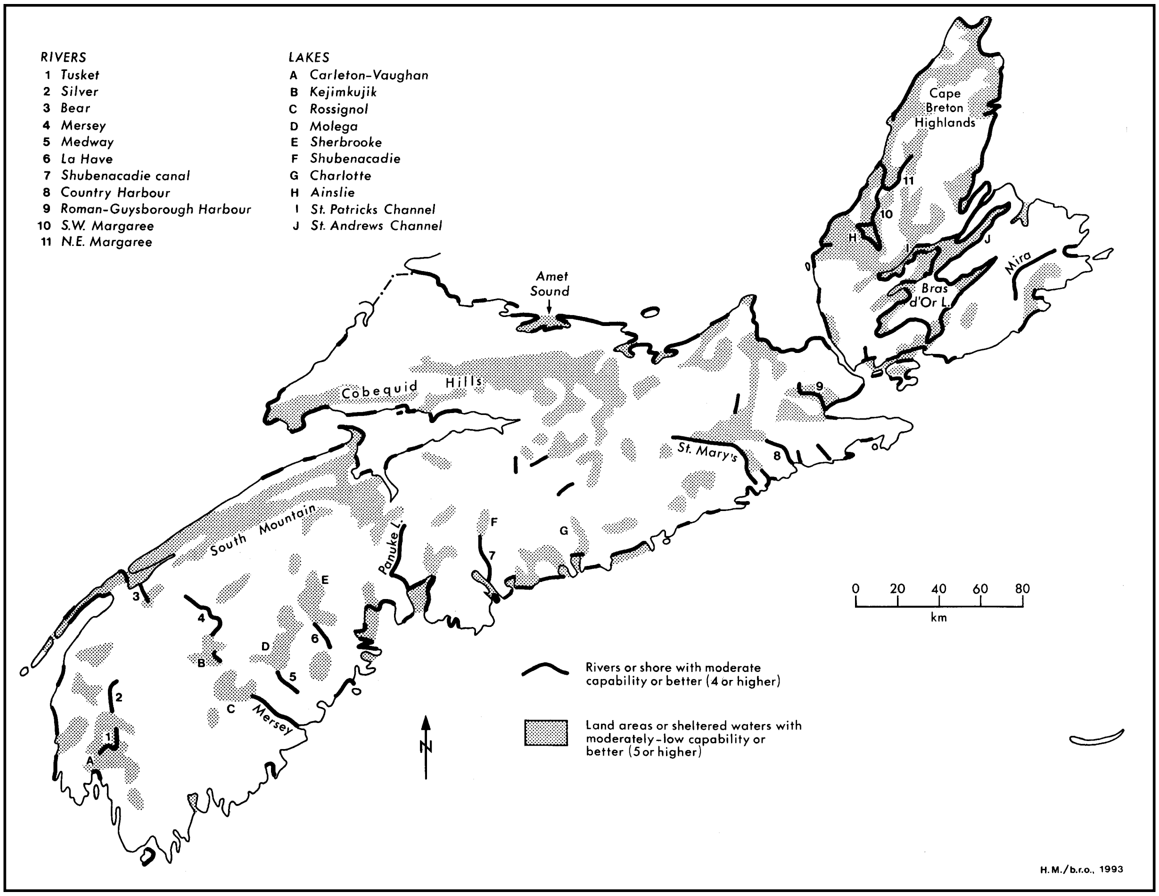

Figure T12.12.1: Land capability for Recreation. Areas in Nova Scotia with above-average capability—that is, linear features (rivers, narrow lakes and shorelines) in classes 1 to 4 and areal units in classes 3 to 5 (no such units exceed a capability of 3). Generalized from Canada Land Inventory maps at scale of 1: 250 000.

hancing factors in this case are high scenic quality, combined with road access on both sides of the valley.

Lakes

Lake shorelines possess few natural beaches, yet still often attain ratings of 3, owing to their capability for cottage use, fishing and boating. Examples are Molega and Ponhook lakes (Unit 432 Queens County), Sherbrooke and Mushamush (Unit 434 Lunenburg County), the chain of lakes along the old Shubenacadie canal route (sub-Unit 413a Dartmouth to Grand Lake) and sections of Porters Lake, Chezzetcook Lake and Lake Charlotte (Units 413a, 453, 833 Halifax County). The shores of Bras d'Or Lake (Unit 916 and District 560) also score 3 along extensive stretches, wherever high scenic quality (provided by views northwards) combines with sheltered waters for boating. Notable are the south shores of St. Andrews Channel, West Bay and East Bay.

Coastlines

Coastal shorelines are magnets for many recreational activities, both dispersed and intensive. Of those sections scoring above average (4 or higher), about half can support modestly intensive or intensive activities (e.g., beach activities, cottage use, boating, rockhounding) and thus fall in capability classes 3, 2 and even 1. These high-capability shorelines are particularly prevalent along the Northumberland Strait, around the Cape Breton Highlands (Regions 200, 500), where their score is based on superior scenery and the presence of the Cabot Trail, and along the Eastern Shore from Eastern Passage to Clam Bay (Unit 833). The waters of the Northumberland shore allow comfortable sea-bathing in the summer, so that the numerous fine sandy beaches score higher (2 and 1) than similar beaches fronting colder Atlantic waters. Most Atlantic beaches score 3, but accessible and developed beaches (notably Gabarus Bay in District 870 and Martinique, Lawrencetown, Queensland and Crescent beaches in Region 800) score 2. The Fundy and Minas shores are not only cold, but also lack sand beaches. The few exceptions (Evangeline Beach and Kingsport in District 610 and Five Islands, District 710) suffer from excessive tides and score 3.

Several saltwater areas of the province, including the Bras d'Or lakes, provide sheltered waters for boating and are shown on the map. Lunenburg Harbour (Unit 832), the western (lee) side of Mahone Bay (sub-Unit 460a), St. Margarets Bay (sub-Unit 460b) and Halifax Harbour (Unit 833) all have well-developed sailing facilities, while the Annapolis Basin (District 620, sub-Unit 913a), Amet Sound, Pictou Harbour (sub-Unit 521a), Lennox Passage (District 860) and the Eastern Shore inlets have similar but less fully realized capability. The Eastern Shore archipelago from Ship Harbour to Sheet Harbour (Unit 834) is being developed as a fine sea-kayaking venue.

Topography

Since most intensive recreation is water based, inland areas with few lakes typically have low or very low capability for recreation (class 6 or 7). This does not imply that they lack recreational value, but simply that they can support or attract only low levels of dispersed activity (hiking, hunting, angling, cross-country skiing and, to some extent, snowmobiling).

Uplands:

As the map shows, the more favoured areas for these activities fall in class 5 (moderately low capability) and tend to coincide with hilly terrain. Notable are North Mountain (District 720) and South Mountain (Unit 451), the Cobequid Hills (Unit 311), Pictou-Antigonish highlands (Unit 312), St. Marys fault-block (Unit 572), Mabou highlands (Unit 314), Ainslie uplands (Unit 584) and the perimeter of the Cape Breton highlands (Region 200). These hilly areas provide higher-quality scenery and typically are mantled in mature deciduous forest, which allows easier cross-country travel. Owing to their exceptional scenery and well-developed trail systems, the Mabou highlands, hillsides overlooking the Northeast Margaree River and the Cap Rouge and Ingonish gateways to the Cape Breton Highlands National Park attain scores of 4 (moderately high capability). Those few hilly localities of the province with elevation, slope and snow conditions suitable for downhill skiing score 3, while sites with developed ski slopes (Ingonish, Ben Eoin, Keppoch, Wentworth Valley and Martock) score 1.

Lowlands:

Lowland farming areas generally rate low for recreation (class 6), owing to lack of legal access across cultivated fields and pasture. Though farmers often do not forbid or deter cross-country access by hikers and hunters, they have legitimate concerns about crop and fence-line damage by snowmobiles and all-terrain vehicles and about shooting near people and livestock. To partially compensate for the lack of cross-country access, access for automobile touring is enhanced in farming areas by well-developed road networks, and cleared fields provide wider vistas. The more intensively farmed and picturesque portions of the Annapolis Valley floor (District 610, Bridgetown to Kingston, and Kentville to Canning) are therefore rated at 5 and even 4.

Accessibility

Much of Nova Scotia is attractive for dispersed recreational activities, owing to scenic quality, low degrees of land exploitation (for urban development, agriculture and silviculture) and legal rights of public access. The interior, however, remains largely inaccessible by road and supports low levels of use by hunters and canoeists. The province's lengthy coastline and numerous lakes create many opportunities for nodes of more intensive activity, but — perhaps fortunately—few have been developed as such, owing to lack of demand (due to, for example, the province's small population). Road access to quality landscapes, boat access to rivers and lakes, trail systems and campsites in the forest, and the presence of amenities at public beaches are all rare, particularly away from major population centres.

Parks

The necessary investment in well-managed recreational areas for intensive and semi-intensive activity has been made by the Canadian Parks Service, by the Parks Division of the Nova Scotia Department of Natural Resources, and, on a smaller scale, by municipalities and the private sector. The federal government maintains two large parks as part of their national system for representing and protecting natural regions.[3] The Cape Breton Highlands and Kejimkujik national parks provide completely different types of recreational experiences, located at opposite ends of the province. Kejimkujik National Park includes a seaside adjunct at St. Catherines River beach.

The Department of Natural Resources owns 276 parks properties, of which 121 are available for recreation as part of a broader system of parks, trails and waterways, and crown-land recreational opportunities.[4] Their sizes and purposes vary considerably and the system includes wayside picnic areas and scenic lookoffs, beaches, and forested campgrounds. The larger provincial parks, such as Blomidon (District 720) and Dollar Lake (sub-Units 436b/413a), provide opportunities for camping, hiking, boating and swimming, as well as for the conservation of natural areas. Recreational needs are leaning towards more wilderness-travel experiences, and Nova Scotia's natural diversity provides the opportunity to integrate wilderness travel with natural area protection. The provincial parks program also includes Heritage Rivers, the Trails Act and the Nature Reserves program, originally managed by the Nova Scotia Museum under the Special Places Act, but transferred to the Department of Natural Resources in 1993. Activities on nature reserves are limited to conservation and research, although outdoor-education activities may be possible in some cases.

Municipal parks, such as Victoria Park in Truro and Point Pleasant Park in Halifax, also play a role in recreational access. In addition, provincial government agencies recognize forty-one trails maintained by municipalities. There are also fifteen waterways for which canoeist's guidemaps are available.[5] Private-sector groups also provide park areas for recreational and educational purposes; Bowater Mersey, for example, "pocket wilderness" provides areas in western Nova Scotia.

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Associated Topics

T5.2 Nova Scotia's Climate, T6.3 Coastal Aquatic Environments, T7.2 Coastline Environments, T8.2 Freshwater Environments, T12.5 Climate and Resources, T12.7 The Coast and Resources, T12.10 Plants and Resources, T12.11 Animals and Resources, T12.13 Scenic Quality

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T12.13 SCENIC QUALITY

Landscape is the visual presentation of the land, whether directly in the field or indirectly through photographs, paintings, or maps. Geographers use the term to refer to the aggregate of surface features, often with no esthetic connotation. Scenery refers to the esthetic qualities of landscape. In this section, we are concerned primarily with an aesthetic assessment of the province's landscapes, and thus with scenery. A secondary purpose, however, is to describe landscapes in value-neutral terms, as a way of summarizing and appreciating the many natural and cultural elements that they comprise.

Scenic assessment is necessarily individual and subjective, since it depends on preferences related to social conditioning, personal experience, temperament, sensibilities, and even formal artistic training. Early attempts to rate and map scenic quality were largely intuitive, but researchers have since used statistical techniques to objectively identify variables influencing ratings made by sample groups. Useful summaries of empirical research are those by Dearden[1] and Penning-Rowsell,[2] while more general discussions of the issues are provided in Penning-Rowsell and Lowenthal[3] and Jakle.[4]

Only two studies to date have used objective methods to rate scenic quality in Nova Scotia: B.A. thesis by Allen[5] and a related paper by Millward and Allen.[6] These studies followed Linton in defining the scenic resource as a composite of two main elements: the "form of the ground" (topography) and the mantle provided by vegetation and human land uses (land cover). In the case of Nova Scotia, the presence of water bodies in the landscape must also be considered, since oceans, lakes and rivers are so frequently present in the visual scene. Allen and Millward rated 10 × 10-kilometre squares on each component separately and added the sub-indices to produce composite scores. Such scores rate potential scenic resources but do not consider whether such resources can be readily viewed. The current or actual scenic value of a site is clearly much greater if there is a network of access routes for the general public. In this regard, paved roads are most widely accessible, while trails and canoe routes provide access only for the more dedicated recreationist.

TOPOGRAPHIC COMPONENT

Scenic grandeur and interest increase with increasing relative relief (see Plate T12.13.1). Relative relief is measured by the range of elevation within an area. Scenic value is assumed to increase with increasing relief, but at a declining rate. On a five-point scale, the scenic value of topography is at a maximum only on the margins of the Cape Breton highlands (District 210). Scores of 4 occur elsewhere in the same highlands, the Mabou and Creignish hills (Units 314 and 313), the Antigonish highlands (Unit 312), and the Cobequid Hills (Unit 311). The


Plate T12.13.1: Highland topography in Cape Breton Highlands National Park (Districts 210 and 220) contrasts with the lowland area of the Annapolis Valley (District 610). Photos: A. Wilson.

flanks of the Annapolis Valley (District 610) score 4 at only three localities: Hampton, Bridgetown and Berwick.

Relative relief provides moderately high scenic value (3), primarily on upland-lowland margins between the Atlantic interior (Region 400) and the Carboniferous Lowlands (Region 500): from west to east they are South Mountain (Unit 422), the Rawdon Ridge (sub-Unit 423a), Wittenburg Ridge (sub-Unit 423b), and the scarp of the Chedabucto Fault. Other areas with moderate scores are the North Mountain ridge (720), the western end of the Cobequid Hills, interior valleys of eastern Colchester and interior Pictou counties, the Mulgrave plateau (Unit 571) and hills surrounding Bras d'Or Lake.

Areas with very little relative relief (scores of 0 or 1 on this component) fall into two main categories: (1) the more southerly and easterly parts of the Atlantic interior (Region 400), including almost all the area south of a line from Weymouth to Lunenburg, and (2) the more extensive sedimentary lowlands, notably the till/clay plains of northern Hants County and the Northumberland plain (sub-Unit 521a). On Cape Breton Island, low relief characterizes the Sydney Coalfield (Unit 531) and coastal areas between Gabarus Bay and the Strait of Canso.

LAND-COVER COMPONENT

A variety of land uses and vegetation adds to visual interest and thus to scenic value. Both land use and vegetation are described by the term "land cover". In terms of visual effect, three main cover types may be distinguished. These are woodland, open country (which includes farmland, barren, marsh and cutover lands) and built-up areas. For scenic rating, it is assumed that variety is more valuable than monotony, that both open country and woodland are clearly preferable to built-up areas, and that open country is somewhat preferable to woodland (mainly because it affords longer vistas). The highest-rated areas, therefore, have a mix of woods and open land, with little or no urbanization.

Areas scoring 4 or 5 on this five-point component are at least fifteen per cent open, mostly due to farm activity. They represent core areas of agricultural activity, related both to soil capability (Canada Land Inventory classes 2 and 3)[7] and easy access along the coast or via tidal rivers. Notable are the Clare district, the Annapolis, Cornwallis and Avon valleys, lowland areas centred on Stewiacke, and coastal lowlands adjacent to Cobequid Bay, Cumberland Basin, the Northumberland shore (particularly Baie Verte, Tatamagouche Bay, Pictou lowlands, and St. Georges Bay), and the Sydney area. Except for Clare, these areas are all in the Carboniferous (Region 500) or Triassic (Region 600) lowlands. Smaller and more adjacent to the above-mentioned cores, plus Isle Madame, are "frontland" areas of Cape Breton Island and the major drumlin fields (Units 831, 833, 433 and 434).

Open wildlands (barrens, marshes, etc.) increase scenic ratings in five main areas: around the southernmost tip of the province in Shelburne County, south of Lake Rossignol, on the exposed headlands of the Chebucto peninsula (e.g., Peggy's Cove), similar headlands around Tor Bay and Dover Bay, and areas of barrens and "flowage" on the Cape Breton highlands.

Most of the interior and upland Nova Scotia, being unrelieved woodland, scores only 2 on this component, as does much of the Atlantic Coast. The Halifax metropolitan area also scores 2, since its built-up areas are interwoven with much woodland. A larger or less fragmented urban area would score less.

WATER COMPONENT

The positive scenic effect of water bodies is assumed to decline marginally; that is, even a fairly minor water presence can add significantly to scenic value, but beyond a certain proportion there is no further gain.

On a five-point scale, almost all coastal areas score the maximum, including the shores of Bras d'Or Lake and its associated channels. In the interior, large freshwater lakes such as Rossignol and Ainslie raise scores to 4 and even 5, but scores generally range between 0 and 3. Scores of 0 occur throughout the interior north of the Atlantic uplands, both on highlands and in sedimentary lowlands, owing to the absence of lakes. The Atlantic upland, by contrast, has the deranged drainage attributable to glacial scour: its many lakes produce scores of 1 to 3. Within this region, two "lake districts" are worthy of mention: one lies to the north and east of Lake Rossignol; the other is situated inland from Yarmouth.

THE COMPOSITE SCENIC RATING

Scores for topography, land cover, and water features may be added to produce a composite scenic score. The Millward/Allen results are shown on the accompanying map (Figure T12.13.1). The pattern is intuitively satisfying, in that it reaffirms popular perceptions of the province's "beauty spots". Of the

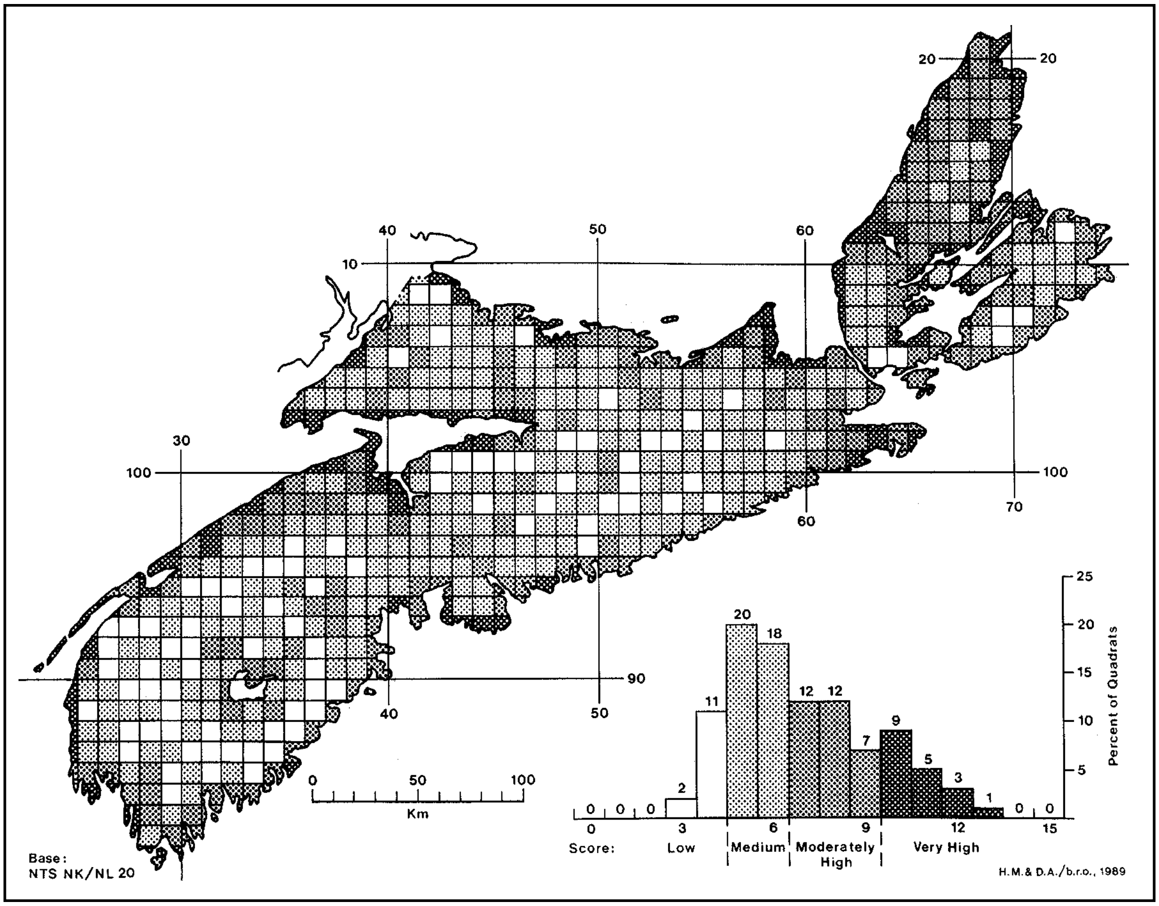

Figure 12.13.2: Index of landscape value. Composite index varies from 0 to 15. Nova Scotia values range from 3 to 14 with mean of 6.9, median of 6 and mode of 5.[6]

twenty-four quadrats scoring 12 to 14 (out of a possible 15), eight occur on the Cabot Trail, and six more occur elsewhere on Cape Breton Island. Of the 10 on mainland Nova Scotia, three centre on Grand Pré and four others occur at the western end of the Annapolis Valley.

INDEX OF LANDSCAPE VALUE

These areas are well known, as is the slightly lower-scoring area south of Halifax, on the rocky shore of the Chebucto peninsula. Other areas scoring "very high" (10 or more) are perhaps less familiar: they include the Lobster Bay area of Yarmouth County, most of the Fundy and Cobequid shores, Tatamagouche Bay, Cape George and St. Georges Bay, and much of the Canso peninsula.

As a general rule, very high scores occur either where prominent hills meet the ocean, or where farming areas abut an indented coastline. The common element is the sea. Other factors—topography, landcover and lakes—influence the overall pattern much less, since they tend to cancel each other. To illustrate: scenic values in the Cobequid Hills (Unit 311) are indistinguishable from those on the Northumberland Plain (sub-Unit 521a), because the hills have more relief but lack open farmland. As another example, much of the Atlantic Interior (Region 400) scores in the same range as the Avalon Uplands (Region 300); the glacially-scoured erosion surface has less relief, but compensates with many lakes. Thus, it is erroneous to assume that, because many inland areas score similarly (in the 6 to 7 range), they have similar landscape characteristics. There are, in fact, three main landscape types in the interior: (1) the glacially scoured erosion surfaces of the south and east (the Atlantic upland), (2) the hills and highlands of the north and (3) the sedimentary lowlands, which are the main areas of settlement and farming.

Areas with low scenic value (scores 3–4) are most prevalent on the southern erosion surface (e.g. south and west of Lake Rossignol) or poorly drained lowlands (e.g. the Cogmagun barrens). More particularly, they occur where there are few lakes, little relief, and no glacial till to encourage farming.

Associated Topics

T2 Geology, T3 Landscape Development, T7.3 Coastal Landforms, T8.2 Freshwater Environments, T9.2 Soil Classification, T12.2 Cultural Landscapes

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