H3.1 OPEN-WATER LOTIC (RIVERS AND STREAMS)

The open-water habitat in rivers and streams is the body of water flowing through the channel. The characteristics of the water can vary considerably in relation to the morphology of the channel. Rivers and streams in Nova Scotia are not deep enough to create layering in the water column.

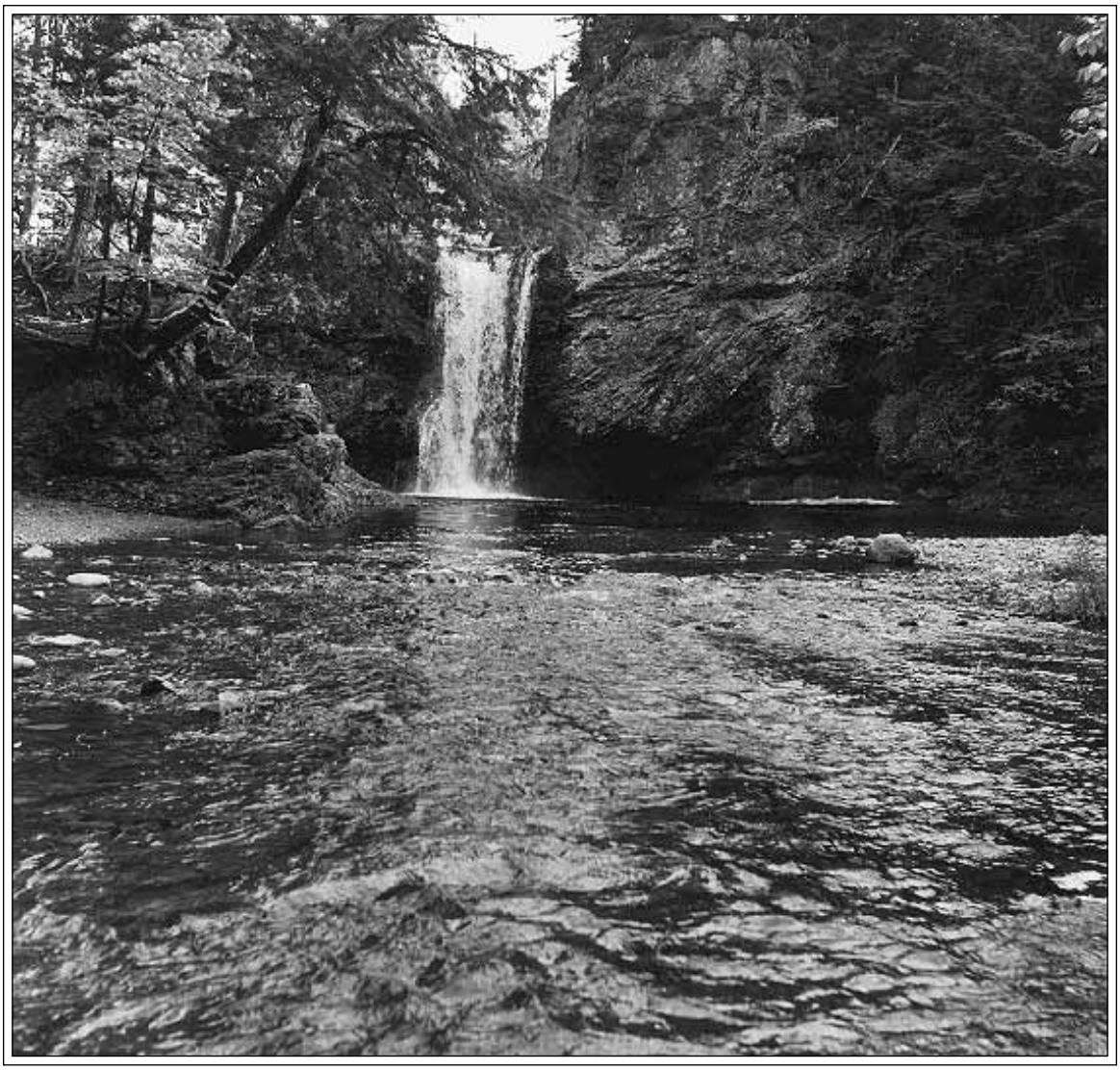

Plate H3.1.1: Drysdale Falls, Colchester County (sub-Unit 521a). An open-water stream habitat with a waterfall and associated cliff habitat (H5.3). The forest is a spruce, hemlock, pine association (H6.2.6). Photo: R. Merrick

FORMATION

The dominant feature of all lotic environments is the continuous movement of water and currents, which cuts the channel, molds the character of the stream and influences the chemical and organic composition of the water.[1] Water running off the land follows courses of least resistance and develops these as distinct channels by erosion. Young or rejuvenated streams, with a high velocity, erode more than they deposit.

Water in slow-moving rivers reflects the characteristic of the terrain; nutrient level and sediment load vary according to region. The slow-moving stream often develops a floodplain, meanders, and associated features and terminates in a lake or estuary.

PHYSICAL ASPECTS

1. *Water conditions:* variables include conductivity, temperature, turbidity, light, seasonal variations. (Chemical composition, including dissolved nutrients, depends on bedrock in rapidly-moving streams.)
2. *Air-water interaction:* wind influences turbulence and gas exchange (O_2 and CO_2).
3. *Land-water interaction:* variable conditions are determined by enclosing land forms, turbidity, runoff with products of erosion and nutrient supply.
4. *Bottom-water interaction:* turbidity, nutrient supply.

ECOSYSTEM

The lotic is primarily determined by the velocity of the current, which can create either slow-moving or fast-moving streams; each has very distinct characteristics. The base of the food chain is dependent on detritus from upstream or from the edges. In slow-moving streams, plant and animal communities largely resemble those found in lentic (lake and pond) habitats. The significant phytoplankton populations that usually exist contribute to a higher rate of primary productivity than that found in fast-moving steams. The level of productivity is dependent upon water temperature and the amount of nutrient input received from the surrounding environment, and therefore subject to seasonal variation. The diversity of consumer organisms varies according to the physical conditions and vegetation. Planktonic populations are relatively high, although not as dense as those found in lakes.

In fast-moving streams, there is very little primary production in the open-water habitat, due to the velocity and turbulence of the current. Populations of consumer organisms (mainly particulate feeders) are low. Riffle areas provide valuable habitat for juvenile trout and salmon. Pools are important resting areas for several fish species, including Atlantic Salmon. The quality of these areas can be adversely affected when shade trees are removed from the banks.

SUCCESSIONAL SEQUENCE

The normally understood process of ecological succession does not apply to open water. In slow-moving steams, the development of habitat depends upon the depositional and erosional characteristics of the river. The fast-flowing, young stages of streams will always be present as the river erodes the landscape. Over time, the young stage will mature into a slow-moving stream, but it can be rejuvenated when a geological obstacle (e.g., a waterfall) is encountered. In mature streams, there is a progressive downstream movement of meanders, leaving shallow or deep pools, backwaters, braided channels and oxbow ponds. There is an associated change in the character of the open water.

PLANTS

Vegetation in the lotic open-water habitat consists mainly of phytoplankton found in slow-moving streams. There are no plankton species unique to rivers; those found there originate mostly from backwaters or lakes. Several species of desmids and diatoms are present in slow-moving rivers, although abundance is much lower than in lakes.

ANIMALS

Some zooplankton species and rotifers can be found in slow-moving streams. Their abundance depends on the amount of the predation from invertebrates and small fish.

Most fish inhabiting fresh water in Nova Scotia will utilize this environment at some stage in their life cycle. Fish species such as Redbelly Dace and White Sucker, and introduced species such as Brown Trout are commonly found in slow-moving streams. Fast-moving streams provide excellent habitat for many kinds of fish, including Brook Trout, Atlantic Salmon parr, Common Shiner, White Suckers and Yellow Perch.

Bird species associated with rivers include mergansers, Black Ducks, Spotted Sandpipers and Belted Kingfisher. Mammals commonly found in rivers are Water Shrews, Star-nosed Moles, Muskrats, otters, mink and beavers.

SPECIAL FEATURES

- Tidal rivers occur when the lower reaches of the habitat are influenced by the sea. The mixing of fresh and salt water creates conditions suitable for brackish water species.
- Some marine-fish species enter freshwater systems through estuaries.
- Special adaptations of stream organisms.
- The effects of acid precipitation on rivers and streams occurs mainly in southwestern Nova Scotia.
- The heating effect of shade removal due to tree cutting.
- River rejuvenation, including the occurrence of rapids and falls, especially along the Atlantic coast.
- Important recreational fisheries, particularly Atlantic Salmon and Brook Trout.
- Stream flow is harnessed for milling or hydro-electric-power generation.

DISTRIBUTION

Slow-moving streams are found in all regions of the province, except where high ground occurs close to the sea. Some of the well-developed larger river systems include the Tusket, Medway, Mersey, LaHave, St. Marys (Region 400); the Shubenacadie and Stewiacke (Region 500); the Cornwallis and Annapolis (Region 600).

Fast-moving streams occur throughout the province in upland areas. These include the Cape Breton highlands (Regions 100 and 200), the Cobequid Hills (Region 300), North Mountain (District 710), and South Mountain (District 420). Slow-moving streams flowing to the Atlantic Ocean are often rejuvenated as they pass through the Meguma bedrock near the Atlantic Coast. Examples of this occurrence are the Musquodoboit River (Units 413a and 453) and the St. Marys River (Unit 842).

● ● ● ● ● ● ● ●

Associated Topics

T6.1 Ocean Currents, T6.4 Estuaries, T8.1 Freshwater Hydrology, T8.2 Freshwater Environments, T10.9 Algae, T11.5 Freshwater Wetland Birds and Waterfowl, T11.11 Small Mammals, T11.13 Fresh Water Fishes, T11.15 Amphibians and Reptiles, T11.16 Land and Freshwater Invertebrates, T12.8 Freshwater and Resources

Associated Habitats

H3.2 Open-water Lentic (Lakes and Ponds), H3.3 Bottom Lotic (Rivers and Streams), H3.5 Water's Edge Lotic (Rivers and Streams)

References

1 Smith, R.L. (1990) *Ecology and Field Biology*. Harper and Row, New York.

H3.2 OPEN WATER LENTIC (LAKES AND PONDS)

The open-water habitat of lentic environments (i.e., lakes and ponds) includes the limnetic and profundal zones of the water column (see Figure T8.2.2). The limnetic zone is the area beyond which rooted plants grow and extends vertically to the depth of maximum sunlight penetration. The profundal zone is the deeper (and often colder) water below the level of light penetration. Most lakes in Nova Scotia are deep enough to have open-water habitats. Most ponds are shallow and support submerged vegetation throughout.

Plate H3.2.1: A pond at Northport, Cumberland County (sub-Unit 521a). Aquatic plants include *Potamogeton* and *Juncus.* Photo: D.S. Davis

FORMATION

The formation of open-water habitats in lentic environments relates to the origin of the lake or pond. Lakes in Nova Scotia tend to be of glacial origin. Ice-scouring results in depressions in the bedrock or surface irregularities in glacial drift. Lakes and ponds can also be formed due to damming by landslides, flood debris, or hydroelectric dams. Ponds can form when a lake is infilled with organic debris or mineral sediment; by the natural cutoff of a meandering river (oxbow), or by solution of gypsum or limestone (sinkhole). The open water is influenced by precipitation, flushing rates, and drainage. Water levels can fluctuate seasonally.

PHYSICAL ASPECTS

1. *Water conditions:* conductivity, temperature, turbidity, light, seasonal variations. (Chemical composition, including dissolved nutrients, depends on bedrock.)
2. *Air-water interaction:* (O_2 and CO_2), wind induces mixing of water column, turbulence and gas exchange.
3. *Land-water interaction:* enclosing land forms, turbidity, runoff with products of erosion and nutrient supply, flushing rates.
4. *Drainage:* open water (lakes); poorly drained, partially open water (ponds)

ECOSYSTEM

Most primary production occurs in the limnetic zone of the open-water habitat. Phytoplankton carries out photosynthesis in the limnetic zone and produces oxygen in the water. Zooplankton consumes the phytoplankton and is, in turn, eaten by higher animals, such as insects and fish.

The amount of primary production by phytoplankton relates to the nutrients, the content morphology and the flushing rate of the lake or pond. In the spring, a large influx of nutrients can produce a rapid growth of phytoplankton, known as a "bloom". Herbivorous zooplankton responds to the increase in phytoplankton. The amount of bloom (i.e., how green the lake appears) is thought to be controlled by the amount of grazing done by the zooplankton.

The profundal zone is a cooler, low-productivity environment characterized by a high abundance and low diversity of oxygen-demanding species. These species may depend on the limnetic zone for food.

In deep lakes, vertical stratification is common in summer, and the cool-water organisms accumulate at the thermocline (see Figure T8.2.1), where they depend on the limnetic zone for their food sources. Temperature and wind changes (e.g., in fall and spring) create a mixing, and the nutrients deposited on the bottom rise and are available to phytoplankton for production.

SUCCESSIONAL SEQUENCE

The normally understood process of ecological succession does not apply to open water. In the early stages of succession, lakes slowly begin to infill from eroding shoreline materials. A vertical erosional-depositional process also takes place within the lake. Infilling of the lake basin results from suspended sediment being brought into the system by inflowing streams and rivers. This sediment is deposited in the deeper parts of the lake until the bottom is slowly built up to a flat surface. The water level then becomes so shallow that wave action decreases and erosion declines to a very slow rate. At this point, the lake begins to resemble a pond. The siltation process continues until the open-water habitat disappears, giving rise to bog, fen, swamp or marsh habitats. The rate at which this occurs depends upon the amount of siltation, the rate of production of organic material and the rate of decomposition.

PLANTS

The open water of lakes and ponds contains numerous phytoplankton species. Diatoms and desmids are common in oligotrophic and distrophic conditions, while blue-green algae are abundant in eutrophic lakes (see Topic T8.2). Duckweeds (*Lemma*) and *Spirodella*.

ANIMALS

The planktonic community of the open water consists primarily of cladocerans (water fleas), copepods, rotifers, air-breathing insects in adult form (e.g., water beetles) and larval form (e.g. mosquitoes). The zooplankton is a primary source of food for open-water fish species, such as Brook Trout, Golden Shiner and Yellow Perch. Black Duck is common in the open water during the summer. Osprey, Bald Eagles, cormorants and loons also utilize the open water for feeding.

SPECIAL FEATURES

- Amphibian populations in ponds
- Ponds are greatly affected by local climatic and geological conditions and are quite different in various regions of the province. It is important to understand the origin of a pond (e.g., sinkhole, river oxbow, beaver dam)
- Landlocked populations of marine fish species (e.g., Atlantic Salmon)
- Freshwater jellyfish in Dartmouth lakes

• • • • • • • •

Associated Topics

T8.1 Freshwater Hydrology, T8.2 Freshwater Environments, T10.2 Successional Trends in Vegetation, T10.5 Seed-bearing Plants, T11.5 Freshwater Wetland Birds and Waterfowl, T11.13 Freshwater Fishes, T11.16 Land and Freshwater Invertebrates

Associated Habitats

H3.1 Open-water Lotic (Rivers and Streams), H3.4 Bottom Lentic (Lakes and Ponds), H3.6 Water's Edge Lentic (Lakes and Ponds), H4.1 Bog, H4.2 Fen, H4.3 Swamp

H3.3 BOTTOM LOTIC (RIVERS AND STREAMS)

The bottom habitat of a lotic environment is the streambed. In some conditions, this habitat can extend across the entire width of the bed. In deeper channels with sloped edges, zonation may create a littoral or edge habitat. In shallow channels or low-water conditions, the streambed can be exposed intermittently.

The streambed can comprise a variety of physical and organic materials and can be either an eroding basin or a depositional environment. These situations can alternate in the same stream, as may be seen in riffles or ponds.

Plate H3.3.1: LaHave River north of Bridgewater (Unit 433). Hard rock bottom is exposed due to low water levels in late summer. Photo: R. Merrick

FORMATION

The nature of a lotic environment is primarily determined by the velocity of the current, which can create either slow-moving or fast-flowing streams; each has very distinct characteristics. Fast-flowing streams are often comprised of two interrelated environments: the turbulent riffle area and the quiet pool.

The bottom of slow-moving streams is comprised mainly of sedimentary rock and thick glacial till. Soils consist of fluvial sediments; silt, mud, sand, gravel and varying amounts of organic material. In fast-moving streams, the bedrock is primarily resistant metamorphic or igneous rocks, with boulder or coarse gravel bottom. Soils consist of sand and gravel, with some organic material, and are often mobile due to water velocity.

PHYSICAL ASPECTS

1. *Bedrock:* (more important in fast-moving streams) exposures of bedrock; particularly resistant metamorphic or igneous rocks and boulder or coarse gravel bottom.
2. *Soil:* (more important in slow-moving streams) sand and gravel, with some organic material; often mobile due to water flow.
3. *Relief:* in hilly country, giving steep stream profiles or, on plains, giving low profiles.

ECOSYSTEM

In slow-moving environments, silt and decaying organic material accumulates on the bottom and becomes the main food source for invertebrates. Productivity is associated mainly with the breakdown of this imported material, such as leaf litter, by herbivores. Some of the organic material is exported, but some remains on site and can develop into peat.

In fast-moving streams, the riffle areas are responsible for most of the primary production. Groups of plants that cling to the bottom are dominant and become as important to streams as phytoplankton is to lakes. They consist mainly of microscopic and filamentous algae and can form a slippery cover on rocks during the summer months. However, this production is only temporary, as it is soon exported downstream by the strong currents. Populations of consumer organisms (chiefly particulate feeders) are relatively low.

The width of the stream also affects the amount of production. Streams two metres wide are four times as rich in bottom organisms as those which are six to seven metres wide.[1] This is one reason why small headwater streams are important spawning and nursery areas for salmon and trout.

SUCCESSIONAL SEQUENCE

In slow-moving steams, the development of habitat depends upon the depositional and erosional characteristics of the river. There is a progressive, downstream movement of meanders, leaving shallow or deep pools, backwaters, braided channels and oxbow ponds. Sediment is deposited on the floodplain during periods of high water, slowly filling up old erosional features. The plants and animals of the river ecosystem are constantly adjusting to these changing conditions (see Figure T8.2.2).

The fast-flowing young stages of streams will always be present as the river erodes the landscape. Over time, the young stage will mature into a slow-moving stream, but it can be rejuvenated when a geological obstacle (e.g., a waterfall) is encountered.

PLANTS

In slow-moving streams, vegetation is generally absent from the bottom habitat, except along the stream bank or hydrosere (see H3.5). In rapidly moving streams, diatoms, blue-green algae and green algae frequently are found on the rock surfaces, and there may be dense growths of liverworts and water mosses (e.g., *Fontinalis*), especially near the stream banks. The flowering plants bur reed (*Sparganium* spp.) and pondweed (*Potomogeton* spp.) are firmly rooted into the gravel bottom and have narrow leaves to provide the least amount of resistance to the current. The Riverweed (*Podostemum ceratophyllum*), found on the LaHave River, is specially adapted to adhere to rock surfaces in fast-flowing water.

ANIMALS

In slow-moving streams, there is an abundance of invertebrates, dominated by aquatic insects. Nymphs and larvae of insects such as blackfly, dragonfly, mayfly, stonefly and caddisfly, as well as adult and larval stages of waterbugs and water beetles, can be found. Many species of crustaceans, rotifers, nematodes and protozoans may also be present. Leeches, oligochaete worms and molluscs are plentiful in oligotrophic waters. Freshwater mussels may be abundant in some areas and include some species with limited distribution. Various sponges and

ectoprocts are also commonly found. All of these organisms are significant, as they consume organic detritus and provide food for other bottom-dwelling animals. Adult newts and tadpoles inhabit the organic debris in pools and slow-moving sections of streams.

In fast-moving streams, aquatic animals are well adapted to withstand the fast current and seasonal variations in water level. The most important invertebrates are the aquatic larvae and nymphs of insects, especially stoneflies, mayflies and caddisflies. Blackfly larvae develop on rocks in the well-aerated water and form their pupae on the leaves of submerged plants. Other invertebrates include several sponges (e.g., *Spongilla*) and freshwater mussels (e.g., *Margaritifera*), which are found in patches of gravel. The larvae of river mussels are parasitic on the gills of fish, an adaptation that counteracts the tendency for populations to be carried downstream by the current.

The insect larvae of fast- and slow-moving streams provides the primary food source for many fish species, including White Sucker, American Eel and Bullhead Catfish (see Topic T11.16).

SPECIAL FEATURES

- The adaptation of plants and animals to resist current flow and maintain their populations in the stream.
- Important recreational fisheries, particularly Atlantic Salmon and Brook Trout.
- Hibernation of Wood Turtles in slow-moving streams.
- The association of the parasitic (glochidia) larval stage of mussels and fish. A rare mussel (*Lampsilis cariosa*) is found in the Sydney River.
- Modification of river courses by human activities, such as gravel extraction and dam construction.

DISTRIBUTION

Slow-moving streams are found in all regions of the province, except where high ground is located close to the sea. Some of the well-developed larger river systems include the Tusket, Medway, Mersey, LaHave, St. Marys (Region 400); the Shubenacadie and Stewiacke (Region 500); the Cornwallis and Annapolis (Region 600).

Fast-moving streams occur throughout the province in upland areas. These include the Cape Breton highlands (Regions 100 and 200), the Cobequid Hills (Region 300), North Mountain (Region 710), and South Mountain (Region 420). Slow-moving streams flowing to the Atlantic Ocean are often rejuvenated as they pass through the Meguma quartzite near the Atlantic Coast (Region 800). Examples of this occurrence are the Musquodoboit River and the St. Marys River.

• • • • • • • •

Associated Topics

T8.1 Freshwater Hydrology, T8.2 Freshwater Environments, T11.5 Freshwater Wetland Birds and Waterfowl, T11.11 Small Mammals, T11.13 Freshwater Fishes, T11.15 Amphibians and Reptiles, T11.16 Land and Freshwater Invertebrates

Associated Habitats

H3.1 Open-water Lotic (Rivers and Streams), H3.4 Bottom Lentic (Lakes and Ponds), H3.5 Water's Edge Lotic (Rivers and Streams)

Reference

1 Smith, R.L. (1990) *Ecology and Field Biology*. Harper and Row, New York.

H3.4 BOTTOM LENTIC (LAKES AND PONDS)

The bottom habitat of lentic environments (lakes and ponds) is the depositional environment in the benthic zone (see Figure T7.2.2). The benthic zone is the area where decomposition takes place. It is associated with abundant biological activity and very little oxygen. The dominant organisms are anaerobic bacteria.

Closely associated with the benthic zone is the profundal zone, which lies directly above the benthic zone but beneath the depth of light penetration (see H3.3).

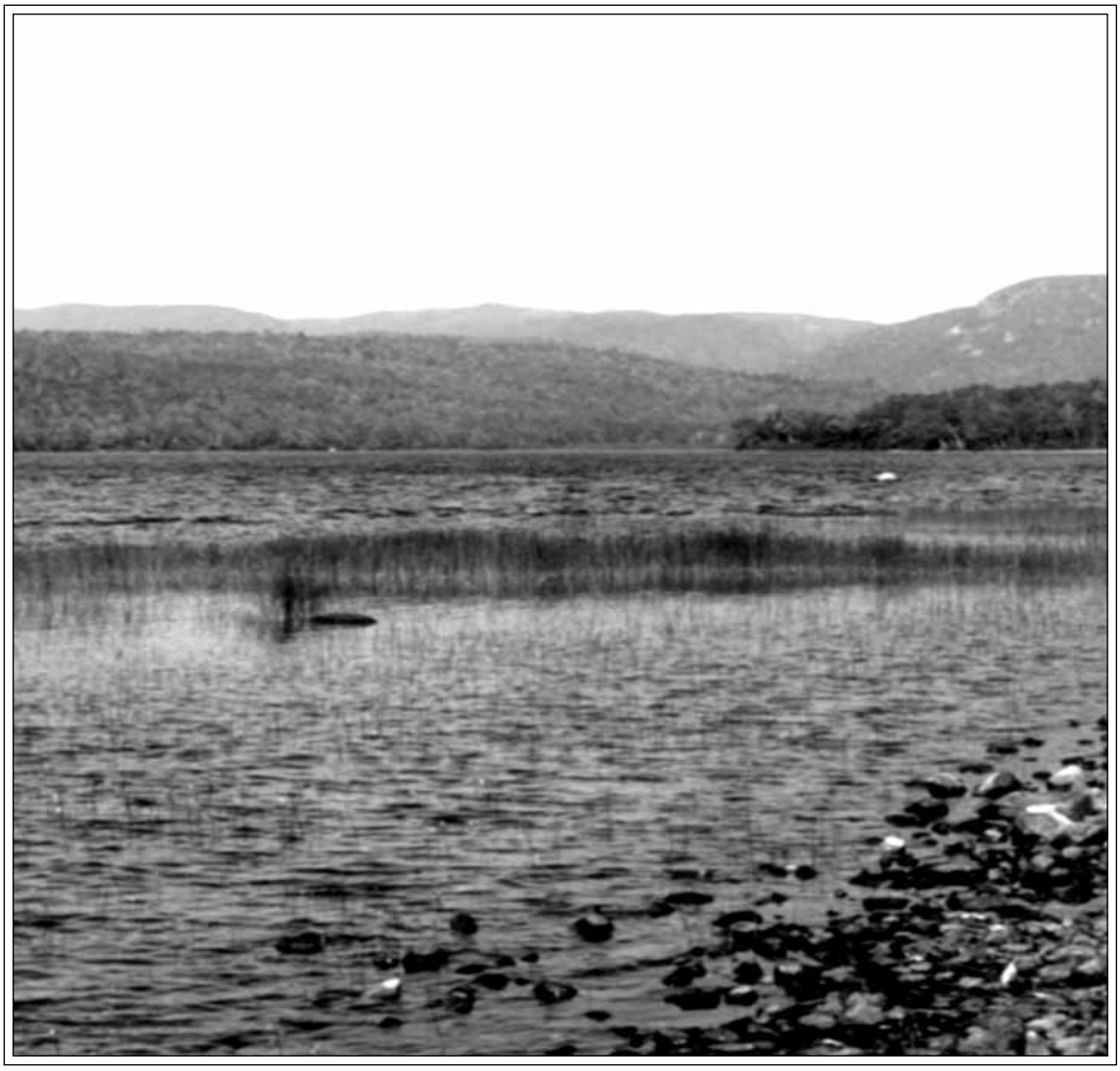

Plate H3.4.1: Warren Lake in Victoria County, Cape Breton County (sub-Unit 552b). The steep-sided lake levels off at 31m and provides a high proportion of bottom habitat compared to edge habitat. Photo: D. Davis

H3.4 Bottom Lentic (Lakes and Ponds)

FORMATION

The formation of the bottom habitat in lentic environments is closely associated with the origin of the lake or pond (see H3.2). Most lakes and pond bottoms in Nova Scotia are covered with "lake-bottom muck" (i.e., silt, clay or organic matter).

PHYSICAL ASPECTS

1. *Bedrock*: may occur in all bedrock types, as well as in alluvial or glacial deposits.
2. *Soil*: deposition of silt, clay, etc.
3. *Relief*: depressional topography
4. *Drainage*: ponds and shallow lakes exhibit seasonal fluctuation of water levels.

ECOSYSTEM

Although the abundance of life in the lentic bottom zone is not great, it is still significant. Organisms living there have adapted to the conditions of soft mud and low oxygen levels. During the summer, a thermocline often develops in eutrophic lakes, causing the bottom waters to become anerobic. However, in deep oligotrophic lakes, where productivity is low, the supply of oxygen is not depleted by decomposers. Under these conditions, the profundal zone can support life, particularly fish, some plankton and certain cladocerans, which live in the bottom ooze.[1]

SUCCESSIONAL SEQUENCE

Succession relates to the deposition of sediments and organic material. As the deposits accumulate, the water level becomes more shallow and the zone of light penetration (limnetic) increases. The nutrient supply in the bottom becomes available for primary production, and plants begin to take root. The benthic zone is thus replaced by an extension of the littoral zone. The character of the water column also changes.

PLANTS

No vegetation is associated with this habitat, since it lies beyond the depth of light penetration.

ANIMALS

The benthic community of this habitat, including the microscopic or meiofauna, have become adapted to conditions of soft mud and low oxygen. The primary constituents are in three groups:

1. bloodworms, including chironomid larvae (midges) and annelids (worms)
2. small clams of the family Sphaeriidae
3. *Chaoborus* or "phantom midges"

Many species of crustaceans, rotifers, nematodes, beetle larvae and protozoans may also be present. These organisms are significant, as they consume organic matter and provide food for other bottom-dwelling animals (see Topic T11.16). Fish species, such as Lake Whitefish and Brown Bullheads, are found in oligotrophic lakes with sufficient oxygen. The bottoms of ponds are important habitats for the larvae of amphibians such as salamanders and frogs (tadpoles).

SPECIAL FEATURES

- Chironomid larvae (midges) have adapted to many benthic habitats that have low concentrations of oxygen. The bright-red-coloured larvae have a pigment which binds to oxygen and enables the storage of oxygen in this type of habitat. Their abundance may be an indicator of poor water quality.

DISTRIBUTION

Deep-water lakes are found throughout Nova Scotia; however, they are more abundant on the hard, igneous and metamorphic bedrocks of the Atlantic Interior (Region 400).

● ● ● ● ● ● ● ●

Associated Topics

T8.1 Freshwater Hydrology, T8.2 Freshwater Environments, T9.1 Soil-forming Factors, T11.13 Freshwater Fishes, T11.16 Land and Freshwater Invertebrates

Associated Habitats

H3.2 Open-water Lentic (Lakes and Ponds), H3.6 Water's Edge Lentic (Lakes and Ponds)

References

1 Smith, R.H. (1990) *Ecology and Field Biology*. Harper and Row, New York.

H3.5 WATER'S EDGE LOTIC (RIVERS AND STREAMS)

The water's edge habitat, or hydrosere, of lotic environments is the extension of the streambed habitat onto the shore and is also referred to as the water's edge component of riparian zones, characterized by hydrophytic vegetation. The edge habitat in rivers and streams is most obvious where deposition or streambed gradient allows for zonation to occur.

Plate H3.5.1: Slow-moving section of MacLellan's Brook**,** Inverness County (sub-Unit 551b). The stream margins are defined by energy changes. The left bank is permanently steep, undercut and has overhanging vegetation; the inward curve of the right bank fluctuates with seasonal water flow and depositional activity, creating an ephemeral environment. Herbaceous plants colonize the cobble bar briefly during the height of summer. The elms in the background are the remnants of a floodplain forest (H6.1.3). Photo: R. Merrick

H3.5
Water's Edge
Lotic (Rivers and
Streams)

FORMATION

The formation is influenced by water flow and deposition. During periods of high discharge, the edge habitat will increase shorewards, possibly extending to the edge of the floodplain. During periods of low water or intermittent streams, the edge habitat decreases, allowing dry-land vegetation to grow right up to the water's edge. The aquatic extension of this habitat is also influenced by water levels, stream gradient and water clarity. This habitat supports a variety of plant species and provides food and cover for animals that occupy the area and for those found in adjacent aquatic or upland habitats. The habitat also aids in reducing pollution from surrounding land areas by slowing runoff and decreasing erosion. In addition, the hydrosere provides shade that helps maintain suitable water temperatures for aquatic life.

PHYSICAL ASPECTS

1. *Bedrock:* any bedrock and glacial till (fast-moving stream–exposed bedrock; particularly resistant metamorphic or igneous rocks, and boulder or coarse gravel bottoms).
2. *Soil:* fluvial sediments, silt, mud, sand and gravel, with varying amounts of organic material; often mobile in fast-moving streams.
3. *Relief:* in depressions, gently undulating and sloping towards the coast.
4. *Drainage:* wet shoreline; seasonal fluctuation of water levels.
5. *Water conditions:* turbidity, deposition.

ECOSYSTEM

In slow-moving streams, the lotic hydrosere contains a diversity of plant communities, many of which are located in the numerous shallow channels and backwaters of the floodplain margins. Some of the organic material produced is exported downstream; some, which may develop into peat, remains on site; some is consumed by herbivores, such as aquatic insects.

In fast-moving streams, primary production is low because adverse conditions, such as coarse, mobile substrate, restrict plant growth. Production from plants near the stream bank and marginal terrestrial vegetation is soon exported by the current. Few consumer organisms (mainly aquatic insects) can be found. The quality of the ecosystem is directly affected by an increase in water temperature caused by the removal of shade trees from the stream banks.

SUCCESSIONAL SEQUENCE

In slow-moving steams, the development of habitat depends upon the depositional and erosional characteristics of the river. There is a progressive downstream movement of meanders, leaving shallow or deep pools, backwaters, braided channels and oxbow ponds. Sediment is deposited on the floodplain during periods of high water, slowly filling up old erosional features. The plants and animals of the river ecosystem are constantly adjusting to these changing conditions (see Figure T8.2.3).

The fast-flowing young stages of streams will always be present as the river erodes the landscape. Over time, the young stage will mature into a slow-moving stream, but can be rejuvenated when a geological obstacle (e.g., a waterfall) is encountered.

Plants

In slow-moving streams, the variable condition of the habitat results in a diversity of plant communities along the stream bank. A distinct zonation in the type of vegetation usually occurs. This is directly related to substrate stability and drainage for plants located on the bank and to the current for those found in the water. The type of vegetation found along the bank is characteristic of other freshwater habitats, including the hydrosere of ponds (H3.6), bogs (H4.1), fens (H4.2), swamps (H4.3) and floodplain forest (H6.1). Aquatic plants adjacent to the stream bank include rushes and sedges found mainly in stony shallows. Water mosses (*Fontinalis* spp.) are often abundant. In calcareous water the alga *Chara* may also be present.

In fast-moving streams, emerging aquatic plants may be found along the stream banks where the current is reduced. Aquatic mosses are also common in this habitat.

Animals

Similar to plants of the hydrosere, the aquatic animals of the slow-moving stream include the rich diversity described for bog, fen, and the hydrosere of ponds. There is an abundance of aquatic invertebrates dominated by insects. Nymphs and larvae of insects such as blackfly, dragonfly, mayfly, stonefly and caddisfly, as well as adult and larval stages of waterbugs and water beetles, can be found. Leeches, oligochaete worms and molluscs are plentiful in oligotrophic waters. Freshwater mussels may be abundant in some areas and include some species with limited distribution. Various sponges and ectoprocts are also commonly found.

Amphibians such as Mink Frogs, are common and may breed and develop in the shallow backwaters and oxbow ponds. Wood Turtles often lay their eggs on sand stream banks. Most bird species are mainly associated with the adjacent forest habitats; exceptions to this are mergansers, Black Duck, Spotted Sandpiper, and Belted Kingfisher. A few mammals, such as the Water Shrew, Star-nosed Mole, Muskrat, otter, mink, and beaver, are characteristic of this environment.

In fast-moving streams, aquatic animals of the hydrosere are well adapted to withstand the seasonal variations in water level. The most important invertebrates are the aquatic larvae and nymphs of insects, especially stoneflies, mayflies and caddisflies. Blackfly larvae develop on rocks in the well-aerated water and form their pupae on the leaves of submerged plants. Other aquatic invertebrates include sponges (e.g., *Spongilla*), although fewer in number than lakes or slow moving streams, and freshwater mussels (e.g. *Margaritifera*), which are found in patches of gravel. The larvae of river mussels are parasitic on the gills of fish, an adaptation that counteracts the tendency for populations to be carried downstream by the current.

The insect larvae of fast- and slow-moving streams provides the primary food source for many fish species, including Lake Chub, White Sucker and Threespine Stickleback. During times of low water, fish tend to concentrate in the larger pools.

SPECIAL FEATURES

- Special adaptations of stream organisms.
- Breeding habitat for Wood Turtles.
- The heating effect of shade removal due to tree cutting.
- Modification of river courses by human activities, such as gravel extraction and dam construction.

DISTRIBUTION

Slow-moving streams are found in all regions of the province, except where high ground is located close to the sea. Some of the well-developed larger river systems include the Tusket, Medway, Mersey, LaHave, St. Marys (Region 400); the Shubenacadie and Stewiacke (Region 500); the Cornwallis and Annapolis (Region 600).

Fast-moving streams occur throughout the province in upland areas. These include the Cape Breton highlands (Regions 100 and 200), the Cobequid Hills (Region 300), North Mountain (District 710) and South Mountain (District 420). Slow-moving streams flowing to the Atlantic Ocean are often rejuvenated as they pass through the Meguma bedrock near the Atlantic Coast. Examples of this occurrence are the Musquodoboit River (Units 413a and 453) and the St. Marys River (Unit 842).

● ● ● ● ● ● ● ●

Associated Topics

T8.1 Freshwater Hydrology, T8.2 Freshwater Environments, T9.1 Soil-forming Factors, T10.5 Seed-bearing Plants, T10.7 Pteridophytes (Ferns and Their Allies), T10.8 Bryophytes Mosses, Liverworts and Hornwarts, T10.9 Algae, T11.5 Freshwater Wetland Birds and Waterfowl, T11.11 Small Mammals, T11.13 Freshwater Fishes, T11.15 Amphibians and Reptiles, T11.16 Land and Freshwater Invertebrates

Associated Habitats

H3.1 Open-water Lotic (Rivers and Streams), H3.3 Bottom Lotic (Rivers and Streams), H3.6 Water's Edge Lentic (Lakes and Ponds), H4.1 Bog, H4.2 Fen, H4.3 Swamp, H6.1 Hardwood Forest.

H3.6 WATER'S EDGE LENTIC (LAKES AND PONDS)

The water's edge, or hydrosere, habitat of lentic ecosystems is the marginal edge of lakes and ponds, where rooted plants can grow. The habitat includes shallow water, where sunlight can penetrate to the bottom, commonly known as the littoral zone (see Figure T8.2.2). The littoral zone often applies to the entire area of ponds, which are generally shallow enough to support submerged vegetation throughout.

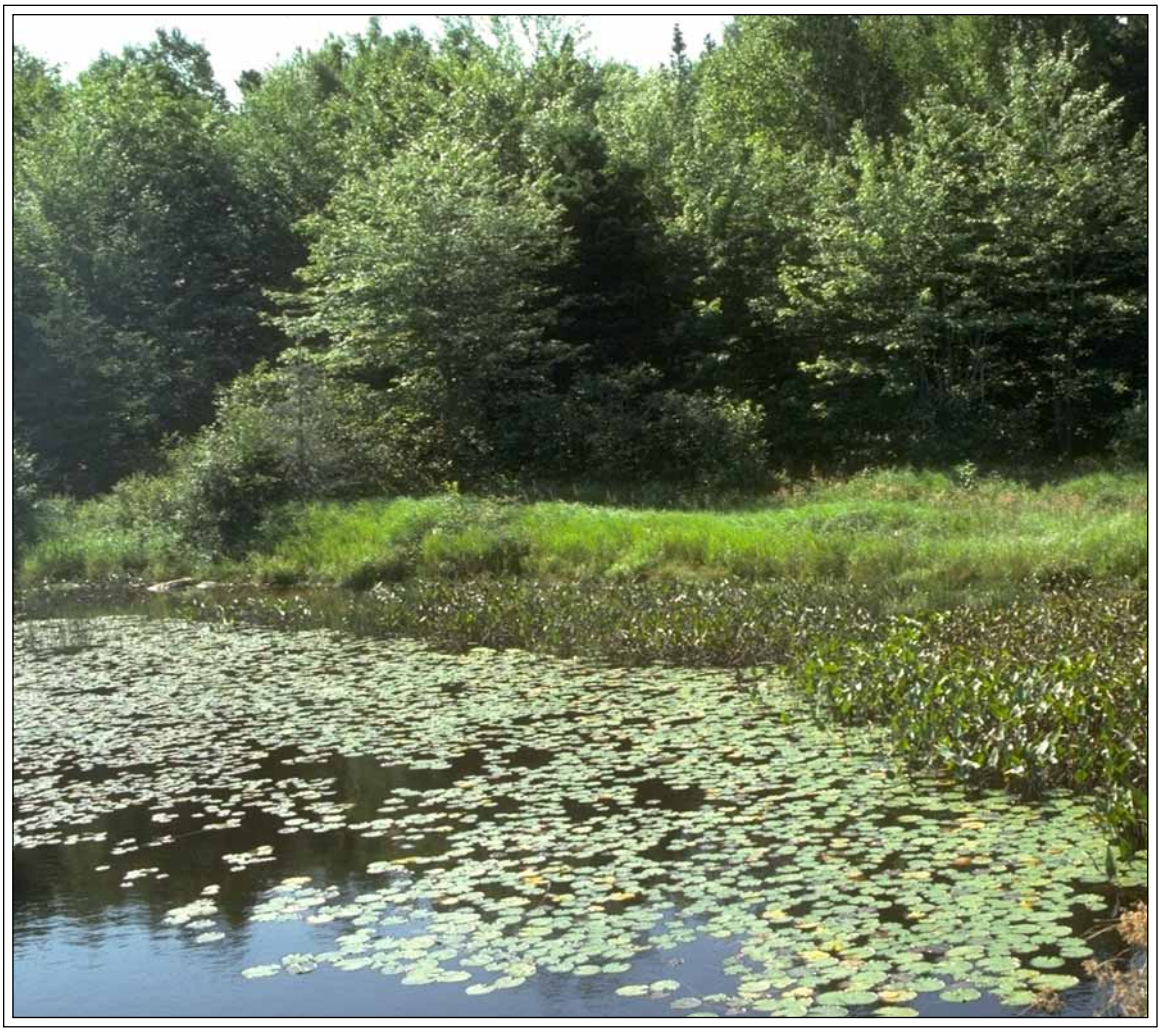

Plate H3.6.1: A sheltered lake shore at Lake Egmont, Halifax County (sub-Unit 511a), showing floating leaves of pond-lilies and emergent Pickerel-weed and rushes. Photo: D.S. Davis.

FORMATION

The water's edge habitat forms at the edge of a lake or pond and is always wet, though the water level may vary seasonally and is invariably frozen for some period during the winter. It is best developed in open, shallow conditions on glacial till in areas of low relief.

PHYSICAL ASPECTS

1. *Bedrock:* any bedrock and glacial till (particularly resistant metamorphic or igneous rocks, and boulder or coarse gravel bottoms).
2. *Soil:* fluvial sediments, silt, mud, sand and gravel, with varying amounts of organic material; often mobile.
3. *Relief:* in depressions, gently undulating sandscape.
4. *Drainage:* wet shoreline; seasonal fluctuation of water levels; variations in water levels can vary in relation to hydrodams – lake levels fluctuate artificially.
5. *Water conditions:* turbidity, deposition

ECOSYSTEM

Aquatic life is most abundant in the shallow water around the edges of lentic environments. Plants and animals generally establish a distinct zonation which varies mainly according to water depth (Figure H3.6.1). Rooted macrophytes, such as sedges, lilies and rushes, which grow in shallow, sheltered areas, are the primary producers. They contribute substantially to the productivity of lentic environments and provide a large input of organic material to the ecosystem.

Plant growth relies primarily on the availability of nutrients from sediments found in the benthic habitat (see H3.4). Macrophytes enhance the recycling of nutrients such as phosphorus by putting them back into circulation from the sediments. This process can produce a buildup of nutrients, resulting in increased productivity and the eutrophication of lakes and ponds. The hydrosere also provides favourable habitat for numerous animal species, including invertebrates, amphibians, fish, waterfowl, and small mammals.

SUCCESSIONAL SEQUENCE

The process of succession slowly converts the hydrosere into a terrestrial habitat. The sedimentation and subsequent infilling of a shallow water zone occurs from several sources. These include organic material produced by plants, silt imported from surface runoff, and the input of suspended sediment from streams. In the early stages of succession, there is a relatively large area of water with distinct zones of plants around the margins. As the pond silts up, these zones progress toward the middle, reducing the amount of water, giving rise to bog, fen, swamp or marsh habitats. The pace at which this takes place depends upon the rates of siltation, the rate of organic production and the rate of decomposition.

PLANTS

The plants occupying the lentic hydrosere can be classified according to four main zones, as shown in Figure H3.6.1.

1. The terrestrial zone of vegetation is characterized by members of the sedge family and sphagnum mosses, and is associated with various fen or swamp plants. In lakeshore areas with a mineral substrate, an association between two plants, Water Lobelia (*Lobelia dortmanna*) and Loosestrife (*Lysimachia* spp.),often develops. This relationship remains dormant until late summer, when water levels are lowest. At this time, these two species become the dominant vegetation in this zone. Other types of plants include Twig-Rush (*Cladium*), Pipewort (*Eriocaulon*) and Broad-leaf (*Spartina pectinata*).
2. The zone of emergent vegetation is characterized by rooted plants with most of their surface above the water. Some of the more common emergent plants found in Nova Scotia include Pickerel-weed (*Pontedaria*), Spike Rush (*Eleocharis*), Bog Buckbean (*Menyanthes*), Pipewort (*Eriocaulon*), Arrowhead (*Sagittaria*), cattail (*Typha*) and bulrush (*Scirpus*). Plant growth relates to the pH of the water, the degree of exposure and geographic location. The emergent plants, together with those on the shoreline, form an important link between water and land environments. They are used for food and shelter by amphibians and aquatic mammals, and provide a convenient means for acquatic insects to enter and exit the water.[1]
3. The zone of floating plants is characterized by plants with leaves on or just below the water surface, and emergent flowers. These may be either rooted or not rooted. Common species include Water-lily (*Nymphaea*), pond lily (*Nuphar*), and pondweed (*Potamogeton*). In small ponds with little surface movement, duckweed (*Lemna*) is usually found covering the surface. The

undersurfaces of lily pads provide suitable resting and oviposit sites for various animals.

4. The zone of submerged vegetation is located between the open-water habitat (see H3.2) and the shore. The character of the zone varies with the region. The plants generally require oligotrophic water conditions, rather than the distrophic situations which receive input from acidic environments, such as bogs. Some of the commonly found plants include pondweed (*Potamogeton* spp.), milfoil (*Myriophyllum* spp.), White Watercrowfoot (*Ranunculus trichophyllus*), Canadian Pondweed (*Elodea canadensis*), and the calcareous algae Stonewort (*Chara* spp.). Found mainly in gypsum or limestone bedrock areas (Region 500), Stonewort often indicates the inner boundary of the littoral zone, as it is able to grow in relatively deep water.

ANIMALS

The plant growth at the edges of lakes and ponds provides food for a wide variety of invertebrates, the most important of which are insects. Adult beetles and bugs are common and are mostly predatory, feeding mainly upon the aquatic larvae and nymphs of other insects, such mosquitos, mayflies, caddisflies and dragonflies. Other species include planktonic and benthic species of crustaceans, as well as numerous ostracods, cladocerans and copepods. Other invertebrates include one widespread species of amphipod (*Hyalella azteca*) and one isopod (*Caecidotea communis*) which is found only in southwestern Nova Scotia and Sydney River (Unit 531). Other invertebrates include species of oligochaete worms, leeches, gastropods (snails) and bivalve molluscs (clams). The diversity of species other than flying insects is generally limited. In small, isolated ponds, species require some form of introduction via a carrier (e.g., the pea clams may be introduced by birds, insects or amphibians). During the summer, small ponds generally experience long dry periods, which requires many invertebrates either to estivate or hibernate until water levels rise.

The number of vertebrate species will vary according to the degree of isolation from larger water systems and the geographic region. Most of the bigger lakes provide for several distinct types of fauna associated with different habitat conditions. The sheltered shores where there is sediment deposition in the hydrosere provide a habitat similar to that found in ponds, and hence the types of animals present are quite similar. However, the diversity of fish species is greater and the predation of invertebrates more significant in lakes than in ponds. Fish include Banded Killifish, Golden Shiner and young White Sucker. In small isolated ponds, fish may be totally absent, which is a distinct advantage for the larvae of salamanders and tadpoles of frogs that utilize the ponds during their early stages of development. Turtles are also mobile and may colonize the larger ponds. They use the sand and gravel banks to lay their eggs. Some amphibians, such as the Green Frog, stay in the edge habitat of ponds as adults; others may disperse to the woods.

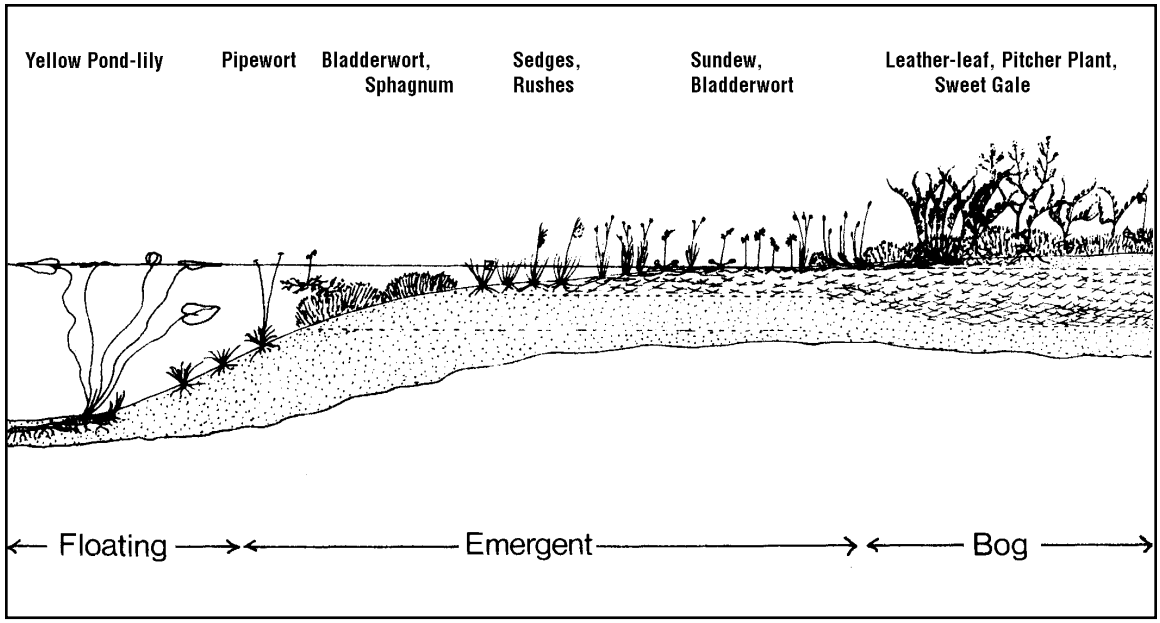

Figure H3.6.1a Zonation of aquatic vegetation at the edge of a dystrophic pond or lake in association with a bog.

Lakes with exposed rocky or cobble shorelines are subject to considerable wave action, which makes the habitat largely unsuitable for rooted vegetation, with the result that animals are correspondingly sparse. Some insect larvae, such as the caddisfly (*Helicopsyche* spp.), and snails (*Physa* spp., *Lymnaea* spp., and *Amnicola limosa*) are found attached to stones. This is generally an impoverished state of the sheltered shore fauna. Mussels such as *Elliptio complanata* burrow in patches of gravel. In addition, the Green Sponge and several species of ectoprocts can be found. Spotted Sandpipers are commonly seen along the shore. Migratory waterfowl, such as Black Ducks and Canada Geese, as well as species of loons, cormorants and gulls are also found in this habitat. Other birds common to the pond habitat include the Red-winged Blackbird, herons, bitterns, small passerines and aerial foragers, such as Tree Swallows. Mammals that may be present include mink, beaver, otter, and Muskrat.

DISTRIBUTION

Found throughout Nova Scotia

SPECIAL FEATURES

- The rare flora of the coastal-plain shoreline (southwestern Nova Scotia) includes Plymouth Gentian and Pink Coreopsis.
- The hydrosere habitat of lakes and ponds supports the developmental and adult stages of numerous invertebrates and vertebrates. Many of these would not exist without the presence of the hydrosere.

● ● ● ● ● ● ● ●

Associated Topics

T8.1 Freshwater Hydrology, T8.2 Freshwater Environments, T9.1 Soil-forming Factors, T10.2 Successional Trends in Vegetation, T10.5 Seed-bearing Plants, T10.9 Algae, T11.5 Freshwater Wetland Birds and Waterfowl, T11.11 Small Mammals, T11.13 Freshwater Fishes, T11.15 Amphibians and Reptiles, T11.16 Land and Freshwater Invertebrates

Associated Habitats

H3.2 Open-water Lentic (Lakes), H3.4 Bottom Lentic (Lakes and Ponds), H3.5 Water's Edge Lotic (Rivers and Streams)

References

1 Odum, E.P. (1971) *Fundamentals of Ecology*. W.B. Saunders, Philadelphia.

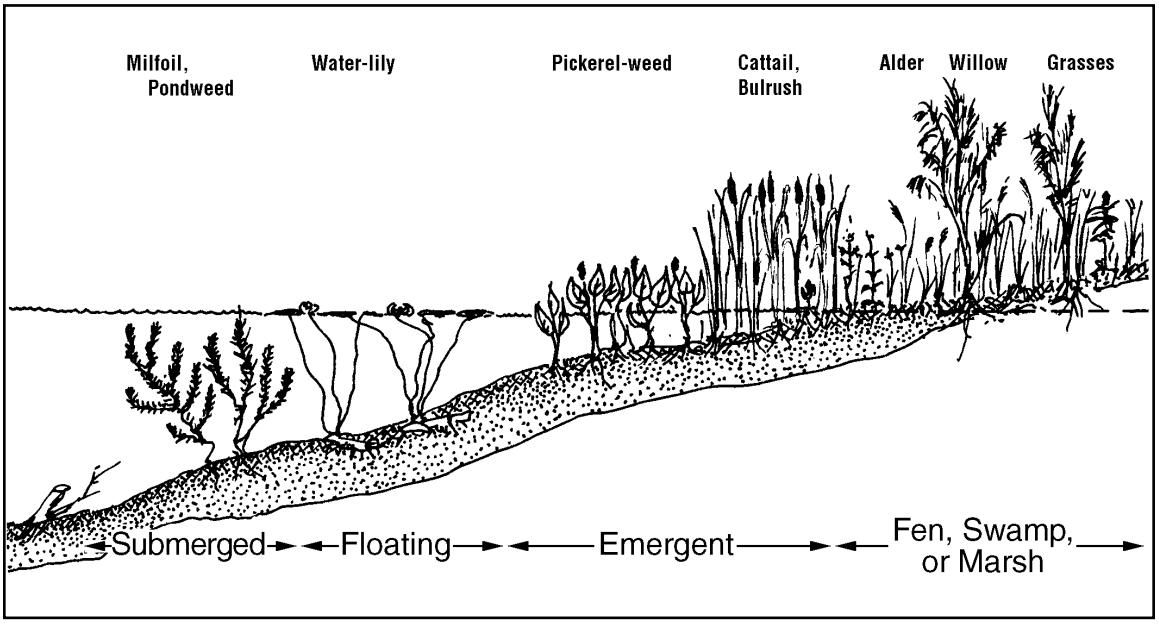

Figure H3.6.1b: Zonation of aquatic vegetation at the edge of an oligotrophic pond or lake in association with a fen.