T11.1 FACTORS INFLUENCING BIRDS

The composition of Nova Scotia's avifauna is influenced by the following factors:

DISTRIBUTION AND HABITAT GROUPINGS

Tufts[1] recognized two life zones in the province, based on climatic and forest features. There is a transition here from warmer, mainly deciduous forests, featuring birds such as Least Flycatcher, Veery, and Black-throated Blue Warbler, towards cooler, mainly conifer forests with species such as Yellow-bellied Flycatcher, Blackpoll Warbler, and Pine Grosbeak. However, it is not practicable to draw lines on a map to distinguish such zones, because forest cover within the province changes from conifer to deciduous or mixed stands, and back, over short distances. Likewise, birds of edge situations occur side-by-side with forest birds almost everywhere. However, open lands, and especially farmlands, within the province are restricted geographically, and the birds of these habitats comprise a separate grouping from those of forest and edge, as do those of freshwater wetlands, coastlines, and marine areas. Erskine[2] recognized three main distribution patterns among the breeding birds of the Maritimes: those that reach their northern breeding limits here, those that reach their southern breeding limits here, and (much the largest group) those of which both northern and southern breeding limits lie outside our province. Members of all three groups breed in Nova Scotia, and birds of most or all habitat groupings occur in each of them.

SEASONALITY

Most birds which breed in Nova Scotia depart in winter, and some others that breed farther north occur here only as migrants or in winter. This applies in all the geographic and habitat groupings in varying degrees. Vast assemblages of migrating shorebirds and other birds of marine habitats provide some of the most prominent avian spectacles in Nova Scotia during their non-breeding seasons. Migrant birds of freshwater wetlands and open lands are less obvious, and transients associated with forests and edge pass through inconspicuously, though in substantial numbers. Wintering birds, excepting those of marine habitats, are generally few in number and occur in much lower diversity than at other seasons.

GEOGRAPHY

Nova Scotia is a peninsula, with adjoining islands, that forms the easternmost part of the North American continent south of Labrador. It is neither isolated, so that many birds have been unable to reach it, nor so small that too few niches exist to accomodate the full variety found on the mainland. No breeding birds widespread in adjacent New Brunswick are absent in Nova Scotia, although many are scarcer here. The province also receives many vagrant birds from the west that came to rest here to avoid being blown out to sea, as well as others brought up the East Coast storm track from more southern areas.

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Associated Topics

T11.2 Forest and Edge-habitat Birds, T11.3 Open-habitat Birds, T11.4 Birds of Prey, T11.5 Freshwater Wetland Birds and Waterfowl, T11.6 Shorebirds and other Birds of Coastal Wetlands, T11.7 Seabirds and Birds of Marine Habitats

References

1 Tufts, R.W. (1986) *Birds of Nova Scotia*, 3rd ed. Nimbus Publishing & Nova Scotia Museum, Halifax.

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T11.2 FOREST AND EDGE-HABITAT BIRDS

HABITAT FACTORS

The densities of birds found in a given habitat are better correlated with the structure of the habitat than with the tree species, although the latter affect the number and mix of bird species found there. The overall fertility of the site, based on bedrock geology and the soils derived from the rocks, under the influence of climate, affects both diversity and density of vegetation and of the invertebrate life it supports; thus, the more fertile forests support denser and more diverse bird communities.

In general, mixed-age, and mixed-species stands support more birds than even-aged monocultures, and dense stands support more birds than open ones. However, the presence of edge, including tree and shrub cover and open areas in close proximity, increases habitat diversity and also bird diversity. Edge and successional habitats abound in Nova Scotia as a result of human settlement (see T12). Few detailed studies of conifer edge and succession have been made, but recent work in Nova Scotia has increased understanding of poplar and birch succession after fire and cutting.[1,2]

VERTICAL ZONATION

In forest habitats, foraging niches are stratified vertically, with a different mix of birds using each zone—ground, low shrub, subcanopy (tall shrubs and young trees) and upper canopy. Trunks and branches add further foraging opportunities, and mature forests offer also stumps, rotting trunks, and openings caused by wind-throw. Most breeding birds of woodlands are insectivorous, and a well-stratified (mixed-age) forest with good vertical diversity helps to segregate their feeding niches (see Plate T11.2.1). Examples of stratification associated with different forest types include

- Pines: variably open upper canopy, subcanopy lacking, low-shrub and ground cover sparse
- Poplars: upper canopy and shrub layers often dense, but with strong seasonal variation

Plate T11.2.1: Although considered a forest bird, the Downy Woodpecker also occurs in orchards and suburban areas with shade trees. This permanent resident in Nova Scotia is insectivorous, finding most of its food in and under the bark of trees. Photo: M. Elderkin

(owing to leaf-fall)
- Spruces (especially Black Spruce): fairly open upper canopy, dense complete ground cover of low shrubs and mosses
- Balsam Fir (climax): mixed-age and thus mixed-height of canopy trees, all stages of regenerative growth in shrub and subcanopy layers, much dead wood on ground but often little plant cover

Younger trees (of all species) often exhibit bushy growth, sometimes leaving no room for a distinct sub-canopy layer.

BREEDING DENSITIES

General densities of breeding birds were estimated for different habitats in the Boreal Region,[3] and the few density data collected from Nova Scotia habitats of these types were roughly similar (see Table T11.12.1).

The earliest stages of secondary succession, up to seven years after fire or cutting, are treated under Birds of Open Habitats (see T11.3), as the birds there are largely distinct from those of forest and edge.

	PAIRS PER km^2
Jack Pine & bog forest (open)	80–200
Spruce (mature)	200–400
Balsam Fir (mature)	300–600
Fir with heavy budworm infestation	400–800
Hemlock (mature)	500–800
Mixed conifers (20–30 yr)	400–800
Maple/beech (mature)	400–650
Birch/poplar (late successional)	300–600
Mixed hardwood (20–40 yr)	800–1000
Young regeneration (8–15 yr)*	300–700

Table T11.2.1: The number of pairs of breeding birds per km^2 for different forest habitats. **The exception occurs in young Jack Pine plantations, where breeding densities are much lower, at 100–200 pairs per km^2.*

COMMUNITY DIFFERENTIATION

The bird communities of different forest types differ to varying degrees.[2, 3, 4] With the great local variation in forest types in Nova Scotia, as a result of geology, climate, and disturbance, the bird communities here show much overlap, with few species restricted to one habitat. Birds characteristic of deciduous or hardwood stands less often occur regularly in conifer-dominated stands than the reverse, and many birds of conifers occur across most of the conifer-dominated types (see Table T11.2.2).

Many other birds are found in each habitat, but more species, as well as higher densities, occur in the more fertile stand types dominated by Eastern Hemlock or Balsam Fir. Mixed wood habitats include varying assemblages of the bird species found in the other types.

The larger species, including birds of prey (hawks, owls), grouse, and ravens, crows, and jays, generally occur at lower densities than many small songbirds. They also range over various habitats, even if nesting mainly in one type. (Birds of prey are discussed in further detail in T11.3 and T11.4.) The cardueline finches, a group adapted to feed on tree seeds, are also wide ranging. Their distribution is less predictable than most birds. Evening Grosbeaks often serve as evidence of Spruce Budworm concentrations, but the other finches—Pine Grosbeak, crossbills, Pine Siskin—appear in response to the seed crops of their preferred food trees.

SUCCESSIONAL HABITATS

The earliest stages of succession after fire or cutting are largely open habitats (see T11.3). Starting 8–10 years after disturbance, the birds of open areas and low shrubbery are gradually superseded by those of tall shrubs, many of which are tolerant species found in edges and openings in all forest stages; for example,
- Yellow-bellied Flycatcher
- Hermit Thrush
- American Robin
- Red-eyed Vireo
- Chestnut-sided Warbler
- Magnolia Warbler
- American Redstart
- Lincoln's Sparrow
- White-throated Sparrow
- Northern Junco

Studies elsewhere suggested no consistent trends in bird density or diversity through the forest succession. Generally the highest levels, both in density

and numbers of species, occurred somewhere in mid-succession rather than in young stands or old growth forest.

Stand Type: HARDWOOD (POPLAR/BIRCH, MAPLE/BIRCH)	
• Least Flycatcher	• Northern Parula Warbler
• Black-capped Chickadee	• Black-throated Blue Warbler
• Veery	• American Redstart
• Hermit Thrush	• Ovenbird
• American Robin	• Canada Warbler
• Red-eyed Vireo	• Rose-breasted Grosbeak
Stand Type: HEMLOCK/WHITE PINE	
• Black-capped Chickadee	• Northern Parula Warbler
• Red-breasted Nuthatch	• Black-throated Green Warbler
• Winter Wren	• Blackburnian Warbler
• Veery	• Ovenbird
• Hermit Thrush	• White-throated Sparrow
• Red-eyed Vireo	
Stand Type: FIR/SPRUCE	
• Yellow-bellied Flycatcher	• Black-throated Green Warbler
• Winter Wren	• Bay-breasted Warbler
• Swainson's Thrush	• Ovenbird
• Golden-crowned Kinglet	• White-throated Sparrow
• Ruby-crowned Kinglet	• Northern Junco
• Magnolia Warbler	• Purple Finch
Stand Type: BLACK SPRUCE	
• Yellow-bellied Flycatcher	• Magnolia Warbler
• Winter Wren	• Yellow-rumped Warbler
• Swainson's Thrush	• Blackpoll Warbler
• Hermit Thrush	• Common Yellowthroat
• Golden-crowned Kinglet	• White-throated Sparrow
• Ruby-crowned Kinglet	• Northern Junco
• Nashville Warbler	
Stand Type: BOG FOREST	
Regular Species	
• Nashville Warbler	• Common Yellowthroat
• Yellow-rumped Warbler	• Lincoln's Sparrow
• Palm Warbler	• Northern Junco

Table T11.2.2: Bird species found most regularly in the various forest types in Nova Scotia.[2, 3, 4] (See T11.5 for additional passerine species associated with freshwater wetlands.)

BIRDS IN FOREST AND EDGE HABITATS AT OTHER SEASONS

Breeding birds advertise their presence by song or other sounds. Outside the breeding season, most birds are less obvious and much harder to study. Most birds moult immediately after breeding, and insectivorous birds, including most forest birds, leave Nova Scotia as soon as moult is completed. Except for stragglers, nearly all flycatchers, wrens, thrushes, vireos, and warblers (with many other species) are absent from the province from September through mid-May, thus spending only 3 1/2 months here each year. The general patterns of moult and migration are known for most of our bird species, but no intensive studies of these activities have been made in the Maritimes. Spring arrivals of insectivorous birds come in a rush during May, when many species may appear in numbers overnight, especially during the passage of the "warm sector" (south of the centre) of a weather system across the province. The fall departure is inconspicuous, featuring silent woods punctuated by "chip"-notes and drab little bird shapes fluttering among the leaves. "Confusing fall warblers" require long study, and many pass by unidentified and undocumented.

Many migrant birds switch from insect food to seeds or fruits after the breeding season, and these frequent edges and open lands then as much as or more than forests. With wider food choice, these species, including the familiar American Robin and many native sparrows, stay longer in fall and return earlier in spring, leaving in October and arriving during April.

Only a few birds of forest and edge appear in Nova Scotia only as migrants or in winter. Birds of the subarctic fringe include mostly widespread species tolerant of most conifer habitats, for example, Swainson's Thrush, Yellow-rumped Warbler and Northern Junco. These swell the passage through the province but cannot be distinguished from individuals of the same species that bred here. Others, such as Gray-cheeked Thrush, Blackpoll Warbler and Fox Sparrow, are at the southern limits of their breeding range here, and most migrants detected are of more northern populations. Only Tree Sparrow, White-crowned Sparrow and Common Redpoll are unambiguous visitors here, coming from the north in the off-season. All of these birds are more often seen here in edge situations rather than forest.

Our forest birds in winter are either residents or nomads. The former include grouse (feeding on leaves, fruits and buds) (see Plate T11.2.2) and woodpeckers, chickadees and Golden-crowned Kinglets

Plate T 11.2.2: The Spruce Grouse is found predominantly in the interior at the edges of second-growth softwood forests. Forestry practices in Nova Scotia have increased their preferred habitat. There are an estimated 24000 breeding pairs in Nova Scotia.[5] Photo: M. Elderkin

(feeding on insect pupae and egg-cases in the trunks, bark or foliage of trees), plus the wide-ranging raptors (predators on birds and mammals) and corvids (scavengers on anything edible). The nomads include the cardueline finches (feeding on tree seeds) and sometimes the waxwings (feeding on tree fruits).

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Associated Topics

T10.6 Trees, T11.3 Open-habitat Birds, T11.4 Birds of Prey, T11.5 Freshwater Wetland Birds and Waterfowl, T11.16 Land and Freshwater Invertebrates

Associated Habitats

H5.1 Barren, H5.2 Oldfield, H6.1–H6.3 Forests

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1 Freedman, B., C. Beauchamp, I.A. McLaren and S.I. Tingley (1981) "Forestry management practices and populations of breeding birds in a hardwood forest in Nova Scotia." *Can. Field-Nat.* 95.

2 Morgan, K., and B. Freedman (1986) "Breeding bird communities in a hardwood forest succession in Nova Scotia." *Can. Field-Nat.* 100: 506-519.

3 Erskine, A.J. (1977) *Birds in Boreal Canada: Communities, Densities and Adaptations.* Canadian Wildlife Service. (*Report Series* no. 41).

4 Lunn, S. (1973) *Avifaunal Survey of Kejimkujik National Park, 1972-73.* Report to Parks Canada, nos. 72-31.

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T11.3 OPEN-HABITAT BIRDS

HABITAT FACTORS

Open lands are essentially two-dimensional habitats, lacking the vertical component of forest and shrub habitats. Birds of open habitats must nest on the ground, or on artificial structures or nearby cliffs. However, most open-country birds use the power of flight to add a vertical dimension to one or more aspects of their activities; thus, Horned Larks and Bobolinks use song-flights as part of their courtship rituals; Northern Harriers and Short-eared Owls fly continuously, low over marshes and fields, in search for their small-mammal prey; and European Starlings rise into the air in a dense cloud to confuse the attack of a passing Peregrine Falcon. (Birds of prey are discussed in further detail in T11.4.) Permanently open habitats were scarce in Nova Scotia before Europeans began clearing the forests for agriculture or settlement (see T12.10), and thus the few open-country birds here include most of the introduced species, which were pre-adapted to such places, e.g., Ring-necked Pheasant, Gray Partridge, Rock Dove, Starling and House Sparrow.

DENSITIES AND COMMUNITIES

Because of the lack of vertical stratification, total densities of birds of grasslands and barrens average lower than those of all but the most sparse forest habitats, usually only 100–200 pairs per km^2. Densities on open bogs and the drier parts of marshes are in a similar range. In the open habitats resulting from fire or clear cutting of forests, shrubs appear after the first year or so, providing vertical zonation and allowing densities of 150–450 pairs per km^2.

Natural grasslands and barrens in Nova Scotia had few native species, most using also bogs and marshes, for example

- Northern Harrier
- American Kestrel (nesting in tree cavities)
- Short-eared Owl
- Common Nighthawk
- Cliff Swallow (nesting on cliffs originally)
- Barn Swallow (nesting on cliffs originally)
- Vesper Sparrow
- Savannah Sparrow
- Sharp-tailed Sparrow (only tidal marshes)
- Bobolink
- American Goldfinch

Plate T11.3.1: The Common Nighthawk is an aerial insectivore, feeding entirely on flying insects during both the night and the day. It breeds on bare ground and sometimes on flat gravel roofs. Photo: M. Elderkin

Horned Lark colonized eastern North America as a breeding species early in the twentieth century. Larks and Vesper Sparrows later declined as the short-grass habitats they favoured became scarce under recent agricultural regimes; now Horned Larks breed most regularly at airports and in fields, and Vesper Sparrows frequent blueberry fields. Common Nighthawk appear to be declining in eastern North America for reasons that are not yet clear (see Plate T11.3.1).

In the earliest (open) stages of forest succession, the bird community comprises mainly birds associated with low-shrub cover, with a few that make use of the stubs and snags that survive most forest disturbances:

- American Kestrel (nesting in tree cavities)
- Northern Flicker (nesting in tree stubs)
- Olive-sided Flycatcher (foraging and courting from stubs)
- Alder Flycatcher
- Eastern Kingbird
- Eastern Bluebird (nesting in tree cavities)
- Cedar Waxwing (foraging from stubs and snags)
- Common Yellowthroat
- Song Sparrow
- Lincoln's Sparrow
- White-throated Sparrow
- Northern Junco

Most of these species also occur in edge situations around and throughout the forested parts of the province.

The Eastern Bluebird is listed as a vulnerable species in Nova Scotia by COSEWIC. The Loggerhead Shrike is also a bird of open habitat listed by COSEWIC. Its status is endangered in Nova Scotia. The Ipswich Sparrow was treated as a separate species from the Savannah Sparrow until 1957. It is almost confined to Sable Island (District 890).[1]

BIRD USE OF OPEN HABITATS OUTSIDE THE BREEDING SEASON

Many more birds use open habitats in Nova Scotia at other seasons than do so in summer. This is partly because of the movement southward of birds that breed on the treeless tundra of the far north. The four common song birds of the Arctic—Horned Larks, American Pipits, Lapland Longspurs, and Snow Buntings appear in fall on beaches and salt marshes, coastal barrens and dyked grasslands, and some of them (except the pipits) remain all winter anywhere that the seed-heads of the plant cover protrude above the snow. The arctic predators, Rough-legged Hawks and Snowy Owls, come south in varying numbers, depending on the cyclic numbers of their lemming prey in the arctic.

Many other birds that breed in forest and edge habitats forage in open lands in fall and spring. However, fewer of these remain for the winter, as the oldfield habitats (see H5.2) that offer much weed seed tend to be deeply snow covered for several months each year. These birds include most of the common and familiar birds of garden and edge, such as the American Crow, the American Robin, various sparrows, and especially the blackbirds, with American Goldfinches. The introduced species are mostly year-round residents and frequent oldfields in fall and spring, but often rely on waste grain and other food scraps around human settlements in winter. The large scavengers—jays, crows, and ravens, and also the large gulls—range widely across open lands and other habitats outside the breeding season, in search for anything edible, including other birds.

The open habitats of early succession after clear cutting are little used outside the breeding season. The ground cover is often too disturbed to provide favourable feeding opportunities. After the beeding season, birds are free to move wherever the feeding is easiest at other seasons.

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Associated Topics

T11.1 Factors influencing Birds, T11.2 Forest and Edge-habitats Birds, T11.4 Birds of Prey, T11.5 Freshwater Wetland Birds and Waterfowl, T12.11 Animals and Resources

Associated Habitats

H4.1 Bog, H4.2 Fen, H4.4 Freshwater Marsh, H5.1 Barren, H5.2 Oldfield, H5.3 Cliff and Banks

References

1 Erskine, A.J. (1992) *Atlas of Breeding Birds of the Maritime Provinces*. Nimbus Publishing & Nova Scotia Museum, Halifax.

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T11.4 BIRDS OF PREY

The birds of prey, collectively known as raptors, include the vultures, hawks, eagles, osprey and falcons (Falconiformes) and the owls (Strigiformes). All are carnivores or carrion feeders and are characterized by the possession of strong beaks and claws. The habits and often large size of these birds have generated considerable public interest, and there is a certain amount of folklore mixed with fact in popular knowledge about the group. All raptors are protected by law in Nova Scotia.[1]

Birds of prey inhabit both forests and open lands. Habitat factors and relationships are discussed in T11.2 and T11.3.

FOOD SUPPLY

Hawks feed in the daytime (diurnal), mainly on small mammals but also on reptiles, amphibians, small birds and insects. Early experience with hawks attacking farm poultry gave rise to the popular names "hen hawk" and "chicken hawk" being applied to hawks in general, perpetuating the tradition that hawks are harmful and should be considered a nuisance. Goshawks will frequently, and Red-tailed Hawks less frequently, take domestic fowl if the opportunity arises, while a number of other hawks will take grouse or small birds. The Bald Eagle and Osprey feed mainly on fish, the latter being an active fishing species. Carrion-feeding Turkey Vultures are not known to breed here but are seen now and again in summer and fall.

Owls hunt either at night (nocturnal) or in the twilight (crepuscular), mainly for small mammals. The Snowy Owl, an occasional visitor to Nova Scotia in winter, is diurnal in habit. Some raptors, such as Red-tailed Hawk, Northern Harrier and Short-eared Owl, generally prefer to hunt over open ground and are commonly seen over fields. Others (Goshawk, Broad-winged Hawk, Sharp-shinned Hawk, Great Horned Owl, Saw-whet Owl, Barred Owl) more often hunt within the forest or along the forest edge. They consume large quantities of rodents and are thus considered to be of benefit to agriculture. The Barred Owl feeds on a wide variety of creatures, including snakes, eels, mice, rats, birds and insects.

BREEDING

Raptors generally prefer nesting sites in remote areas, to avoid disturbance, but nests are not unusual closer to human activities and habitation. The diurnal birds of prey commonly nest in high trees, often in old nests of crows (particularly the Broad-winged Hawk and the Merlin). Osprey and Bald Eagle make large, conspicuous nests, which are built up each year.

The Northern Harrier is an exception, as it builds its nest on the ground in wet grasslands or shrubs, close to the marshland feeding habitat. Peregrine Falcons nest on the ledges of cliffs in preference to trees. Hawks usually lay their eggs during May. The owls are largely tree-nesting species. The Saw-whet and Barred Owls use holes in trees, while the Great Horned Owl and Long-eared Owl use old nests of other birds or even dense growths of witches'-broom in spruce trees. Short-eared Owls nest on the ground.

Plate T11.4.1: Cold winters with deep snow can keep the Saw-whet Owl from finding its principal food (small mammals) and can result in high mortality. Photo: M. Elderkin

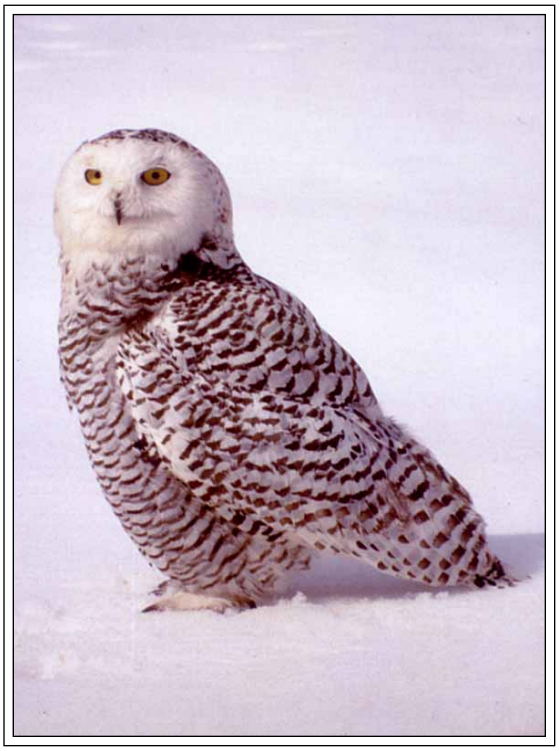

Plate T11.4.2: The Snowy Owl breeds in the tundra habitat of the Artic. It is an irregular but sometimes frequent winter visitor to Nova Scotia. Photo: M. Elderkin

Eggs are laid between March and May, and the young are hatched between April and June, depending upon the species. For more information refer to the *Atlas of Breeding Birds of the Maritime Provinces.*[2]

SPECIES DIVERSITY

There are eleven species of hawks and eagles reported as breeding in Nova Scotia. Most are relatively common and have shown some increases in population since the 1960s. Cooper's Hawk was once recorded as breeding. In addition, there are seven other species that visit the province but do not breed. This group includes the Rough-legged Hawk, which may be common during winter, and some rare hawks, eagles and vultures.

There are species of owl that breed in Nova Scotia. The Great Horned Owl and Barred Owl are perhaps the most common. The Long-eared, Short-eared and Northern Saw-whet owls are also confirmed breeders, although not as common (see Plate T11.4.1). The Boreal Owl is believed to breed here.[2] Five other species are rare visitors: the Northern Hawk-Owl, the Great Grey Owl, Common Barn Owl, Eastern Screech Owl (two confirmed sightings) and the Snowy Owl (see Plate T11.4.2).

DISTRIBUTION

Most of the hawks and owls that breed in Nova Scotia appear to be generally distributed, but old remote forest stands provide the best nesting situations for many species. The Bald Eagle and Osprey occur close to their marine and freshwater feeding areas, particularly in northern Nova Scotia and along the Atlantic shore. The Northern Harrier is most abundant where there are extensive marshes, as in the Chignecto Isthmus (Unit 523) and the Wolfville, Grand Pré area (District 610). Eagle habitats have been documented as part of the mapping of significant wildlife habitats by the provincial Department of Natural Resources.[3]

CULTURAL FACTORS

The false images, created in the past, that hawks are pests led to the widespread and indiscriminate killing of these birds. However, this has largely, though not entirely, been remedied through education and legislation. The widespread use of insecticides and herbicides since the Second World War has led to declines in raptor populations. The insecticide DDT is well documented as being detrimental in this respect, through its effect on calcium metabolism and egg-shell thickness. Many species have shown recoveries since the withdrawal of DDT, but other widely used chemicals still pose a threat.

Loss of habitat and disturbances of nesting areas by forestry, recreation and other activities are also problems.[4]

The Peregrine Falcon, which has not bred in Nova Scotia since around 1960, has been reintroduced to suitable habitats near Cape d'Or and around the Minas Basin (District 710, sub-Unit 913a). Cooper's Hawk is considered by COSEWIC to be a vulnerable species in Nova Scotia.

Associated Topics

T11.1 Factors Influencing Birds, T11.2 Forest and Edge-habitat Birds, T11.3 Open-habitat Birds, T11.5 Freshwater Wetland Birds and Waterfowl, T11.11 Small Mammals

Associated Habitats

H2.5 Tidal Marsh, H4.4 Freshwater Marsh, H6.1–H6.3 Terrestrial Forested

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1 Tufts, R.W. (1986) *The Birds of Nova Scotia*. N.S., 3rd ed. Nimbus Publish & Nova Scotia Museum, Halifax.
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T11.5 FRESHWATER WETLAND BIRDS AND WATERFOWL

Freshwater and coastal aquatic habitats are used by water birds, which feed on aquatic organisms, and by many other birds which frequent the varied vegetation of water-land interfaces. This Topic deals mainly with birds associated with freshwater habitats. Waterfowl (ducks and geese) have been studied much more than other wetland birds, and factors influencing their distribution are discussed separately.

HABITAT FACTORS

Table HI.1 in the Introduction to **Habitats** compares terminology used to classify wetlands in various systems and identifies the terminology chosen for wetland habitats in the *Natural History of Nova Scotia*.

Discussion of water birds requires rational arrangement of wetland habitats. As a minimum, the habitat framework involves consideration of the successional process by which vegetation and mineral soil encroach on freshwater areas, converting them to terrestrial habitats (see H3.6). It also integrates the gradients from open sea to lakes and to dry land. T11.2 and T11.3 mention bog forests and open bogs and marshes, which are also transitional to the wetland habitats treated here. T11.6 discusses birds of the coastal habitats, in which lands meet the sea.

The hydrosere describes gradients, over time, from open water to terrestrial habitats. In fertile (eutrophic) situations, the gradient goes from open water with only submerged aquatic vegetation through deep and shallow marshes, with emergent herbaceous vegetation standing in water; to shrubby or treed swamps, with woody vegetation standing in water for at least part of the year; to deciduous forests and shrubby thickets (carrs) on damp soils. In less fertile and more acidic situations, the

Plate T11.5.1: Male Common Merganser spend most of the winter in brackish salt water along the coast where fish are accessible. Photo: B. Bancroft

(oligotrophic/dystrophic) gradient passes from open waters, often with rocky shoresthrough water areas, with some emergent vegetation; to wet areas, with some standing water and shrubby as well as herbaceous vegetation; to damp areas (bogs), with a surface mat and shrub and moss hummocks plus well-spaced small trees; and to low bog-forest of conifers. These processes are slow, progressing over several hundred years for completion, unless interrupted by fires or changes in water level (e.g., impoundments or drainage) during that time. At all stages, there is also a small-scale gradient from the wetlands through water-edge (riparian) habitats to adjacent drier lands.

Marine areas and coastal wetlands are treated in succeeding topics (see T11.6 and T11.7). The other gradients start from open salt water, one passing through the brackish water of estuaries to the fresh waters of rivers, lakes and brooks; the other including salt marshes and barrier-beach lagoons (brackish), through fresh marshes, to moist terrestrial habitats.

WETLAND USERS

"Many birds characteristic of wetlands nest some distance away on dry land, often in a plant community in no way associated with wetlands."[1] Others nest in vegetation above or adjoining the waters of wetlands. Various groups of birds lead their young from the nest, before these can fly, to rear them on open water, in marshes, or on shores. Nevertheless, many birds may be assigned to particular stages of one or more gradients, though some more-tolerant species occur in nearly all wetland habitats.

Open Water

Several water birds "spend most of their time, including foraging, resting, and preening, on open water, but these do not nest over water as a rule. This is a heterogeneous group linked only by their dependence on deeper open waters for feeding."[1] They feed mostly on fish and include

- Common Loons
- Double-crested Cormorant (few; most in Nova Scotia are coastal birds)
- Great Blue Heron (few; most here are coastal birds)
- Common Goldeneye
- Hooded Merganser and Common Merganser (see plate T11.5.1)

The three latter species all use tree cavities for nesting. Some Ospreys and Bald Eagles, also tree nesters, frequent fresh waters, as do a few Herring Gulls and Common Terns, though these species usually use coastal areas in this province.

Deep and Shallow Marshes

Birds that build floating nests anchored to aquatic vegetation seldom go ashore for any purpose. These, along with others that nest in emergent plants above water, comprise the marsh-bird community. This community is poorly represented in Nova Scotia. The Red-winged Blackbird is the only common songbird in this group, and it has spread greatly here in the last half-century. Others include

- Pied-billed Grebe (local)
- American Bittern
- Sora
- Virginia Rail (local)

Several other marsh birds which have bred in very small numbers in Nova Scotia's border region (Unit 523) are almost unknown elsewhere in the province. These include

- Yellow Rail
- Common Moorhen
- American Coot
- Black Tern
- Marsh Wren

Various ducks also belong here, although most nest in upland situations. Only a few are widespread, including Green-winged Teal, Black Duck and Ring-necked Duck.

Most other dabbling ducks, such as the Mallard and Blue-winged Teal, or the scarcer Northern Pintail, Northern Shoveler, Gadwall and American Wigeon, are virtually confined to the few fertile marshes. Wood Ducks, which nest in tree cavities and artificial nest boxes, also lead their young to marshes for rearing. Redheads and Ruddy Ducks are marginal species, virtually restricted in this province to the border region. The Least Bittern is considered vulnerable in Nova Scotia according to COSEWIC ratings; however, its habitat, especially in artifical impoundments, is increasing.[2]

Wet Pasture or Meadow

Seasonally flooded wet areas, characterized by grasses, sedges and poorly drained soils, are used by various wetland songbirds as well as larger species. These habitats are generally associated with or altered by human activity. Some birds use these habitats through the summer (e.g. Northern Harrier,

Common Snipe, Savannah Sparrow, Swamp Sparrow, Red-winged Blackbird). Dabbling ducks also occur here in spring and early summer before flood water levels recede. Swallows also forage over wet meadows throughout the summer.

Swamp and Riparian Shrubbery

Wooded swamps on floodplains provide favourable habitat for the tree-cavity-nesting ducks noted above. Shrubby swamps are used particularly by a few species: American Woodcock, Yellow Warbler, Northern Waterthrush, Common Yellowthroat. Swamp forests harbour a wide array of forest birds that also occur regularly in other deciduous forests (e.g., Eastern Wood-Pewee, Veery, American Robin, Northern Parula Warbler, American Redstart, Song Sparrow).

Lakes and Rivers with Stony or Unvegetated Shores

Common Mergansers and Spotted Sandpipers are the characteristic birds of these less-fertile waters. Belted Kingfishers and Bank Swallows, which burrow in exposed banks to nest, also use these habitats as well as others. Many of these birds also nest around coastal wetlands with open shores.

Fens and Bogs

Both these vegetated wetlands generally have their water table at the level of the land. However, the distinction is in higher (fen) vs. lower (bog) nutrient supply for the vegetation. There is also a gradient from open to shrubby bogs and on to low bog forest. Most birds found in these habitats are tolerant species that occur widely in other wetlands, for example Black Duck, Ring-necked Duck, Northern Harrier and Common Snipe.

Various songbirds are also regular, such as Alder Flycatcher, Palm Warbler, Common Yellowthroat, Song Sparrow, Lincoln's Sparrow, Swamp Sparrow, Red-winged Blackbird, Rusty Blackbird and Common Grackle. Of all these, only Palm Warblers and Rusty Blackbirds are nearly restricted to bog habitats.

WATERFOWL ECOLOGY AND DISTRIBUTION

Some of the major factors influencing the use of inland habitats by waterfowl include fertility, climate, shoreline gradient and water/land interspersion and the disturbance of birds and their habitats.

Fertility

Insufficient nutrients in the soil and water limit the growth of vegetation and aquatic invertebrates used by waterfowl. Excessive salinity or acidity, or other chemical factors, can also inhibit growth of plants and animals, even in the presence of adequate nutrients.

Climate

Factors include duration and extent of ice cover, water-level variability, and incidence of unfavourable rainfall/temperature combinations during the hatching period. Springtime flooding sometimes destroys nests. Adverse conditions at hatching reduce productivity and early freeze-up may affect how long both local birds and migrants remain in an area.

Shoreline Gradient and Water/land Interspersion

Shallow, sloping shorelines permit more extensive marsh development A wetland with islands and a highly indented shoreline provides isolated breeding spaces for more ducks than would a similar area with more regular shoreline The interspersion and juxtaposition of vegetation, influenced by all of the above factors, also act on the use of the area by waterfowl.

Disturbance of Birds and their Habitat

People and domestic animals can make some otherwise-suitable wetlands unacceptable to waterfowl. Major human disturbances to wetlands bird habitat include the use of motor vehicles and other machines, including motorboats, in or adjacent to wetlands; spring burning or cultivation of open lands near water; hunting; and drainage, dumping or other destruction of wetlands.

Waterfowl production in Nova Scotia occurs in three main habitat complexes:

1. a very few, very small, fertile freshwater wetlands with high densities and high diversity of breeding ducks
2. more, but still few, more-or-less brackish to saltwater wetlands associated with coastal bays and inlets, with moderate to low densities and low diversity (mainly Black Ducks, with some Blue-winged Teals); this category is discussed further in T11.6 but is included here for a fuller perspective
3. the vast majority of inland wetlands, generally quite infertile and featuring very low densities and low diversity (Black Ducks and Ring-necked Ducks)

A preliminary estimate of breeding waterfowl numbers in the Atlantic provinces[1] suggested that the relative densities (pairs/km^2) in these categories were roughly

a. 12–115; b. 30; c. 0.06–6.

The spring duck population (breeding pairs) by habitat works out to roughly
a. 4336; b. 9510; c. 8854
—or about 19, 42 and 39 per cent, respectively, of the total.

The few fertile areas attract attention, by both hunters and bird-watchers, out of all proportion to their area, because both density and diversity of ducks are much higher than elsewhere. The border lowlands (Unit 523) are the best known of these areas, comprising mostly former coastal marshes converted, by dyking, drainage, and subsequent re-flooding, into impoundments managed for waterfowl and wild-rice production. Gypsum deposits also contribute to the fertility of local wetlands at Amherst Point and locally elsewhere in the province. Rivers, where seasonal inundation by runoff has allowed development of floodplains, are also of above-average fertility, and a few wetlands have been enriched by nutrients from agricultural runoff. Examples of the former are the Musquodoboit, Shubenacadie, Stewiacke, and Kennetcook valleys in central Nova Scotia (sub-Unit 511a), and the Margaree Valley on Cape Breton Island (Unit 591).

Lakes and stillwater areas of streams throughout the province provide many small pockets of breeding and brood-rearing habitat for ducks, and beaver flowages provide some of the better inland habitat for a variety of wetland species. Although densities there are low, the large total area of "hinterland habitats" across the province accounts for a quite significant part of the total duck production. As disturbance by people there, including hunting, is usually much less than in the more fertile areas, it is possible that the infertile hinterlands are net exporters of ducks, and they help to maintain numbers in the fertile areas.

BIRD USE OF FRESHWATER WETLANDS OUTSIDE THE BREEDING SEASON

Birds that breed in Nova Scotia wetlands often remain there for weeks or months after the year's young are fully fledged. Numbers of waterfowl in Nova Scotia's inland waters often reach annual peaks during August, although sanctuary areas (e.g. Amherst Point) may hold large numbers again in the first weeks of the duck-hunting season. Freezing prevents most use of fresh waters by aquatic birds during the winter months each year. Most plant and animal foods used by wetland birds are obtained from the water. As most production of food organisms there ends even before freezing commences, most birds move away from freshwater wetlands during September and October. Except where current, in rapids or at the outflows of hydroelectric dams, keeps inland waters open, few water birds occur there between early November and late March. Common Goldeneyes and Common Mergansers are the species that winter most regularly on fresh waters in this province, although they are also commonly found along the coast (see Plate T11.5.1).

In spring, the urge to breed brings some water birds back to inland marshes as soon as any open water is present. Black Duck pairs appear at spring holes in brooks and wet pastures in March, and the spring thaws soon provide places for local breeders. The bulk of the migrating waterfowl, however, congregate in coastal wetlands (see T11.6). Other species of water birds mostly return during April, with the more strictly insectivorous species, such as Yellow and Palm Warblers and Lincoln's Sparrow, arriving after mid-May.

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Associated Topics

T8.2 Freshwater Environments, T8.3 Freshwater Wetlands, T11.1 Factors influencing Birds, T11.2 Forest and Edge-habitat Birds, T11.3 Open-habitat Birds, T11.6 Shorebirds and Other Birds of Coastal Wetlands, T12.11 Animals and Resources.

Associated Habitats

H3.1 Open Water Lotic (Rivers & Streams), H3.2 Open Water Lentic (Lakes & Ponds), H3.5 Hydrosere Lotic (Rivers & Streams), H3.6 Hydrosere Lentic (Lakes & Ponds), H4 Freshwater Wetlands

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T11.6 SHOREBIRDS AND OTHER BIRDS OF COASTAL WETLANDS

Habitats grade into each other, abrupt changes being the exception. In this Topic, we discuss the birds that use the shores and other coastal wetland habitats that provide transitions between fresh and salt waters and between land and sea. The throngs of migrant shorebirds that stop off in Nova Scotia *enroute* between the arctic and tropical wintering grounds provide one major focus, but the use of coastal marshes and inlets by migrating waterfowl also provides some of the more impressive avian spectacles to be seen in the province. The birds of rocky coasts and offshore islands are dealt with in T11.7, as many of them forage at sea and come to land only to breed. Some (secondary) seabirds forage along the shores and other habitats treated in this topic, and any separation between these groups is, to some degree, arbitrary.

COASTAL HABITATS

The shores exposed directly to the open sea vary from sand through gravel and cobble to rock, with only seaweeds in the intertidal zone to provide food for animal life (see Plate T11.6.1). Lateral transport of sand and gravel forms bars, partly or completely enclosing some bays and lagoons (barrier-beach ponds), in which the water varies from salt to only weakly brackish, depending on the relative inflow of fresh and salt water. Where wave action is reduced, in bays and estuaries, the finer sediments (silt and mud) accumulate, in some areas forming vast flats exposed at low tides. Salt-tolerant vegetation forms salt marshes at their landward fringes, where this is not inhibited by wave action at high tides. Tidal marshes formerly occupied extensive areas around the Inner Bay of Fundy (sub-Unit 913a), where the very large tides had laid down extensive mud flats, but most tidal marshes were dyked for agriculture during the last 300 years (see T12.7). A wide variety of

Plate T11.6.1: The Pectoral Sandpiper is a fairly common transient, especially in the fall. It can be found on all types of beaches, from mud to cobble, depending on the food abundance. Photo: M. Elderkin

coastal wetland habitats in Nova Scotia support a high diversity, and often very large numbers, of birds.

FOOD SUPPLY AND HIGH-TIDE ROOSTING OF SHOREBIRDS

Nova Scotia's extensive intertidal zone provides feeding areas where shorebirds can accumulate fat supplies sufficient to allow non-stop flights to South America. No areas farther south on the Atlantic seaboard are known to allow comparable feeding opportunities in late summer. Most shorebirds feed in the intertidal zone on benthic invertebrates. The main prey species, used by the over two million Semipalmated Sandpipers and many thousands of other shorebird species in late July through early September each year, is the burrowing amphipod *Corophium volutator* ("mud shrimp").[1,2] This crustacean species occurs in intertidal mud flats, in North America only in the Bay of Fundy and Gulf of Maine (Region 900). In Fundy, it occurs in summer in densities up to 20 000 per square metre of mud, and it is reproducing at the time the first shorebirds arrive in late July. Food therefore is very abundant at that time. Shorebirds forage in highest densities on the mud flats which support the highest densities of *Corophium*.[2] The larger shorebirds, especially Short-billed Dowitcher and Black-bellied Plover, also feed on the bloodworm *Glycera dibranchiata* and the small clam *Macoma balthica*. The smaller Semipalmated Plover concentrates on the small worm *Heteromastus filiformis* as well as *Corophium*.[2]

The largest concentrations of birds are found where the large tidal range has resulted in extensive intertidal areas in the Bay of Fundy. Tidal-marsh development is also important, particularly for the export of nutrients on which the mud-flat-invertebrate populations depend. Greater and Lesser Yellowlegs and Least Sandpipers often forage in the tidal-marsh zone, and other species retreat there during the high-tide periods, when the flats are covered. The main roosting sites at high tides are on sand or gravel beaches, but the larger shorebirds, and also Semipalmated Plovers, also fly inland to roost on bare fields.

By far the greatest numbers of shorebirds are found in the inner Bay of Fundy, where enormous areas of mud flats are exposed. More birds (2–3×) are seen in Chignecto Bay and Cumberland Basin (Unit 523, sub-unit 913b) than in Minas Basin and Cobequid Bay (District 620, Unit 913a). Maximum same-day numbers in those areas are of the order of 400 000 vs. 150 000 birds, and the differential between the areas has been fairly consistent over

T11.6 Shorebirds and Other Birds of Coastal Wetlands

PLACE	Semipalmated Sandpiper	Semipalmated Plover	Black-bellied Plover	Lesser Golden-Plover	Least Sandpiper
Burncoat	45 000	1200	1500	75	100
Economy	1500	450	750	0	185
Evangeline Beach	10 000	1500	1875	1500	450
Five Islands	10 500	300	375	0	75
Highland	7500	750	185	0	300
Johnson	20 000	750	950	450	3
Marys Point	20 000	1125	1200	1350	1425
Minudie	45 000	0	0	0	0
Mountville	45 000	0	0	0	0
Pembroke	750	450	0	0	0
Salter Head	1500	75	875	0	0
Highland	7500	750	185	0	300

Table T11.6.1: Autumn distribution of Fundy shorebirds, adapted from data collected by the Canadian Wildlife Service between 1976 and 1983.

twenty years of study, despite wide fluctuation in annual numbers. The difference may arise from more extensive salt marshes providing richer food resources in the Chignecto area or from larger proportions of favoured particle sizes in the sediments there (more sandy-mud with less sand and less silt) than in the Minas/Cobequid area.

Although the Fundy shorebird picture is dominated numerically by the huge numbers of Semipalmated Sandpipers, most other shorebird species also appear there in larger numbers than elsewhere in the province. Most shorebirds are seen in favoured beach areas, especially along the Northumberland Strait (sub unit 521a) and locally on other coasts, but the numbers are never very large (hundreds to a few thousands) even though nearly as many species are present as in Fundy concentration areas (see Table T11.6.1)[5]. The Piping Plover is an endangered species in Nova Scotia listed under COSEWIC.

SHOREBIRD MIGRATIONS

For most shorebird species, the fall-migration route is more easterly than that used in spring, whether the birds winter in temperate or tropical South America or along the shores of Central America, the West Indies, and the southern United States. The more westerly routes in spring take advantage of better feeding in mid-continent at that season. In Atlantic Canada invertebrate densities in intertidal mud flats are much reduced by ice-scouring during the winter. However, by late summer the densities here have recovered, providing fuel for the longer overwater flights on the fall route.[6,7]

BREEDING BIRDS OF SHORES AND COASTAL WETLANDS

Although most shorebirds seen here in fall come from the north, a few shorebird species breed in Nova Scotia's coastal habitats. The white-sand beaches of the outer coasts are home to the endangered Piping Plovers, only about 60 pairs of which now breed here. The more northern Semipalmated Plover reaches its southern limits as a breeding bird in Nova Scotia, where it frequents gravel beaches, in numbers similar to those of its relative. The Least Sandpiper, here breeding mainly on Sable Island (District 890), is also at the southern limit of its range, but the Spotted Sandpiper is widespread on the coasts as well as inland in Nova Scotia. The Willet is the large, noisy shorebird of tidal marshes, here near the northern limit of its breeding range.

Few landbird species breed along the seashores of Nova Scotia, the most restricted being the Sharp-tailed Sparrow, which is virtually restricted here to salt marshes. Savannah Sparrows also breed in open habitats (tidal marshes, grassy dunes) along the landward fringes of many coastal wetlands. Belted Kingfishers and Bank Swallows nest in earth banks wherever these occur, along the coasts as well as inland.

Coastal wetlands support substantial numbers of breeding waterfowl (see T11.5), especially Black Duck, with smaller numbers of Blue-winged Teal, American Wigeon and Red-breasted Merganser. Even more ducks, of these and other species, breed farther inland but bring their young to marshes in the brackish zone for rearing or after they attain flight.

Many fish-eating birds, which nest near the coasts—in trees or cliffs or on islands—forage in the shallow waters of bays, estuaries and lagoons. Most of these birds also breed and forage around inland waters to a much more limited extent (e.g., Double-crested Cormorant, Great Blue Heron, Osprey, Bald Eagle, Herring Gull [omnivorous, but eats fish too], Great Black-backed Gull and Common Tern).

A few Black-crowned Night Herons, and perhaps even fewer Snowy Egrets, nest with the larger Blue Heron on Bon Portage or Outer Island (Unit 841), foraging in nearby intertidal areas.

USE OF COASTAL WETLANDS BY MIGRATING AND WINTERING BIRDS (SEE ABOVE FOR SHOREBIRDS)

Salinity and tidal action keep coastal waters open later in fall and earlier in spring than most freshwater areas. Generally, the areas most frequented by waterfowl and other aquatic birds—the shallow, sheltered waters and adjacent shores - are the first to become ice-bound and the last to open. In southwestern Nova Scotia, some coastal bays and lagoons remain open through most winters, and, with milder winters since about 1975, wintering of waterfowl has occurred farther north and east than formerly.

Besides shelter, migrating and wintering, waterfowl require food, whether they feed on plants or on animals that feed on plants or plant detritus. The most important plant of shallow salt and brackish waters for waterfowl is Eelgrass, followed by the salt marsh grasses (*Spartina* spp.).

Staging of migrating dabbling ducks, especially Black Ducks and the teals, mostly occurs in salt marshes and adjacent open-water areas, and Blue-winged Teals leave in September or early October, well before ice and snow restrict access there. Green-winged Teals depart in October, but many Black

Ducks remain all winter, withdrawing to the southwest as other areas are closed to them. Disturbance by hunting leads to increased use at this season of habitats that are less accessible to people. Most use occurs where marshes are most extensive, allowing more "escape terrain", especially in the bays and inlets of Northumberland Strait (sub-Unit 521a), the macro-tidal marshes around Minas Basin, Cobequid Bay, and Cumberland Basin (Units 912, 913), and (especially in winter) the Yarmouth County shores (Unit 831). Small pockets of suitable coastal habitat occur elsewhere, for example, around the Bras d'Or Lake (District 560) and in the large inlets from Cole Harbour to Musquodoboit Harbour (Unit 833).

Canada Geese occur in numbers in rather few areas, mainly where dense Eel Grass beds are found in sheltered bays. The preferred areas in fall and winter traditionally were the inlets between Port Joli and Lockeport (Unit 841) on the South Shore, long the northernmost area on the Atlantic seaboard where geese occurred every year. Milder winters recently have seen use of the Cole Harbour-Musquodoboit Harbour area replace the Port Joli area as the province's largest wintering and staging area for geese. Regular use from fall to spring, but by smaller numbers, occurs in southeastern Cape Breton Island (Lingan to Mira Gut, Unit 531) and in Yarmouth County. Spring and fall staging, but no wintering, occurs in inlets along the Northumberland Strait (Linden to River John), where Eel Grass is the staple diet, and around Minas Basin and Cobequid Bay, where salt marshes and croplands also hold substantial numbers. Salt marshes around Cumberland Basin were much used in spring in the 1960s but are currently less utilized.

Use of coastal waters by diving ducks, mainly feeding on Blue Mussels and other shellfish, is covered in T11.7, as such use is concerned with the sea rather than its shores.

The shores and dunes comprise some of the very few natural open terrestrial habitats in Nova Scotia. These open habitats are where the land birds of the Arctic first appear in fall, with Horned Larks, American Pipits, Lapland Longspurs and Snow Buntings all appearing there in October and November, with smaller numbers during the return movement in April.

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Associated Topics

T6.3 Coastal Aquatic Environments, T6.4 Estuaries, T7.3 Coastal Landforms, T8.2 Freshwater Environments, T8.3 Freshwater Wetlands, T.11.3 Open-habitat Birds, T11.5 Freshwater Wetland Birds and Waterfowl, T11.7 Seabirds and Birds of Marine Habitats, T11.17 Marine Invertebrates, T12.7 Coast and Resources

Associated Habitats

H2.3 Sandy Shore, H.2.4 Mud Flat, H. 2.5 Tidal Marsh, H2.6 Dune System

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T11.7 SEABIRDS AND BIRDS OF MARINE HABITATS

The term "seabird" is used here to denote birds that obtain the majority of their food from coastal waters (neritic species) or from the open ocean (pelagic species), although some people restrict its use to the latter group. Neritic (secondary) seabirds use the land for feeding or resting at certain times, whereas pelagic (primary) seabirds are largely independent of the land except for nesting. By this definition, marine ducks, such as eiders and scoters, and shorebirds, such as phalaropes, are seabirds, as well as the pelagic species, of which three species of alcid, three saltwater terns, three gulls, two cormorants, one eider and one storm petrel breed here in Nova Scotia.

COASTAL HABITATS

Coastlines exposed to the open sea are discussed here rather than in T11.6 because their use by birds is nearly restricted to resting and nesting, foraging being in adjacent waters rather than on the shores. Such arbitrary arrangements always have some exceptions: the use of (exposed) sand beaches by shorebirds such as Piping Plovers was covered in the previous topic, whereas foraging on rocky shores by Purple Sandpipers and Ruddy Turnstones is treated here. Islands are mostly included with marine habitats, unless they are sheltered within narrow inlets or lagoons.

FOOD SUPPLY

Seabirds feed almost entirely on fish and marine invertebrates. Spatial and temporal variations in the abundance of food species, such as immature herrings, sand lance and capelin, are major determinants of the breeding seasons, colony locations and movements of seabirds. The abundance of food for seabirds is dependant on such factors as ocean currents, seasonal phytoplankton blooms, localized upwellings, and the presence of a fishery (see Plate T11.7.1).

BREEDING

The breeding season stretches from March to September. Seabirds differ from other birds in that usually they cannot breed on their feeding grounds. At breeding time birds, their eggs and young are particularly vulnerable to predation, so adults seek safe island breeding sites. The distribution of seabirds during the breeding season, therefore, is largely determined by the availability of suitable breeding sites and accessible food. The number of suitable breeding sites is generally limited, and seabirds assemble to breed in colonies. Pelagic seabirds spend almost their entire life at sea, coming ashore only to breed. They are characterised by clutches of a single egg, and they breed, typically, in large colonies on the most inaccessible islands. Coastal seabirds, in contrast, are characterised by multi-egg clutches and normally breed in many more, smaller colonies.

Island breeding sites are most numerous along the complex Atlantic coast of Nova Scotia, particularly where there are drowned drumlin fields (District 830). Gull, tern and cormorant colonies favour these sites. Cliff nesting sites provide protection from

Plate T11.7.1: The Herring Gull is our most common gull. Its numbers have increased since the use of open landfills and modern fish-processing methods have augmented food supply. There are an estimated 25 000 breeding pairs in Nova Scotia.[1] Photo: M. Elderkin

ground and aerial predators. High, stable cliffs are limited to northern Cape Breton (District 210). Lower, eroding cliffs can be found on the Northumberland Strait (Districts 520, 580) and the Bay of Fundy (Regions 600, 700). Black-legged Kittiwakes and cormorants breed on cliffs in Cape Breton Island, while cormorants and gulls breed on the lower cliffs in the Bay of Fundy.

Common Eiders breed on largely wooded islands adjoining waters with rocky reefs and islets (typically in Unit 834). Wintering species are sparsely distributed, except in the major coastal marshes that occur in Unit 833.

BREEDING SPECIES

Seabird species known to be breeding in Nova Scotia at present are:[1]

Pelagic Species
- Leach's Storm Petrel (*Oceanodroma leucorhoa*)
- Atlantic Puffin (*Fratercula arctica*)
- Razorbill (*Alca torda*)
- Black-legged Kittiwake (*Rissa tridactyla*)

Neritic Species
- Double-crested Cormorant (*Phalacrocorax auritus)*
- Great Cormorant (*Phalacrocorax carbo*)
- Common Eider (*Somateria mollissima*)
- Black Guillemot (*Cepphus grylle*)
- Herring Gull (*Larus argentatus*)
- Great Black-backed Gull (*Larus marinus*)
- Arctic Tern (*Sterna paradisaea*)
- Common Tern (*Sterna hirundo*)
- Roseate Tern (*Sterna dougallii*)

Leach's Storm Petrels breed on several islands on the Atlantic Coast. They breed in burrows and their numbers are not well known. However, it is estimated 100 000 pairs breed in Nova Scotia.[2] Puffins breed at three sites and Razorbills, in very small numbers, at only two. A related species, the Black Guillemot, breeds much more abundantly in small colonies or individually at many sites around the coast. Kittiwakes are small pelagic gulls which breed abundantly from Newfoundland north to the Arctic. They also breed at five recently occupied sites in Cape Breton.

Herring Gulls and Great Black-backed Gulls breed abundantly all around the coast, as do Double-crested Cormorants. Great Cormorants have a more northerly distribution, not breeding in the Bay of Fundy or on the Atlantic Coast south of Shelburne County (Unit 841). Great Cormorants and Great Black-backed Gulls forage offshore more than inshore during breeding season (when only immature Black-backs are at dumps or fish plants). Eiders are most abundant on the Eastern Shore and southern Cape Breton Island, breeding abundantly in the Bay of Fundy only on the New Brunswick side. Terns also breed most abundantly on the Atlantic Coast. There are few available breeding sites on the Gulf and Fundy coasts.

OTHER PELAGIC BIRDS

Sightings of another eighteen species of seabirds are regularly reported in Nova Scotia.[3] Most of the birds in the ocean off Nova Scotia breed at more northerly locations. The Greater and Sooty Shearwaters, which sweep north into our waters in April, breed in the South Atlantic; Wilson's Storm Petrels breed in the Antarctic. All come to take advantage of seasonal fish runs or zooplankton abundance.

SEABIRDS OUTSIDE THE BREEDING SEASON

Outside the breeding season, the pelagic species retreat out to sea, some species completely leaving Nova Scotia waters in winter. Non-breeding birds of these species, and pelagic visitors, seldom come in sight of land in summer except when storm-driven or where upwelling concentrates feeding opportunities. Brier Island (District 810, Unit 912) is an important area for phalaropes during fall migration. Tens of thousands of Red Phalaropes take advantage of the large amounts of food brought to the surface by highly localized upwellings.

The neritic species spread out from their colonies along the shores, in some cases moving inland along river and lake systems, before some of them depart southward. Seabird species that breed farther north, up to the Arctic (e.g., Northern Fulmar, Northern Gannet, Black-legged Kittiwake [only a few breed here], Thick-billed Murre, Dovekie), appear in Nova Scotia waters, mostly out of sight of land, in late fall, some staying for the winter along the shelf break.

The return movement, to local and more northern breeding colonies, gets under way in late March and continues into May, when the Southern Hemisphere breeders begin to arrive, especially Greater Shearwater, Sooty Shearwater and Wilson's Storm Petrel.

Eiders also appear along coasts where they do not breed, starting with moulting males in July, and including all age and sex classes by September. The coastline of southwest Nova Scotia is typically inhabited by moulting male Eiders. Through the fall, they are joined by thousands of passing scoters, of all

three species, from Labrador, Ungava, and the Hudson Bay lowlands, nearly all of which winter south of Nova Scotia. Smaller concentrations of other diving-duck species (e.g., Oldsquaw, Harlequin Duck [endangered], Common Goldeneye [also on rivers and estuaries], Red-breasted Merganser) frequent the province's nearshore waters in late fall through early spring, as do various piscivorous diving birds that breed inland or farther north, such as Red-throated Loon, Common Loon, Horned Grebe, and Red-necked Grebe. The first and last of these mostly winter farther south, but the others are regular here through the colder seasons.

DISTRIBUTION

In all seasons, substantial numbers of pelagic birds are found to the north and east of Newfoundland and on the continental shelf, with the greatest densities at areas of upwelling and high productivity along the shelf slope. In winter, northerly birds such as fulmars, murres, kittiwakes and Dovekies dominate the pelagic-seabird community. By April, the shearwaters have arrived and are most abundant along the edge of the Scotian Shelf and on the Grand Banks. In summer, the more northerly species have retreated to their breeding range and shearwaters are the most abundant species. At the mouth of the Bay of Fundy at this season, local up-welling and enhanced productivity attract large numbers of phalaropes, relatives of sandpipers that spend most of the year at sea. Seabirds are not abundant in the upper reaches of the Bay of Fundy or in the southern part of the Gulf of St. Lawrence.

HISTORICAL CHANGES

There have been major changes in the Nova Scotian seabird community since European settlement. Initially heavy exploitation reduced the numbers of most species, but in the last hundred years conservation efforts have brought increases in most species. Eiders have increased from a few hundred pairs at the beginning of the century to an estimated 8000 pairs breeding in the province now. In the same time period, Great Cormorants increased from a remnant population of less then a hundred breeding pairs to around 3700 pairs, and the Double-crested Cormorant increased from a few hundred pairs breeding on the eastern shore to some 12 000 pairs. Herring and Great Black-backed Gulls have increased from only a few thousand pairs to more than 60 000 pairs. The number of immature gulls in this population is about 100 000, a total of over 220 000 birds.

There have also been decreases. Laughing Gulls ceased to breed in Nova Scotia in the early 1960s, having been displaced by increasing numbers of larger gulls. Terns have decreased from several hundred thousand pairs (the majority breeding on Sable Island, District 890) to only a few thousand pairs at present. This decline is continuing. Roseate Terns, a threatened species, have a North American population of around 3600 pairs and perhaps 50 pairs breed in Nova Scotia, which is near the northern limit of their breeding range. Their numbers appear to be decreasing in parallel with decreases in numbers of Arctic and Common Terns.

Recently there have been substantial increases in the Nova Scotian populations of several seabirds. Black-legged Kittiwakes extended their breeding range to Cape Breton, south from Newfoundland in the early 1970s. Since that time they have increased to over 600 pairs, and in 1992 began breeding in southern New Brunswick. Black-headed Gulls are European birds which began breeding in western Newfoundland in the 1960s and have recently been observed, in increasing numbers, in Nova Scotia during the summer. There have been indications that they have attempted to breed in tern colonies on the eastern shore. Atlantic Puffins have increased at both their traditional breeding places in Nova Scotia (Bird Islands, Unit 531 and Pearl Island, Unit 832) and have recently begun breeding in the Seal Island group. More than 120 puffins now summer at Pearl Island, a tenfold increase in the last decade.

CULTURAL FACTORS

The changes which have been observed in the seabird community in Nova Scotia can be ascribed to human influence. In Atlantic Canada, direct exploitation of seabirds is no longer the major conservation problem nor is human disturbance of colonies; most changes are incidental affects of human use of the oceans (see T12.16).

Associated Topics

T6.1 Ocean Currents, T6.2 Oceanic Environments, T6.3 Coastal Aquatic Environments, T6.4 Estuaries, T11.14 Marine Fishes, T11.16 Land and Freshwater Invertebrates, T12.11 Annimals and Resources

Associated Habitats

H1.2 Benthic Ocean, H2.1 Rocky Shore, H5.3 Cliff and Bank

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T11.8 LAND MAMMALS

SPECIES

Fifty-seven land-mammal species have been recorded in Nova Scotia (Table T11.8.1). The mammal fauna of Nova Scotia includes fewer species than are found, for example, in southern Ontario. This is because a number of central-continental species which occupy habitats similar to those in Nova Scotia have not yet penetrated this far north and east. This difference is generally more pronounced in the diversity of small mammals, which are less mobile and are constrained by tighter habitat restrictions than the larger, more mobile mammals.

The composition and distribution of the mammal fauna in Nova Scotia is influenced by a number of factors:

1. climatic change and colonization routes
2. life zones
3. variety of available environments
4. natural barriers
5. introductions and extinctions, and the impacts of human settlement

COLONIZATION

The existing mammal fauna populated Nova Scotia after the last retreat of the ice sheet by four different routes:

1. moving in from the glacial refugia on what is now the continental shelf
2. moving in from unglaciated areas on the coastal side of the Appalachians via the Chignecto Isthmus (land bridge) (Unit 533)
3. over sea by swimming, rafting on ice, or crossing ice bridges
4. by human introduction

Of these four routes, the land bridge was the major entry point for the largest number of species. Thus, the interaction between the relative mobility of different species and the shifting of climatic zones in relation to the position of the landbridge is significant. As the ice retreated, the first animals to appear would be those with more northerly affinities. Certain southern species, such as the porcupine, raccoon, skunk and woodchuck, have arrived comparatively recently. Coyotes are a western species and are the most recent colonizers in Nova Scotia.

LIFE ZONES

Nova Scotia lies within the Canadian Biotic Province, which includes New England, southern Quebec, southern Ontario and parts of the western Great Lakes. Nova Scotia can be subdivided into two life zones.

The Atlantic Upland (Regions 100, 200, 300, 400, 800) is cool and humid with many conifers and bogs. Here the species include Varying hare, Lynx, Red Squirrel, Moose, Marten, Beaver and Deer Mouse. The Acadian Plain (Regions 500, 600, 700) is low, fertile, flat, and well drained with large agricultural areas. It is sometimes included in the Alleghanian Life Zone, which is, in turn, part of the more southerly Austral Region. Here the species include Raccoon, Skunk, White-tailed deer, Short-tailed Shrew and White-footed Mouse. Beyond this broad division, it is not easy to delineate distinct regional fauna, although certain species (e.g., the White-footed Mouse) do show a marked regional distribution. In general, however, mammals are too mobile, and habitats in the province too widely distributed, for distinct mammal regions to develop.

ENVIRONMENTS

Nova Scotia encompasses a variety of terrestrial and aquatic environments for mammals, including forests, wetlands, agricultural areas, mountains, valleys and seashores. Browsing mammals thrive in areas of new hardwood and shrub growth associated with early-successional forests in disturbed areas. Others, like the marten, require mature vegetation. Certain species, like the fox and the raccoon, favour more open areas and edge habitats. The lynx needs large areas of wildland; however, it can exist next to human habitation if there is no competition and appropriate habitat.

NATURAL BARRIERS

A large expanse of water presents a very definite barrier to the distribution of mammals. Cape Breton is an island separated from the mainland by the Strait of Canso, which is over a mile in width. A causeway was built in the 1950s. Compared with other islands in the Gulf of St. Lawrence, Cape

Breton has a relatively rich mammalian fauna. Only seven of the mainland Nova Scotia species are missing: the Fisher, Porcupine, Skunk, Arctic Shrew, Smoky Shrew, Long-tailed Shrew and White-footed Mouse. The Raccoon was also originally missing but has been recently introduced. The islands which are more isolated (Newfoundland, Magdalen and Anticosti) have approximately half the species found on the adjacent mainland.

It is highly probable that Cape Breton had a land connection to the mainland within the last 12,000 years. This theory is reinforced by the presence of native mice and shrews. These small animals would have had little chance of making the crossing safely on an ice raft. Several of the missing species were comparative latecomers to the region and would have therefore been too late to take advantage of the landbridge. The raccoon, for example, reached northern New Brunswick only in the last century. Now that a causeway is in place, a solid ice bridge regularly forms between Cape Breton and the mainland, which no doubt assists the movement of larger mammals in both directions. No insular races of mammals have developed on Cape Breton. The moose is a different subspecies, but only because some moose from the western provinces were released on the island after the native subspecies had almost become extinct in the 1940s.

The barriers to the colonization of Sable Island (District 890) are obviously more formidable. Only marine mammals are native to the island, which they share with feral horses.

INTRODUCTIONS AND EXTINCTIONS

Four rodent species have been introduced, three of them presumably inadvertently. The Black Rat subsequently failed to compete successfully with the Norway Rat and has not become established. Grey Squirrels were deliberately introduced to southwest Nova Scotia in the 1930s but disappeared from there within a few years. They occasionally appear in other areas.

Unsuccessful attempts were made to re-introduce caribou in the Liscomb area (District 410) in 1939 and in Cape Breton in 1968 and 1969. More successful was the release of fishers in various parts of the mainland in the 1940s and again in the 1960s. The Arctic Hare was also been introduced on Scatarie Island (District 870), where it thrived for a few years before disappearing. Marten were re-introduced to Nova Scotia in Kejimkujik National Park (Region 400) in 1987 and subsequent years. The newest mammal to appear in Nova Scotia is the coyote. The coyote originally had an exclusively western distribution, but in the 1900s (for reasons that are not wholly clear) it began moving eastwards. It is now found throughout the entire province, including Cape Breton Island and Brier Island.

Three native species are known to be extinct or extirpated. Little is known about the Sea Mink except that it was trapped for fur in the Bay of Fundy. The last specimen was taken in 1894 at Campobello Island. The animal is now extinct. The wolf was probably never common in Nova Scotia and was extirpated from the Maritimes in the late 1800s. The caribou were forced out by hunting and climatic changes, which caused vegetation changes.

GENERAL REQUIREMENTS

The two most important requirements for mammals are food and cover. Many mammals will eat a wide variety of foods, although they do have preferences. Food sources for the insectivores and very small herbivores are linked to soil productivity and the diversity of ground vegetation. These mammals are therefore most abundant in the more productive habitats, such as hardwood forests and floodplains, and more depleted in such less, productive habitats as Jack Pine stands and barrens. In the case of carnivores this link still exists, but is less direct. The largest carnivores, which eat higher on the food chain and do not need to eat as frequently as smaller animals, are more mobile. Therefore they are not necessarily confined at all times to habitats which contain a suitable food supply.

Cover provides shelter from extreme environmental conditions, concealment from predators, and a secure place to rest, sleep, or raise young. Snow accumulation is an important factor. Deer often winter at lower elevations or near the coast where snowfall will be less; this enables them to move about and to feed close to the ground. Many small mammals, on the other hand, rely on persistent snow cover over leaf litter for their winter shelter.

Family	Species	Distribution	COSEWIC Status History	Seasonal Activity
ORDER INSECTIVORA				
Soricidae	Arctic shrew (Black-backed Shrew)	Locally common, mainland only, disjunct	Native	Active year round
Soricidae	Common Shrew (Masked Shrew, Cinerous Shrew)	Common throughout	Native	Active year round
Soricidae	Smoky Shrew	Common, mainland only	Native	Active year round
Soricidae	Gaspé Shrew	Rare, local, Cape Breton Highlands only	Vulnerable, Native, discovered 1971	Active year round
Soricidae	Long-tailed Shrew (Rock Shrew)	Known from only two localities in the Cobequids	Native, discovered 1984	Active year round
Soricidae	Water Shrew	Locally common throughout	Native	Active year round
Soricidae	Pygmy Shrew	Uncommon, local, throughout	Native	Active year round
Soricidae	Short-tailed Shrew (Mole Shrew)	Common throughout	Native	Active year round
Talpidae	Star-nosed Mole	Locally common throughout	Native	Aquatic in winter
ORDER CHIROPTERA				
Vespertilionidae	Little Brown Bat	Common throughout	Native	Hibernator
Vespertilionidae	Long-eared Bat	Uncommon throughout	Native	Hibernator
Vespertilionidae	Eastern Pipistrelle	Uncommon to rare, western mainland	Native	Hibernator
Vespertilionidae	Silver-haired Bat	One record, southwest N.S.	Native	Probably hibernates
Vespertilionidae	Red Bat	Rare, probably widespread	Native	Migratory/Hibernator
Verpertilionidae	Hoary Bat	Uncommon throughout	Native	Migratory/Hibernator
ORDER PRIMATES				
Hominidae	Human Beings	Common throughout	Native/Introduced	Active year round

Table T11.8.1: Species of land mammal recorded in Nova Scotia.

Family	Species	Distribution	COSEWIC Status History	Seasonal Activity
ORDER CARNIVORA				
Canidae	Wolf (Grey Wolf, Timber Wolf)	Never as common as elsewhere in Canada	Native; Extirpated in late 1800s	
Canidae	Coyote	Common throughout	Invaded from N.B. around 1977	Active year round
Canidae	Arctic Fox	Three Cape Breton records from ice-floe stragglers	Extralimital vagrant	Active year round
Canidae	Red Fox	Common throughout	Native	Active year round
Ursidae	American Black Bear	Common throughout	Native	Partial hibernator
Procyonidae	Raccoon	Common on mainland, recently established in southern Cape Breton	Native	Active year round
Mustelidae	American Marten	Local in southwest mainland and Cape Breton Highlands	Native; Extirpated and then reintroduced in Kejimkujik Nat. Pk.	Active year round
Mustelidae	Fisher	Southwestern Nova Scotia and eastern mainland	Native; Extirpated in NS 1922; reintroduced in southwest mainland	Active year round
Mustelidae	Ermine (Weasel)	Common throughout	Native	Active year round
Mustelidae	American Mink	Common throughout	Native	Active year round
Mustelidae	Sea Mink	Reported to have occurred along southwest NS coast	Extinct, c. 1894; Native	
Mustelidae	Striped Skunk	Common in agricultural areas of mainland	Native	Active year round
Mustelidae	River Otter	Common throughout	Native	Active year round
Felidae	Cougar (Mountain Lion)	Many sightings/tracks, but no photo or specimen	Endangered Native; Status uncertain in N.S.	Active year round
Felidae	Lynx (Canada Lynx)	Local in Cape Breton Highlands and northern mainland	Native	Active year round
Felidae	Bobcat (Wildcat)	Common on mainland, absent from Cape Breton	Native	Active year round

Table T11.8.1: Continued

Family	Species	Distribution	COSEWIC Status History	Seasonal Activity
ORDER ARTIODACTYLA				
Suidae	Wild Boar	Feral on a fenced private reserve (Roberts, I.) in Yarmouth Co., some have escaped	Introduced	Active year round
Cervidae	Caribou (Woodland Caribou)		Extirpated 1925, Native; Unsuccessfully reintroduced in CBI in 1960s	Non-migratory
Cervidae	White-tailed Deer	Common throughout	Native; Invaded/introduced 1894-1910.	Active year round
Cervidae	Moose	Common throughout	Extirpated on CBI 1924, Native; Reintroduced from Alberta	Active year round
ORDER RODENTIA				
Sciuridae	Eastern Chipmunk	Common throughout	Native	Partial hibernator
Sciuridae	Woodchuck (Groundhog)	Common on mainland, recently invaded CBI	Native	Hibernator
Sciuridae	Grey Squirrel	Infrequent; Urban areas	Introduced repeatedly but unestablished	Partial hibernator
Sciuridae	American Red Squirrel	Common throughout	Native	Partial hibernator
Sciuridae	Southern Flying Squirrel	Relict population	Native; Discovered in Kejimkujik NP 1971, Gaspereau Valley 1984	Partial hibernator
Sciuridae	Northern Flying Squirrel	Common throughout	Native	Partial hibernator
Castoridae	American Beaver	Common throughout	Native	Active year round
Cricetidae	Deer Mouse	Throughout, but local in SW mainland, common elsewhere	Native	Active year round
Cricetidae	White-footed Mouse	Mainland only, common in SW, Rare/local in N and E	Native	Active year round
Arvicolidae	Red-backed Vole	Abundant throughout	Native	Active year round
Arvicolidae	Southern Bog Lemming	Uncommon and local throughout	Native	Active year round

Table T11.8.1: Continued

Family	Species	Distribution	COSEWIC Status History	Seasonal Activity
ORDER RODENTIA continued				
Arvicolidae	Muskrat	Common throughout	Native	Active year round
Arvicolidae	Meadow Vole (Meadow Mouse, Field Mouse)	Common throughout	Native	Active year round
Arvicolidae	Rock Vole (Yellow-nosed Vole)	Cape Breton Highlands	Native; Discovered 1974	Active year round
Muridae	Black Rat (Roof Rat)	Ports	Introduced repeatedly in seaports but unestablished	Active year round
Muridae	Norway Rat (Brown Rat)	Common in urban and agricultural areas	Introduced	Active year round
Muridae	House Mouse	Common in urban and agricultural areas	Introduced	Active year round
Zapodidae	Woodland Jumping Mouse	Common throughout	Native	Hibernator
Zapodidae	Meadow Jumping Mouse	Locally common throughout	Native	Hibernator
Erethizontidae	American Porcupine	Common on mainland; possibly invading CBI	Native	Active year round
ORDER LAGOMORPHA				
Leporidae	Snowshoe Hare (Varying Hare, "Rabbit")	Common throughout	Native	Active year round
Leporidae	Arctic Hare		Introduced and established on Scatarie Island, off eastern Cape Breton. Not known if it is still present	Active year round
ORDER PERISSODACTYLA				
Equidae	Horse	Sable Island	Introduced	Active year round

Table T11.8.1: Continued

POPULATION FLUCTUATIONS

Such animals as the Snowshoe Hare, the Muskrat and several species of mice and voles show marked population fluctuations. Their numbers can vary considerably from year to year. These fluctuations often appear to be synchronised over a large area and therefore do not relate to short-term weather or habitat-quality changes. The cycles will also affect certain other species that are heavily dependent on one item in their diet. Numbers of lynx, for example, reflect the abundance of Snowshoe Hare, while the bobcat, which has a more varied diet, is less affected.

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Associated Topics

T4.3 Colonization by Animals, T11.9 Carnivores, T11.10 Ungulates, T11.11 Small Mammals, T11.12 Marine Mammals, T11.16 Land and Freshwater Invertebrates, T11.18 Rare and Endangered Animals, T12.11 Animals and Resources

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T11.9 CARNIVORES

The mammals of this group are primarily flesh-eaters, but some, like the bear and raccoon, are omnivorous. Twelve species of carnivore are now present in Nova Scotia.

DOG FAMILY

The Red Fox and the recently arrived coyote are the only members of this family in Nova Scotia. The earlier presence of the wolf was probably marginal, perhaps only amounting to the occasional incursion from New Brunswick. Arctic Foxes frequent southward-drifting ice floes off the Labrador coast, and in 1923, 1935 and 1991 there were records of Arctic Foxes reaching Cape Breton Island. Red Foxes prefer semi-open country and are seldom found in dense forest. They are often associated with agricultural land.

CAT FAMILY

Two members of this family, the bobcat and lynx, are definitely found in Nova Scotia, while circumstantial evidence indicates the presence of a third member, the cougar. The bobcat, a more southerly animal than the lynx, is widely distributed throughout the province, while the lynx is now largely restricted to the Cape Breton Highlands (Region 200).

Snowshoe Hare is an important part of the diet of both species, although the bobcat is somewhat less dependent on it. In other parts of the country a relationship between the population cycles of the hare and the lynx has been observed, but this has not been well documented in Nova Scotia. The lynx prefers dense climax boreal forest with a dense undercover of thickets and windfalls, while the bobcat will frequent a much wider range of habitats, including swamps, second-growth forest, and even agricultural land.

The cougar is a much larger animal than either of the other cats and requires large areas of unpopulated forest land. It is estimated that the home range of cougar is

Plate T11.9.1: The Common Weasel or ermine is widespread throughout Nova Scotia. It preys mostly on small mammals, such as mice, and the eggs of ground-nesting birds, and occasionaly on young hares. The ermine turns white in the winter, except for the tip of its tail, which is black. Photo: M. Elderkin

often in excess of 90 km^2. Sightings, fresh tracks and cougar screams have been reported, but no cougar has yet been photographed, trapped or shot.

BEAR AND RACCOON

Although a member of the carnivore order, the Black Bear's diet is three-fourths vegetable matter. It is widely scattered throughout the province but more numerous in the five western counties.

Bears range widely over a variety of habitats and often move on to barrens in the summer to forage for berries. There appears to be a concentrated Black Bear population in the brush barrens east of Yarmouth and west of the Tobeatic and Kejimkujik National Park (Districts 410, 440). The Plateau–Taiga (Region 100) also supports a population during the fall, when blueberries are abundant. It is not known how extensively these bears travel seasonally or during a poor berry year.

The raccoon is a member of the family Procyonidae. It is a widely distributed New World animal and a relatively recent arrival in Nova Scotia. Raccoons are usually found in forested lowland areas near water courses, wooded coastline and salt marsh. They are also often associated with urban and agricultural land, especially in the Annapolis Valley (District 610). They have only recently become established on Cape Breton Island, after being introduced illegally from one of the eastern United States.

WEASEL FAMILY

Six species of mustelids (weasels and their allies) occur in Nova Scotia. The mink and otter are semi-aquatic mammals found in streams, lakes, marshes and along the coast, while the ermine (Short-tailed Weasel) uses a wide variety of wooded habitats. All three are common in Nova Scotia (see Plate T11.9.1).

The Pine Marten requires mature coniferous forest; the Fisher will tolerate a wider habitat mix, but needs large cavities in trees for denning. Both have faced drastic decline in numbers due to habitat destruction by cutting and fire. The remnant marten population (exclusive of the Kejimkujik re-introduction) is restricted to the Cape Breton highlands. The Fisher probably disappeared from Nova Scotia early in this century but was reintroduced and appears to have adapted somewhat better than the marten to second-growth forests.

The Striped Skunk is a southerly animal which is believed to have spread into Nova Scotia since 1850. Its numbers declined after 1930, possibly due to disease introduced by skunk farming, until the skunk was almost extinct. Since then skunks have re-established themselves and are now found throughout the mainland. The highest densities are found in farming areas.

Associated Topics

T11.8 Land Mammals, T11.11 Small Mammals, T12.11 Animals and Resources

Associated Habitats

H3 Freshwater, H5.1 Barren, H5.2 Oldfield, H5.4 Talus Slope, H5.5 Cave, H6.1–H6.3 Terrestrial Forested

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T11.10 UNGULATES

RANGE

Three species of ungulate have at one time inhabited Nova Scotia, and their respective fortunes illustrate the effects of long-term climatic change, habitat alteration and hunting pressures. The Caribou is the most northerly species, with a range extending high into the Arctic. It is an animal of the tundra and the true boreal forest. The range of the Moose substantially overlaps that of the Caribou, but is restricted to the forested regions and reaches farther south. The White-tailed Deer has a much more southerly range, extending well down into South America. Habitat requirements also show a successional gradation through the three species: Woodland Caribou primarily eat lichens associated with the climax forest; Moose prefer near-climax vegetation with shrubby growth; deer thrive on early-successional stage vegetation associated with cut-over, forest fires, mixedwood forests, natural grasslands and forest opening, abandoned farms and "edge effect" associated with roads and powerlines.

CLIMATIC CHANGE

Archeological evidence (the contents of native peoples' middens) proves that deer were present in Nova Scotia long before the first European settlers arrived. This would be consistent with the warming trend after the Wisconsin glaciation. As the climate started to cool, deer populations diminished and the Caribou became more firmly established. By the time the first white settlers appeared the last deer had probably gone, but a new warming trend was beginning to decrease Caribou numbers. Caribou were affected not only by climatic change but also by widespread hunting and by the destruction of the climax forests by cutting and (particularly in south-western Nova Scotia) by fire, which killed tree and ground lichens. Caribou are migratory and apparently moved from the Cobequid Hills (Unit 311) to winter in south-western Nova Scotia. Lichens grow very slowly and once burned they may take 80–100 years to re-establish themselves. Caribou were extirpated on the mainland by 1905 and in Cape Breton by 1921.

THE ARRIVAL OF DEER

The destruction of the Caribou range and the subsequent new shrub growth benefited Moose, but they were also vulnerable to hunting pressures, particularly in winters of deep snow. Moose numbers thus fluctuated with changes in hunting legislation. The forest disturbance and gradual warming trends favoured deer even more and they started to reappear in the 1890s, both through deliberate introductions and by the movement of herds in from New Brunswick. Before European settlement, deer were plentiful in North America only where natural fire and windfalls created forest openings. After settlement, the distribution pattern showed a boom in deer numbers on the northern lumbering frontier and a decline in southern areas, as permanent agriculture became entrenched. Deer populations in Nova Scotia followed this trend with rapid expansion occurring 1945–55 following the widespread abandonment of farm lands during the Depression years. Between 1955 and 1965, a decline occurred, possibly due to the population having exceeded the carrying capacity of the range.

MOOSE SICKNESS

The effects of land clearing resulted in a greater overlap of deer and Moose ranges. In the 1940s it became evident that Moose were dying in large numbers of a mysterious disease labelled "Moose sickness". Moose appeared to prosper only in those areas where deer were not abundant. It was not until 1964 that the cause of Moose sickness was identified as a nematode parasite, *Parelaphostrongylus tenuis*, carried by, but not harmful to, deer.

Unsuccessful attempts were made to reintroduce Caribou in the Liscomb Game Sanctuary in 1938 and in Cape Breton in 1968 and 1969. But climatic and habitat conditions no longer favoured Caribou presence. Caribou were also susceptible to Moose sickness. Moose numbers fluctuated with the changes in hunting legislation, and Moose all but disappeared from Cape Breton. Attempts to reintroduce individuals from the mainland did not appear to help, but in 1947 and 1948 eighteen Albertan Moose were released with more success. Moose in Cape Breton

Plate T11.10.1: White-tailed Deer congregated in a deer yard, where they feed on the twigs, buds and leaves of both softwood and hardwood trees. Photo: R. Hall

today belong to the western subspecies *Alces alces andersoni*, while mainland Moose are *A.a. americana*. On the mainland, hunting regulations fluctuated with changes in Moose numbers which were likely influenced by the introduction and spread of *P. tenuis*.

HABITAT AND FOOD FACTORS

Moose and deer eat herbaceous vegetation in summer and switch to woody browse in winter. Moose also eat aquatic plants, although these are not an indispensable item in their diet. Favoured deer browse includes Red Maple, White Birch, Sugar Maple, Yellow Birch, Mountain and Striped Maple. Moose particularly favour White Birch stands. Both species have benefited from the depredations of the Spruce Budworm, where this has been followed by accelerated harvesting, which in turn promotes new growth. However, the increase in hardwood browse may eventually be outweighed by the decrease in cover.

WINTER

Deer are southerly animals and more stressed by hard winters than Moose. They feed close to the ground for as long as possible, but they always have to balance their food requirements with the need for winter cover. Long periods of deep snow force them to come down from higher elevations to find shelter in valleys, where suitable hardwood browse is often available in conjunction with softwood shelter (see Plate T11.10.1). In southern Cape Breton, deer concentrate on the coast in winter and feed on kelp and other seaweeds.[1]

Moose will also yard in hard winters but usually at higher elevations. Those which winter at lower elevations with more shallow snow are exposed to *P. tenuis*. Orientation is important because south and southwest slopes offer a more favourable microclimate. The shelter requirements of Moose are not as stringent as for deer, and they are usually able to select areas with greater food resources.

At present, Moose appear to be increasing in numbers, particularly in western Nova Scotia and Cape Breton. Deer reached a population peak in 1986 and have subsequently declined.

Associated Topics

T4.1 Post-glacial Climatic Change, T4.3 Post-glacial Colonization by Animals, T10.6 Seed-bearing Plants, T10.6 Trees, T10.11 Lichens, T11.8 Land Mammals, T11.15 Land and Freshwater Invertebrates, T12.11 Animals and Resources

Associated Habitats

H5.2 Oldfield, H6 Terrestrial Forested

References

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T11.11 SMALL MAMMALS

There are several different criteria, based on weight and size, for classifying small mammals. We chose all mammals weighing less than one kilogram, plus those closely related (such as the hare) which may weigh more. In this context, small mammals include bats, rodents, insectivores, and hares. They form an important part of the terrestrial food web by eating large amounts of seeds, plants and insects, and then themselves becoming a vital food resource for larger predators (with the exception of bats).

SHREWS, MOLES AND SMALL RODENTS

Most small-mammal populations undergo drastic fluctuations and may determine the levels of predatory species such as the fox, weasel and some hawks. Typically, the smaller mammals like shrews have high metabolic rates which require large and constant energy inputs. They are therefore closely confined to habitats that provide ample and accessible food. Common Shrews or Water Shrews require high levels of soil moisture and are associated with open water. A thick litter layer is often an important factor, allowing small animals to make runways and stay mobile under snow cover in winter. In Nova Scotia, few small mammals are true hibernators, and they are therefore vulnerable to severe winter conditions, especially extremely low temperatures with little or no snow cover.

Common and widespread small mammals include the Common Shrew, the Short-tailed Shrew, Red-backed Vole, Meadow Vole (numbers of which sometimes reach plague proportions) Deer Mouse (see Figure T11.11.1) and the Woodland Jumping Mouse. Five species of the squirrel family are present in Nova Scotia; two (the chipmunk and woodchuck) are ground dwellers.

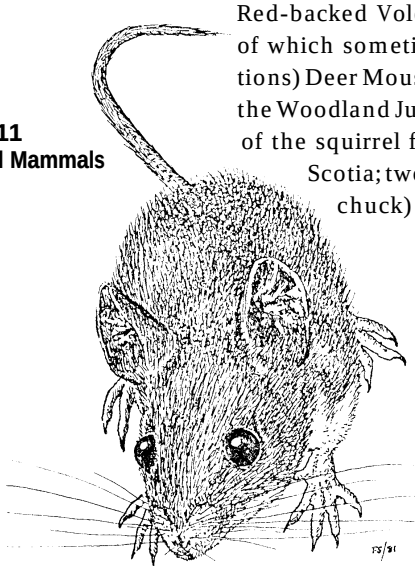

Figure T11.11.1: The Deer Mouse is found throughout the Province, but is most common in the northern mainland and Cape Breton Island. It inhabits forested and edge habitats.

DISJUNCT SPECIES

Several species are disjunct, meaning that there is a gap between their range elsewhere and their occurrence in Nova Scotia (see T11.18). These include the Gaspé Shrew, the Long-tailed Shrew, the Arctic Shrew and the Rock Vole, all of which have more northerly distributions. The Southern Flying Squirrel and the White-footed Mouse have more southern affinities. So far, the former is known to exist only in a pocket around the Kejimkujik area, which has very warm summer temperatures, and at a site in the Gaspereau Valley (Region 400).

Small coastal islands in Nova Scotia support unusually high populations of some species, such as the Common Shrew and Meadow Vole.

BATS

Only one species of bat, the Little Brown Bat, is common throughout the province. Another five species are uncommon or rare. Three species hibernate in Nova Scotia, while the other three are migratory. Hibernation requires a stable temperature-and-humidity regime and security from disturbance. Caves and abandoned mines are usually selected. Hayes Cave in Hants County (District 510), 4.5 km west-southwest of South Maitland, is the only known large hibernaculum in Nova Scotia at present. In winter it is occupied by between 3800 and 8000 bats.[1] Miller's Creek Cave, also in Hants County, was used by about 6000 bats prior to the early 1970s, when gypsum-quarrying operations caused it to be abandoned.

HARES

Two species of hare are found in Nova Scotia: the Snowshoe (or Varying) Hare and the Arctic Hare. Like Moose and deer, the Snowshoe Hare is a browsing animal, eating herbaceous material in summer and woody material in winter. They favour early- to mid-successional stages of mixed forests, dense alder thickets and softwood swamps. Population cycles occur every 8–10 years (see Plate T11.11.1). The Arctic Hare, which was introduced on Scatarie Island (District 870), is larger and can withstand colder winters. Its present status on Scatarie is unknown.[2]

Plate T11.11.1: The Snowshoe Hare is commonly and mistakenly called rabbit. There are no native species of rabbit found in Nova Scotia. Photo: M. Elderkin

The beaver and Muskrat are both largely aquatic. The beaver is associated with deciduous trees, especially aspen, in upland areas, while the Muskrat favours freshwater swamps and cattail marshes in lowland areas, and also tidal creeks (see Plate T11.11.2).

Plate T11.11.2: Beaver above and Muskrat below lodges in Lake Egmont, Halifax County (sub-Unit 511a). In Nova Scotia, Muskrats and beavers generally den in banks where conditions are right, i.e., shallow water, both species build lodges out in open water. Photo: B. Wright

For both species, water levels are an important factor, as dramatic rises (especially in spring) can wash out dens and drown the young. Beavers are found throughout the province, although population densities are not as high in western Nova Scotia because appropriate habitat is less common. The beaver was threatened by extermination at the end of the nineteenth century, but numbers rebounded after the trapping season was closed. Muskrats are most common in the Carboniferous Lowlands (Region 500). The porcupine is a comparative latecomer to Nova Scotia. It prefers hemlock, pine and second-growth birch and poplar.

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Associated Topics

T8.2 Freshwater Environments, T11.8 Land Mammals

Associated Habitats

H3 Freshwater, H4 Freshwater Wetlands, H5 Terrestrial Unforested, H6 Terrestrial Forested

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T11.12 MARINE MAMMALS

There are twenty-one species of whales, dolphins and porpoises (cetaceans)[1], and six species of seals and walrus which occur in the waters around Nova Scotia (see Table T11.12.1). These mammals are important components of the marine ecosystem, feeding near the middle or top of the food chain. The large quantities of food (mainly fish) which they consume means they compete directly with people for a commercial resource.

Many whales are considered endangered, vulnerable or threatened because of their low population numbers and slow rates of reproduction. Walrus used to breed on Sable Island (District 890) and islands off Cape Breton but, hunted for their oil, had disappeared from our waters by the late 1800s.

Cetacean strandings occur occasionally in Nova Scotia, though more frequently these are of dead rather than live animals. Large whales are most often buried by the municipalities, with heavy equipment at the site where the whale has washed ashore. It is not known why groups of apparently healthy cetaceans strand, though it may be due to illness of one or more individuals within the group, or simply that the animals become disoriented in shallow inshore waters. In recent years, mass strandings of Atlantic White-sided Dolphins and Atlantic Long-finned Pilot Whales have occurred in Cape Breton, and Atlantic Harbour Porpoises have occasionally stranded at low tide after swimming up rivers or entering herring weirs in the Bay of Fundy. A Northern Bottlenose Whale spent several days in Sydney River in 1992, before eventually stranding in Sydney Harbour.

Seals may haul out on ice or land to bask in the sun for extended periods, though healthy animals will not normally allow humans to approach too closely. When seals haul out near populated areas, caution is required, as seals will aggressively defend themselves and can bite humans and domestic pets.

Plate T11.12.1: Humpback Whale north of Brier Island (Unit 912). Humpback Whales can be identified by their irregular tail flukes. The Right Whale generally has a straighter tail fluke (see Plate H1.1.1 in **Habitats**). Photo: C. Haycock (BIOS)

CETACEANS

Whales, Dolphins and Porpoises

Whales, dolphins and porpoises fall into two groups, the baleen whales (Mysticeti) and the toothed whales (Odontoceti). Baleen whales use modified hairy plates (baleen) to sieve small fish and invertebrates from large volumes of water, while toothed whales are hunters and grasp prey, such as fish and squid, which are then swallowed whole. Toothed whales also have a single external blowhole, while baleen whales have two blowholes. Baleen whales are further divided into two families: rorquals, with thin, streamlined bodies and expandable throat grooves, and Right Whales, which have thicker bodies and lack throat grooves. Baleen whales include the world's largest living animals—an adult Blue Whale may weigh more than 100 tonnes and reach a length of more than 25 m.

Cetaceans are most often identified on the basis of the shape and size of the blow; colouring and pigmentation; the presence, shape and size of the dorsal fin; and the shape of the tail flukes—though general behaviour and seasonal occurrence of the animal(s) also provide some clues.

COMMON NAME	SCIENTIFIC NAME	DISTRIBUTION
ORDER CARNIVORA (FAMILY PHOCIDAE - Seals)		
Grey Seal	*Halichoerus grypus*	Common on Atlantic Coast and Sable Island
Harbour Seal	*Phoca vitulina*	Common in all coastal waters and Sable Island
Harp Seal	*Phoca groenlandicus*	Present in Gulf of St. Lawrence, late winter to early spring
Hooded Seal	*Cystophora cristata*	Present in Gulf of St. Lawrence, late winter to early spring
ORDER CARNIVORA (FAMILY ODOBENIDAE - Walrus)		
Walrus	*Obobenus rosmarus*	Occasional straggler from arctic waters
ORDER CETACEA (SUBORDER ODONTOCETI - Toothed Whales)		
Striped Dolphin	*Stenella caeruleoalba*	Worldwide (tropical, subtropical and temperate); pelagic; Sable Is. strandings
Common Dolphin	*Delphinus delphis*	Widespread tropical warm-temperate waters. Pelagic, highly gregarious
Bottlenose Dolphin	*Tursiops truncatus*	Tropical to temperate waters, not common off NS (1993 stranding)
White-beaked Dolphin	*Lagenorhynchus albirostris*	Northern North Atlantic, from Cape Cod (spring) to Davis Strait
Atlantic White-sided Dolphin	*Lagenorhynchus acutus*	Northern North Atlantic (Cape Cod southern limit); in Gulf of St. Lawrence. Individual and mass strandings common in NS; seen with fin and pilot whales
Killer Whale	*Orcinus orca*	Worldwide year-round; migrate north in spring, uncommon off NS
Atlantic Long-finned Pilot Whale	*Globicephala melaena*	West Greenland to Cape Hatteras; in Gulf of St. Lawrence; large herds in inshore waters from June to November; mass strandings in Cape Breton
Atlantic Harbour Porpoise	*Phocoena phocoena*	Cold waters from Davis Strait to N. Carolina; common in coastal NS and Bay of Fundy in summer (entangles in herring weirs); hunted by M'ikmaq in past.
Risso's Dolphin	*Grampus griseus*	Tropical to temperate waters, Newfoundland south to Lesser Antilles
Beluga Whale	*Delphinapterus leucas*	Inshore species, confined to arctic/subarctic waters; population in Gulf of St. Lawrence (500); seen around Cape Breton, in Halifax Harbour, St. Margarets and Chedabucto Bays
Pygmy Sperm Whale	*Kogia breviceps*	Appears widely distributed based on stranding data; rarely seen at sea
Sperm Whale	*Physeter macrocephalus*	Widely distributed in deep waters (>180 m) of all oceans, females/calves in tropical/ temperate waters, males migrate as far north as the Davis Strait
Northern Bottlenose Whale	*Hyperoodon ampullatus*	Cold temperate to arctic North Atlantic waters; favours deep waters from Rhode Island north to pack ice edge in Davis Strait (spring/summer); population in the Gully southeast of Sable Island is likely year round
True's Beaked Whale	*Mesoplodon mirus*	Little known; stranding data from Florida and St. Anne's Bay, Cape Breton.
Blainville's Beaked Whale	*Mesoplodon densirostris*	Wide tropical/temperate distribution; 1 stranding in Peggy's Cove
ORDER CETACEA (SUBORDER MYSTECETI - Baleen Whales)		
Minke Whale	*Balaenoptera acuterostrata*	From Gulf of Mexico north to pack ice, winters in temperate waters, migrates north past NS in May; concentration in Gulf of St. Lawrence in summer
Sei Whale	*Balaenoptera borealis*	Worldwide; two stocks in western North Atlantic, centred on Scotian Shelf and Labrador Sea; range from Labrador to Gulf of Mexico; pelagic
Fin Whale	*Balaenoptera physalus*	Worldwide; winter from ice edge south to Florida; summer from Cape Cod to Arctic Circle (often seen in Bay of Fundy, offshore NS, Chedabucto Bay)
Blue Whale	*Balaenoptera musculus*	Worldwide; Panama to Baffin Bay; occasional sightings (usually lone individual) offshore NS as whales migrate to/from summer feeding grounds in Gulf of St. Lawrence and southern Greenland
Humpback Whale	*Megaptera novaeangliae*	Widely distributed over shallow banks and in shelf waters, western N. Atlantic stock migrates past Bermuda to winter near tropics, off NS from spring to fall (Bay of Fundy, Cape Breton)
Right Whale	*Eubalaena glacialis*	Range from Nfld. to Florida; Bay of Fundy and Roseway Basin (SW of NS) important feeding/mating areas in summer/fall; winter round Bermuda

Table T11.12.1: Species of seals, whales and dolphins found in Nova Scotian waters.

Whales display a wide range of activities in coastal waters, including blowing, breaching (jumping clear of the water), spyhopping (raising the head from the water to look around), fluking-up (raising the tail flukes from the water), lobtailing (slapping the water with the flukes) and flippering (waving or slapping a flipper on the water).

Cetaceans travel singly or in groups, called pods, characteristic of the species. Toothed whales usually travel in pods of six to eight individuals, while Harbour Porpoises are usually alone or in pairs. Large pods of up to 2000 Saddleback Dolphins and 500 Pilot Whales and White-sided Dolphins have also been observed.

Like all other mammals, cetaceans are warm-blooded, breathe air and feed their young on milk. Because they are warm-blooded, unlike fish, they must spend a lot of energy maintaining body temperature when in cooler waters. Hearing is the most important sense for cetaceans. Besides communication and feeding, it has been suggested that their highly specialized systems of sound production may be important for navigation.

Seasonal Distribution

Cetaceans are highly mobile, and most species overwinter in warmer waters and exploit the biologically productive areas around Nova Scotia as a summer feeding ground. For species such as the Blue, Fin, Sei, Minke, Right, Humpback and Sperm whales, and dolphins and porpoises, which visit Nova Scotia in summer, the area is the coolest part of their range. For arctic and subarctic species such as Killer Whales and Northern Bottlenose Whales, Nova Scotia is the warmest part of their range. These whales migrate south in late summer and fall to remain in ice-free waters over winter; in spring and summer they appear to follow the retreating ice pack north. The Northern Bottlenose Whale population on the Scotian Shelf (Region 900), however, may represent a separate, non-migratory stock. Smaller numbers of Fin, Humpback, Pilot and Northern Bottlenose whales, and Harbour Porpoises are present throughout the year. In general, the number and variety of whales in our waters increases in the spring and remains highest throughout the summer months, which is the best time of year for whale watching.

In the Bay of Fundy (Unit 912), the whales most likely to be observed on whale-watching tours include Humpbacks, Fins, Minkes and, on occasion, Right whales. Along the northwest coast of Cape Breton (Unit 914), pods of Pilot Whales and Fin Whales may be observed from shore. Fin Whales, which are surpassed in size only by Blue Whales, can be seen regularly from shore in late winter and spring, feeding on herring near the approaches to Halifax Harbour and in Chedabucto Bay (Unit 911). Minke Whales, which are our smallest baleen whales, are also occasionally spotted in these areas in late spring, but they are not as abundant as Fin Whales and are much less obvious. Fin Whales may be observed from shore all along the Atlantic coast of Nova Scotia wherever concentrations of herring or other schooling fish are found. Harbour Porpoise can be observed in inshore waters, with the largest reported concentrations in the Bay of Fundy and smaller numbers in the Northumberland Strait (Unit 914).

Feeding (see Table T11.12.2)

Most large whales eat about four per cent of their body weight per day while in summer feeding grounds, less in wintering areas. Smaller toothed whales, such as dolphins and porpoises, may consume ten per cent body weight per day.

Baleen whales feed on krill, copepods, squid and small schooling fish by swallowing or skimming. Usually a large mouthful of water and food is engulfed at one time, and the water is forced out through the baleen. Right Whales and occasionally Sei Whales feed by swimming at the surface with the mouth open, simultaneously sieving out food particles (skimming). Dense concentrations of prey organisms, often ten to 100 times higher than that found in surrounding areas, are required for baleen whales to feed effectively, and the distribution of whales in our waters is centred around these highly productive areas.

Toothed whales feed primarily on fish, though squid, octopus and larger crustaceans are also eaten. Killer Whales occasionally feed on seals, smaller whales or pelagic birds.

Reproduction

Cetaceans have extremely low reproductive potentials, which makes them particularly vulnerable to habitat or environmental change. Populations are thought to be separated into stocks, with individuals only moving between stocks when stocks are large or overlapping. For small, reproductively isolated stocks of cetaceans, recovery from harvesting or environmental damage is very slow. The number of Beluga Whales in the St. Lawrence estuary does not appear to be increasing despite the protection afforded them for several years. Right Whales, which occur in Nova Scotia waters, are also endangered—only about 325 identified individuals remain of the North Atlantic stock. The number of Humpback Whales appears to be increasing, though they are

BALEEN WHALES	
Blue Whale	euphausiids
Fin Whale	euphausiids, sand lance, mackerel, squid, herring, copepods
Sei Whale	euphausiids, copepods, fish, squid
Minke Whale	sand lance
Right Whale	copepods, euphausiids
Humpback Whale	sand lance, capelin, euphausiids
TOOTHED WHALES	
Sperm Whale	squid, cod, redfish, octopus
Northern Bottlenose Whale	squid, herring
Pilot Whale	squid, cod, mackerel, groundfish
Killer Whale	squid, cod, herring, groundfish, whales, seals, birds
Beluga Whale	fish, bottom invertebrates, squid
Blainville's Beaked Whale	mainly squid, fish
True's Beaked Whale	mainly squid, fish
Pygmy Sperm Whale	mainly squid, fish
DOLPHINS AND PORPOISES	
White-beaked Dolphin	squid, octopus, cod, herring, haddock, capelin, benthic crustaceans
Atlantic White-sided Dolphin	herring, smelt, silver hake, squid
Common Dolphin	fish, squid
Risso's Dolphin	mainly squid
Bottlenose Dolphin	shrimp, eels, catfish, menhaden, mullet
Striped Dolphin	fish, squid
Harbour Porpoise	herring, mackerel, cod, smelt, pollock, redfish

Table T11.12.2: Feeding modes and food preferences of Nova Scotia cetaceans.

	AGE*/LENGTH AT FIRST REPRODUCTION (YEARS OR METRES)	GESTATION PERIOD (MONTHS)	LACTATION PERIOD (MONTHS)	CALVING INTERVAL (MONTHS)
BALEEN WHALES				
Blue Whale	5–7 yr	10–11	6–7	2–3
Fin Whale	7–8 yr	11	6	2–3
Sei Whale	9 yr	11	6	2
Minke Whale	6(m)/7(f) yr	10	6	1
Right Whale	5–10 yr	12+	12	3–4
Humpback Whale	4–5 yr	10–11	10	2
TOOTHED WHALES				
Sperm Whale	7–13 yr	12–13	24	3–6
Northern Bottlenose Whale	6–7 yr	12	12	2–3
Pilot Whale	12(m)/6(f) yr	16	22	3–4
Killer Whale	–	12–16	24	4–7
Beluga Whale	5–8 yr	14	12	2–3
Blainville's Beaked Whale	9 yr	–	–	–
True's Beaked Whale	–	–	–	–
Pygmy Sperm Whale	–	9	12	1–2
DOLPHINS AND PORPOISES				
White-beaked Dolphin	–	10	–	–
Atlantic White-sided Dolphin	6–8 yr	11	18	–
Common Dolphin	5–7 yr	10–11	5–10	1.3–2
Risso's Dolphin	3 metres	–	–	–
Bottlenose Dolphin	10(m)/5(f) yr	12	12–18	2
Striped Dolphin	2.1 metres	12	9–18	3
Harbour Porpoise	3–4 yr	10.6	9	1
*(m)=males, (f)=females				

Table T11.12.3: Reproductive information on whales, dolphins and porpoises of Nova Scotia.

still considered endangered or threatened. Blue, Fin, Humpback, Minke, Right, and Sperm whales are all designated as protected species by the International Whaling Commission (IWC), and Harbour Porpoises are considered threatened.

Most species of whales take several years to reach sexual maturity. The gestation period ranges from ten to sixteen months, and normally only a single calf is born. Lactation lasts for six to ten months for baleen whales and twelve to twenty-four months for toothed whales. Calving intervals for most species are from two to three years, though it varies from one to seven years, depending on the species (see Table T11.12.3).

Natural mortality rates of whales are low but damage due to human activities is significant. Stranding data and recent studies on Right Whales show collisions with ships are responsible for a large proportion of whale deaths.

PINNIPEDS

Seals

Seals belong to a group of mammals known as pinnipeds, which means feather-, fin- or web-footed. Five species occur off Nova Scotia (see Table T11.12.1), all true seals of the Family Phocidae. Grey Seals and Harbour seals occur year round and are the most commonly observed seals, though they inhabit the shoreline only seasonally. These species haul out on land to breed along the Nova Scotia coast in winter and late spring, respectively. Harp and Hooded seals are less common and breed on the pack ice of the northwest Atlantic. Pups are born in mid-winter near the Magdalen Islands and off Newfoundland. Adults and pups from breeding grounds in the Gulf of St. Lawrence drift eastwards and are occasionally seen along the western shore or northern tip of Cape Breton Island. Ringed Seals may also be seen in Nova Scotia, although the species is circumpolar, and shore-fast ice north of southern Labrador is the closest breeding ground to Nova Scotia. Most Harp, Hooded or Ringed seals sighted around Nova Scotia are juveniles, feeding in our waters near the southern limits of their ranges.

Seals observed in Nova Scotia may be distinguished on the basis of physical characteristics, as well as seasonal occurrence and distribution. The pups of Grey and Harbour seals are born at different times of the year, and each species prefers a different environment in which to raise its young.

SPECIES ACCOUNTS

Grey Seal

The Grey Seal is often called a "horse-head" because of its long, arched, heavy muzzle, which is particularly noticeable on the adult male. When younger Grey Seals occur with Harbour Seals, the shape of the nostrils can sometimes be used as a more reliable field identification characteristic than the shape of the head. The nostrils of the Grey Seal tend to be parallel, with a gap at the bottom. The coat of an adult is variable, though females are generally lighter-coloured and more mottled than the heavy-shouldered, battle-scarred males. Adult males are also much larger than females: an average male is 225 cm long and weighs 300–350 kg; the average female is 200 cm long and weighs 150–200 kg.

Grey Seals in Nova Scotia belong to the western North Atlantic stock, which is one of three distinct breeding groups in the world, comprising approximately one quarter of the world Grey Seal population.[2] Breeding colonies occur at the Magdalen Islands (Deadman Island) in the Gulf of St. Lawrence; Amet Island in the Northumberland Strait (sub-Unit 521a); Hay Island and the Basque Islands off Cape Breton (District 870); Sable Island (District 890) Camp Island off the east coast of Nova Scotia (Unit 834); and the largest group on shifting, newly formed ice in the Northumberland Strait and St. Georges Bay (Unit 914) (see Figure T11.12.1).

Grey Seals are gregarious and form large breeding colonies on pack ice or on land in remote, wave-exposed sites. Females haul out shortly before giving birth, while adult males remain nearby and challenge rival males for dominance. The pups, which are born from late December to early February, remain on land for about 3–5 weeks following birth. They are weaned in 2–3 weeks, at which time the mother abandons them abruptly. The pups fast on the ice, or land, while moulting their white birth coats, before instinctively taking to the water, where they learn to feed on their own. Towards the end of the nursing period, the females become receptive to the waiting males and may mate several times with various partners. After mating, Grey Seals disperse widely from the breeding colonies, as do the young pups. Both pups and adults can be very vocal, with a variety of loud, quavering calls.

In May/June, Grey Seals haul out on land to moult. They are common along the coast from spring till autumn, feeding mostly where schooling fish occur and at the mouths of rivers. While their feeding habits are mostly coastal, they will also be found year round in offshore waters.

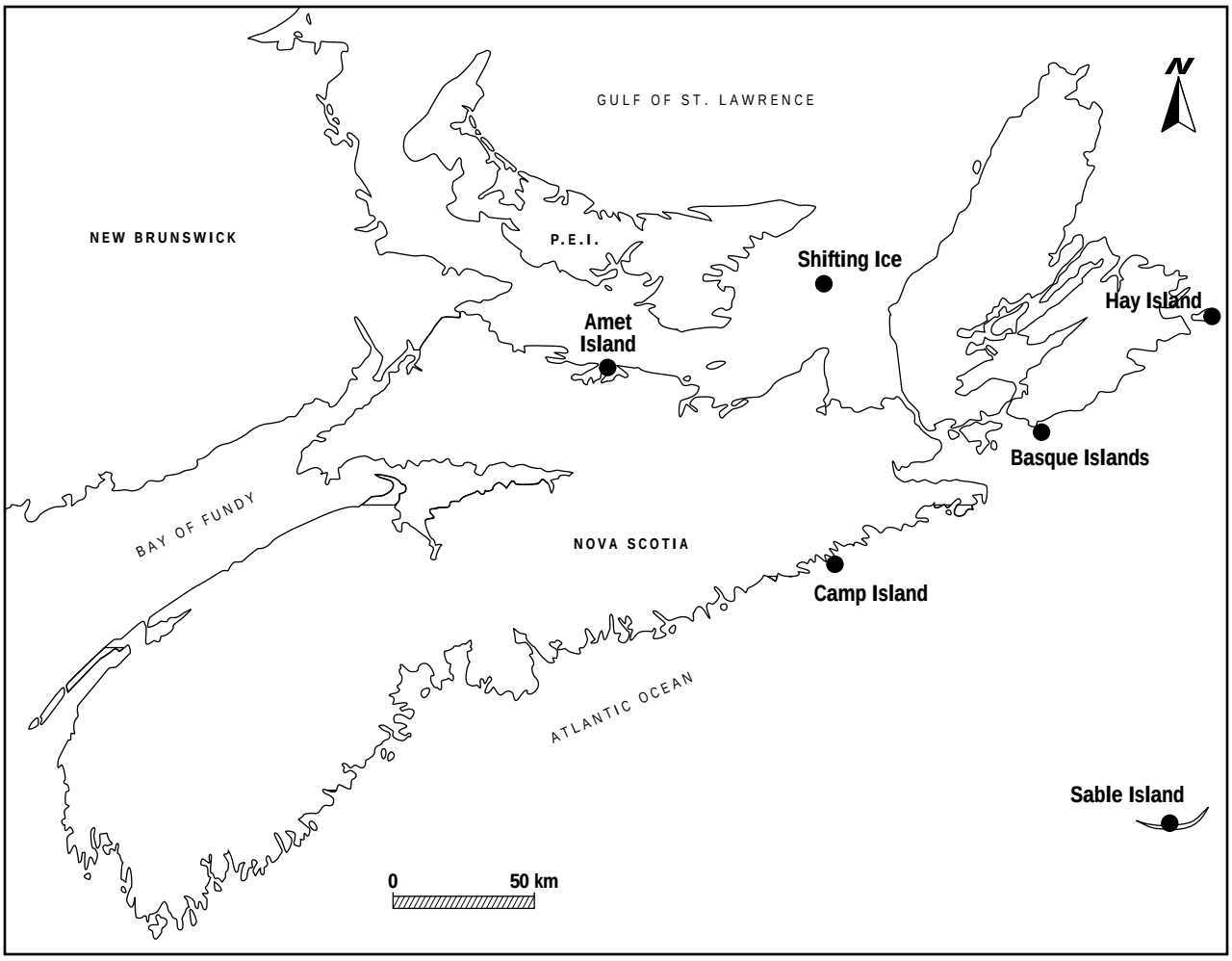

Figure T11.12.1: Major breeding colonies of Grey Seals.[2]

Harbour Seal

The Harbour Seal, which is also known as the Common or Spotted Seal, is much smaller and generally darker than the Grey Seal. The adult male, with a maximum weight of 110 kg, is only slightly larger than the female. The Harbour Seal has a more rounded head, a smaller, dog-like muzzle and V-shaped nostrils, and a more uniformly spotted coat than the Grey Seal.

The Harbour Seal population is thought to be stable or increasing, though estimates are difficult because the seals do not form large breeding colonies on land. Harbour Seals are found in small breeding groups in the quiet waters of sheltered bays and inlets. They can sometimes be found in fresh water, moving up estuaries into rivers and lakes, away from the sea. Their pups are often born at low tide on intertidal mud banks, sandbars or rock ledges, from late April through June, peaking in late May. Within the Maritimes, most Harbour Seals are found on Sable Island and along the Atlantic Coast of Nova Scotia (Region 800).

The pup sheds its first coat in its mother's uterus and is born with the adult grey coat.[3] Pups are ready to swim shortly after birth and are carefully tended by their mothers, who, if threatened, may carry their pups between their fore flippers or on their bellies. Pups are weaned after about a month, and mating occurs immediately afterwards. Throughout the summer, Harbour Seals continue feeding along the coast, following the inshore migrations of fish and hauling out occasionally to bask in the sun. Harbour Seals are the least vocal of all seals, and adults usually only snort, grunt or growl as threat displays.

Harbour Seals haul out on land to moult in early August and begin to move away from the coast in the

late fall. They are less frequently seen in winter, having moved further offshore to avoid the ice in frozen inlets. Harbour Seals do not appear to haul out when the air temperature is too low, preferring instead to remain in the water; this may also contribute to fewer sightings in the winter.

Harp Seal

Adult Harp Seals have a black face and a silver grey body, with a distinctive black wishbone or "harp" shape on their back. This characteristic marking does not develop until after they reach sexual maturity, and juveniles, which are most likely to be observed in Nova Scotia waters, are silvery grey with irregular black blotches. Adult males and females are roughly the same size, about 170 cm long and 130 kg. Harp Seal pups, or "whitecoats", are born on pack ice off Newfoundland and the Magdalen Islands from late February to mid-March.[4] This species gained international media attention in the controversy surrounding the annual seal hunt in Canadian waters.

Ringed Seal

The adult Ringed Seal has prominent grey-white rings, which may be separate or fused together, along its dark grey back. The belly is silver. Ringed Seals are relatively small and in Canada average 135 cm. Whitecoated pups are born in early April in birth lairs on shorefast ice north of southern Labrador. Juveniles, the stage most likely to be observed around Nova Scotia, may be identified as Ringed Seals by the short nose and ringed markings, in contrast to the "spots" of a Harbour Seal.

Hooded Seal

Adult male and female Hooded Seals have a bluish grey coat with irregular black blotches. Juveniles, the stage most likely to be observed around Nova Scotia, are called "bluebacks," and are blue grey on their backs and silver grey on their sides and belly. The adult male hooded seal is easily identified by an inflatable sac, or "hood," on top of the nose and forehead. The male can also inflate the nasal septum to form a large red balloon during aggressive behaviour. Male Hooded Seals are considerably larger than females, at 300 kg and 250 cm in length, compared to 160 kg and 220 cm for females. Hooded Seals, like Harp Seals, whelp on the pack ice off Newfoundland and in the Gulf of St. Lawrence in February and March.[4] Hooded Seals have been noted to roam great distances.

Feeding Relationships

Seals are opportunistic feeders—the type of food eaten varies seasonally and probably reflects availability of prey rather than a particular food preference. Their diet consists mainly of fish, though invertebrates such as squid, crabs, molluscs and polychaetes are also eaten. Studies suggest that seals feed at between two and six per cent of their body weight each day. A population of 1000 harbour seals would eat about 675 t of fish yearly.

Atlantic Cod—*Gadus morhua*
Atlantic Herring—*Clupea harengus*
Atlantic Mackerel—*Scomber scombrus*
American Plaice—*Hippoglossoides platessoides*
Capelin—*Mallotus villosus*
Flounders—*Pleuronectidae*
Haddock—*Melanogrammus aeglefinus*
Lumpfish—*Cyclopterus lumpus*
Pollock—*Pollachius virens*
Atlantic Salmon—*Salmo salar*
Atlantic Sand Lance—*Ammodytes americanus*
Atlantic Saury—*Scomberesox saurus*
Silver Hake—*Merluccius bilinearis*
Skates—*Rajidae*
Rainbow Smelt—*Osmerus mordax*

Table T11.12.4: Fishes eaten by Grey Seals.

SPECIES	FOOD	%
Grey Seal	herring	28
	cod	26
	mackerel	18
	squid	17
	invertebrates	11
Harbour Seal	herring	24
	squid	20
	flounder	14
	alewife	7
	hake	6
	other	2
	invertebrates	27

Table T11.12.5: Food preferences of Grey and Harbour Seals.

Table T11.12.4 lists species of fish eaten by Grey Seals and Table T11.12.5 lists food preferences of Grey and Harbour Seals.,

Seals are long-lived and have few natural predators. Grey and Harbour Seals (particularly pups) are eaten by sharks, though man has historically been the most important predator, harvesting them for meat, oil and skins. Harbour Seals may live for up to 25–30 years and Grey Seals for 30–35 years. The female generally lives longer than the male.

CULTURAL FACTORS

Both whale and seal populations have been affected by hunting in Nova Scotia (see T12.11). Today, whale watching has become an important economic resource in the province.

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Associated Topics

T6.1 Ocean Currents, T6.2 Oceanic Environments, T11.14 Marine Fishes, T11.17 Marine Invertebrates, T11.18 Rare and Endangered Animals, T12.11 Animals and Resources

Associated Habitats

H1.1 Open Water, H2.1 Rocky Shore, H2.2 Boulder/Cobble Shore, H2.3 Sandy Shore

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T11.13 FRESHWATER FISHES

Forty-three species of fish have been recorded in the lakes and streams of Nova Scotia (Table T11.13.1). Only one species, the Sea Lamprey, is of the jawless fish (Agnatha) class; the rest are bony fish (Osteichtyes) and can be divided into four categories:

1. freshwater species
2. euryhaline/marine species—occasionally venture up into estuaries.[1,2]
3. diadromous species—fishes that migrate between the sea and freshwater
4. anadromous species mature at sea and spawn in fresh water; catadramous species mature in fresh water and spawn at sea (American Eel only);

The fish fauna of Nova Scotia's lakes and streams is characterized by two prominent features, both of which relate to the peninsular nature of the province:

1. the fish fauna is impoverished compared to the numbers of species found further west (a feature shared by the flora and other fauna of the province)
2. the fauna is heavily influenced by the salt-water environment which surrounds Nova Scotia.

DISTRIBUTION OF SPECIES

The seventeen purely native freshwater species have all entered Nova Scotia during the 13,000 years since the retreat of the last ice sheet. Before human intervention, movement from one watershed to another would depend on river capture (see T3.2) or on the freshening of the coastal waters by the melting ice sheet enabling freshwater species to move around the coast from one river to another.

The distribution pattern of freshwater fish in Nova Scotia shows a definite decrease in species diversity, moving away from the Chignecto lowlands. This pattern may be explained in two ways. The increase in species in the Cumberland County area suggests that certain fish, such as the Blacknose Dace, have not yet been able to penetrate any further into the province. The absence of any purely freshwater species on Digby Neck and in northern Cape Breton is thus a reflection of these regions' distance from the point of entry and lack of freshwater colonization routes.

A second interpretation sees the pattern as an indication that many species were once much more widely distributed and have since been eliminated from certain regions, possibly due to habitat loss. The high species diversity in Cumberland County therefore becomes a reflection of the higher productivity of freshwater environments in that area than the southern uplands.

Species which exhibit various degrees of tolerance to salt water were able to move more readily from one river system to another via estuaries, and are therefore more widely distributed. Acidity and geographic considerations may, however, restrict distribution of some species (such as Atlantic Salmon) and decrease their relative abundance. This increases the relative abundance of other species (such as eels) within the broader constraints imposed by temperature and stream size. Species distribution in two Nova Scotia river systems (the Medway and Gold) included primarily Brook Trout, Atlantic Salmon and American Eel. In the Medway River system, the relative abundance of salmon was reduced and that of eels increased when compared to those in the Gold River system due to pH differences. (The midsummer distribution of major fish species in these rivers was determined primarily by stream size and temperature).[4]

The Brook Trout is native only to northeastern North America; however, its popularity as a game fish has caused the species to be widely distributed throughout the world.[3] Commonly known as the Speckled Trout, its habitat in Nova Scotia extends from rapidly moving streams and rivers, beaver ponds and lakes to estuaries. It prefers waters between 10°C and 18°C.

Brook Trout in Nova Scotia mature at two years of age and usually spawn in late September. The eggs overwinter in gravel beds, hatching in April to release the sac-fry, each equipped with a yolk sac to nourish it for a further six weeks' residence in the gravel beds. In optimum conditions, the Brook Trout can expect to reach 5–10 cm in their first year. Further growth depends on water quality, competition for food and other habitat factors. The Brook Trout usually only survives three to four years and may attain 25 cm in a stream or small river, 30 cm in a large lake and 35 cm in an estuary. A 61–cm sea-run trout weighing 3.4 kg was caught in the Salmon River, Halifax County, in 1871 and is now preserved in the Nova Scotia Museum of Natural History.

SPECIES	ORIGIN	STRATEGA
Sea Lamprey	Native	Anadromous
Atlantic Sturgeon	Native	Anadromous
Tarpon	Visitor	Marine
American Eel	Native	Catadromous
Blueback Herring	Native	Anadromous
Gaspereau (Alewife)	Native	Anadromous
American Shad	Native	Anadromous
Atlantic Menhadin	Annual visitor	Marine
Lake Whitefish	Introduced	Freshwater
Atlantic Whitefish	Native	Anadromous
Coho Salmon	Introduced	Anadromous
Chinook Salmon	Introduced	Anadromous
Rainbow Trout	Introduced	Freshwater
Atlantic Salmon	Native	Anadromous and landlocked
Brown Trout	Introduced	Anadromous
Brook Trout	Native	Freshwater (& sea run pop.)
Lake Trout	Native	Freshwater
Rainbow Smelt	Native	Anadromous
Chain Pickerel	Introduced	Freshwater
Goldfish	Introduced	Freshwater
Northern Redbelly Dace	Native	Freshwater
Lake Chub	Native	Freshwater
Golden Shiner	Native	Freshwater
Common Shiner	Native	Freshwater
Blacknose Shiner	Native	Freshwater
Blacknose Dace	Native	Freshwater
Creek Chub	Native	Freshwater
Fallfish	1 record	Freshwater
Pearl Dace	Native	Freshwater
White Sucker	Native	Freshwater
Brown Bullhead	Native	Freshwater
Atlantic Tomcod	Native	Anadromous
Banded Killifish	Native	Freshwater
Mummichog	Native	Euryhaline-Marine
Atlantic Silverside	Native	Euryhaline-Marine
Fourspine Stickleback	Native	Freshwater-Euryhaline-Marine
Brook Stickleback	Native	Freshwater
Threespine Stickleback	Native	Freshwater-Euryhaline-Marine
Ninespine Stickleback	Native	Freshwater (brackish)
White Perch	Native	Freshwater
Striped Bass	Native	Anadromous and Catadromous
Smallmouth Bass	Introduced	Freshwater
Yellow Perch	Native	Freshwater

Table T11.13.1: Origin and habitat strategies of freshwater fish species in Nova Scotia.

Introduced Species

Human intervention also plays an important part in the distribution of species throughout Nova Scotia. Six species—the Rainbow Trout, Brown Trout, Chain Pickerel, Lake Whitefish, Goldfish and Smallmouth Bass—have been introduced through public stocking programs and privately by Nova Scotia anglers. These introductions, particularly that of the Smallmouth Bass, have changed the community structure in freshwater habitats by competing with native species.

Fish Assemblages

A recent survey of fish in 145 headwater lakes in Nova Scotia concluded that three major factors determine fish distribution: lake area, lake acidity and geographic location.[5] (Some of the smaller species, such as Banded Killifish and sticklebacks as well as the American Eel, were excluded from the survey because of the method of sampling chosen.) Peterson and Martin-Robichaud identified five types of fish assemblages in Nova Scotia lakes:

1 Brook Trout
2 Brook Trout–White Sucker
3 multi-species, with White Sucker, Yellow Perch and Brown Bullhead as the most frequent members
4 Yellow Perch
5 multi-species, with Smallmouth Bass and/or White Perch predominant

Lake area was the single most important variable separating the five assemblages, with Brook Trout lakes averaging the smallest in area, while White Perch/Smallmouth Bass inhabit lakes of the greatest area. High levels of acidity were correlated with low species diversity and the predominance of Yellow Perch.

Type 1 lakes were the only kind found on Cape Breton Island, while Type 4 lakes were encountered only in southwestern and eastern Nova Scotia. Type 3 lakes were the most numerous and were dispersed throughout the province.

WATER QUALITY FACTORS

The influence of such factors as climate and water quality on distribution at the regional scale is not yet fully known. The water-temperature regime varies considerably from one lake to another, depending on basin size and shape. In general, the waters of southwest Nova Scotia are somewhat warmer than in the rest of the province. Some warmer-water species, such as White Perch and Banded Killifish, appear to be at the northern limit of their range in this area.[6]

The influence of water chemistry on different species still requires further study. In general, the harder waters of the sedimentary rocks in the Carboniferous Lowlands (Region 500) support a larger number of species. Certain species have not been recorded in the granitic areas of the Atlantic interior (Region 400) and the Atlantic Coast (Region 800), and it is possible that the very soft waters are not sufficiently productive for them.

The relationship between the number of fish species and the type of bedrock may partly relate to the pattern of invasion of Nova Scotia by freshwater species. The number of species is highest in the Chignecto Isthmus and declines with increasing distance from it towards the southwest and northeast extremities of the province. Coincidentally, granitic bedrock is concentrated some distance from Chignecto to the south of a line joining Chedabucto Bay and Annapolis. The relationship between bedrock type and species diversity may be partly but not entirely due to this coincidence.

HABITAT FACTORS

One consequence of the limited number of species in Nova Scotia is that the reduced competition and predation permits them to occupy a wider range of ecological niches. For example, the Banded Killifish throughout most of its range in North America is restricted to weedy lake shallows and slow-moving streams. In Nova Scotia, however it is also found in swift-flowing streams and deep open water. Similarly, many salmonids occupy a wider variety of niches than has been observed elsewhere. In some areas, the trout population is being displaced from marginal habitats by increasing competition and predation.

MOVING-WATER ENVIRONMENTS

River systems generally exhibit a gradation of lotic (moving water) environments, ranging from shallow, fast, turbulent waters in the headwaters down to the slower, deeper waters of the lower reaches. In areas that have a diverse fish fauna a comparable zonation of species often develops. In Nova Scotia this is less obvious due to the smaller number of species and their resulting use of a wider range of habitats. In general, upstream fishes are very active, streamlined predators and have the ability to hold their position in swift currents. The salmonids are typical species of this habitat.

Much of Nova Scotia is drained by slower-moving waters as a result of the comparatively gentle slope of the Atlantic Interior and the predominance of the deranged drainage pattern. In these slower-moving waters, minnows and perch are more typical. As the water slows down even further, the larger bottom, feeding species, such as White Suckers, become more common.

STILL-WATER ENVIRONMENTS

Lentic (still water) environments are characterized by size, circulation patterns and trophic status. A large, deep lake will usually become thermally stratified in the summer, permitting the year-round existence of cold-water fish in the deeper layers. Oligotrophic lakes, which predominate in Nova Scotia, have abundant oxygen at all depths but low nutrient levels. They support a low biomass, and fish growth is slow. Trout are the characteristic species. Eutrophic lakes are more productive but have lower oxygen content. In such lakes, salmonids are replaced by Chain Pickerel, Smallmouthed Bass, perch, killifish and bullheads.

MIGRATORY SPECIES

A number of species are anadromous: they mature in salt water but return to fresh water to spawn. Included in this group are Gaspereau, salmon, Striped Bass, Smelt, Atlantic Whitefish and the Sea Lamprey. The American Eel is the only catadromous species found in North America. Eels leave fresh water in fall and migrate to the Sargasso Sea to spawn.[6]

SPECIAL FEATURES

1. The Lake Whitefish is a valuable freshwater species elsewhere in Canada. In Nova Scotia, the species was introduced at the turn of the century, and today populations are found in lakes in Kejimkujik National Park, in several lakes near Musquodoboit Harbour and in St. Marys River drainage basin. A unique population exists in the Mira River, Cape Breton. They are, however, apparently more common in western Nova Scotia. The Lake Whitefish is a cool-water species which feeds on benthic invertebrates and requires lakes that are stratified in summer. The Nova Scotia populations exhibit very slow growth rates and are considered to be threatened.
2. The first record of an Atlantic Whitefish (Acadian Whitefish) was established in 1925; the only populations in the world today are in the Petite Rivière watershed in Lunenburg County and possibly the Tusken River system. The species is listed under COSEWIC as endangered.
3. In 1978, spawning Coho Salmon were recorded in the Cornwallis River. The following year, three juveniles were reported in Salt Brook, a tributary of the Cornwallis River.[7] The identity of Chinook Salmon was also verified in the Nictaux River.[7] Their spawning was unsuccessful, however, and the species may have since disappeared.[8] Both the Coho and Chinook Salmon are Pacific fish and apparently originate from stocking programs in New Hampshire.[7]
4. There are several landlocked populations of anadromous fish in Nova Scotia. The populations are smaller than sea-run populations and can occur naturally or anthropogenically. The Shubenacadie watershed supports a population of Atlantic Salmon which feed on a natural, landlocked population of Rainbow Smelt (American Smelt). The Atlantic Whitefish, on the other hand, is landlocked in the Petite Rivière watershed as a result of the damming of the Petite Rivière River.

The Rainbow Trout were introduced as a game species in several systems in Nova Scotia but have usually run to sea, where they are called Steelheads. There are stocked populations of Rainbow Trout in landlocked lakes in Annapolis, Kings and Cape Breton counties.

CULTURAL FACTORS

Water quality can change from runoff and siltation occurring as a result of forestry, agriculture and development. Acid rain has also affected water quality of lakes and rivers in southwestern Nova Scotia. The ability for fish like salmon to survive in freshwater habitats is an important indicator as to water quality.

The decline in the numbers of fish species in Nova Scotia lakes surveyed since 1960 has been positively correlated with pH and lake surface area.[9] The pH of lakes from which acid-intolerant species such as Brook Trout and White Perch had disappeared was significantly lower than that which still supported populations of those species.

The most severe impacts from acid rain are limited to the southwestern half of the province, where acidification of lakes has halved fish populations.[10] It is technically feasible to restore lost habitat by adding limestone. A small-scale liming project has been carried out by the Department of Fisheries and Oceans in order to establish a refuge for the preser-

vation of a nucleus of native salmon stock.[11] In most cases, however, the cost of the liming program is not perceived as justified by the economic benefits of the anticipated salmon enhancement: a liming project would expend approximately $200 per restored salmon.[12]

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Associated Topics

T3.2 Ancient Drainage Patterns, T4.3 Post-glacial Colonization by Animals, T6.2 Oceanic Environments, T6.4 Estuaries, T8.1 Freshwater Hydrology, T8.2 Freshwater Environments, T11.14 Marine Fishes, T11.16 Land and Freshwater Invertebrates, T12.11 Animals & Resources

Associated Habitats

H2.5 Tidal Marsh, H3 Fresh Water, H4 Freshwater Wetlands

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T11.14 MARINE FISHES

Fish is the most abundant and diverse group of vertebrates in the ocean, with 538 species recorded in the Canadian Atlantic Region alone.[1] Three main classes or groups of fishes are represented in Nova Scotia waters: the jawless fishes (Agnatha), including the Sea Lamprey and the hagfish; the cartilagenous fishes (Chondrichthyes)—the sharks and rays; and the bony fishes (Osteichthyes). The latter group contains most of the local species.

The familiar commercial species of marine fish in Nova Scotia make up only a small proportion of the total number of species. Numerous lesser-known but occasionally abundant species inhabit the various marine and estuarine habitats.

The largest fishes include the Basking Shark, the second-largest shark species in the world (after the Whale Shark), and the White Shark, which has been recorded at over 11 m in length at the mouth of the Bay of Fundy.[1] The smallest species are probably the various species of sticklebacks found in shallow areas along the shore, and the lumpsuckers and tadpole-like snailfish, which live among bottom rocks and algae. These species reach maximum sizes of 3 to 10 cm.

DISTRIBUTION

Marine fish have definite patterns of distribution, linked to a variety of factors, including water temperature, bottom type, depth and water-column productivity. Shallow marine environments are used as nursery areas for larvae and juveniles of many fish species. Distributions often change predictably with seasons in response to environmental factors such as water temperature or food availability. For example, many of Nova Scotia's herring overwinter in dense schools in Chedabucto Bay (Unit 911) in eastern Nova Scotia and move to waters off southwest Nova Scotia and the mouth of the Bay of Fundy (Unit 912) in summer to feed and spawn. Cod, haddock, pollock and Silver Hake spawn primarily on the offshore banks, while American Plaice and redfish spawn widely over the shelf.

Fisheries scientists have identified distinct geographic groupings, known as stocks, of most commercial species. By analogy, stocks are like massive herds of terrestrial animals such as Reindeer or Caribou. Stocks are defined as groups of organisms usually separated geographically and in other ways from other stocks of the same species, and in which there is little if any interbreeding. Stocks are managed as individual units, and many of the offshore fishing zones were established to encompass particular fish stocks.

The abundance of a fish species relates to unpredictable physical and biological conditions which influence the success of a particular year's young—known as a year class. Periods of high abundance usually follow a period, several years before, when conditions favoured survival and maturation of young. In such cases, periods of abundance in the fisheries typically have been followed by stock "collapse". Stocks may rebound from collapse if measures to manage the fishery are put in place, but recovery is never certain.

Many species (including some that are commercially important) live in estuaries, in other coastal waters and even in fresh water for part of their lives. Species that spawn and undergo early development at sea and live mostly in fresh water are classed as catadromous. Those that spawn in fresh water and spend varying proportions of their lives in coastal or offshore waters are classed as anadromous. In either case, the move requires a major change in the physiology of the fish to adapt to changes in salinity.

The line between freshwater and marine fishes is not always easy to draw, as certain species move freely between both systems. The marine fishes likely to be found in Nova Scotia's coastal waters may be divided into five groups:

1 small fishes of estuaries and tidal inlets
2 groundfish
3 pelagic species
4 mesopelagic species
5 exotic warm-water and eastern-arctic species

Fishes in the first group depend on the types of intertidal and subtidal habitats available. The concentrations and movements of the other groups relate to temperature, salinity, bottom characteristics and food resources—factors which are closely dependent on the movements of the major water masses in the northwest Atlantic and on the bathymetry of the continental shelf. Generally speaking, the shallow-water environments offer more opportunities for specialization and therefore have high species diversity. Further offshore, the species diversity is lower but the

biomass is high—the feature on which the great fisheries of the Atlantic coast are based.

ESTUARINE FISH

Up to twenty fish species are commonly found in Nova Scotia's estuarine systems. They include fishes that remain in estuaries for their entire life cycle or leave for only a short period to spawn in fresh water. The young, on hatching, flush immediately back into the sea.

Anadromous fishes that pass through estuaries on their way to spawning grounds in fresh water include Gaspereau, Atlantic Salmon and American Shad.The spring migrations of Gaspereau and shad are the highlight of seasonal fisheries in many areas of Nova Scotia. Some of these species are known for their long migrations. Atlantic Salmon from the Maritimes can reach waters off Greenland before returning to spawn, while a large proportion of American Shad, which spawn in rivers along the entire North American east coast, spend the summer feeding in basins in the Upper Bay of Fundy (Unit 913). Both Atlantic Salmon and Rainbow Smelt (American Smelt) can adapt to life strictly in fresh water and become "landlocked" in some cases.[2]

Winter Flounder, Striped Bass and Atlantic Sturgeon use the upper estuary for spawning, and their young may spend several years using estuaries as nurseries before migrating to the sea.

Species which typically occur in fresh water (such as Brown Trout, Brook Trout and four species of stickleback) often exploit coastal estuaries during parts of the year because of the abundance of food and sometimes favourable temperatures. Many freshwater species are able to take advantage of the productivity due to the presence of a freshwater wedge (see T6.4). In some estuaries, this wedge can extend a considerable distance downstream. The juveniles of many commercial demersal and pelagic fishes, such as cod, pollock and herring, also feed in coastal environments.

The American Eel is the only catadromous species in North America, reproducing at sea in the mid-Atlantic Ocean (Sargasso Sea). The young transparent glass eels, or elvers, are carried to Nova Scotia waters by ocean currents and enter streams and lakes, where they live for five to ten years before a fall migration takes them to the sea to spawn.

Coastal and estuarine habitats can offer abundant food resources, but fish diversity is often restricted by the less-hospitable environment. Fish must be tolerant of strong currents and fluctuating temperatures and salinities. Tidal marshes, and rockweed and Eel Grass beds are important components of the estuarine and coastal environment. Few animals feed directly on the living plants; instead, the food chain begins with decaying plant remains or "detritus". Detritus and dissolved nutrients washing into the coastal zone promote a "pulse" of increased production by microscopic plants and plankton organisms, as well as in the community of epibenthic (near bottom) detritus-grazing organisms (mysids, sand shrimp, etc.). These in turn supports the juvenile and adult fishes that occur in coastal and estuarine habitats.

GROUNDFISH

Groundfish (included with the demersal fishes) can occur offshore as well as in coastal inlets and estuaries. Groundfish species include cod, flatfishes (e.g., flounder, plaice, halibut), redfish, haddock, pollock and hake. These species usually have egg and larval stages which drift with ocean currents and settle to the seabed. They live close to the bottom for much of their adult life. The Winter Flounder is one of the best-known inshore marine groundfish species, whose survival in cold inshore waters even in winter is thought to be due to "antifreeze" proteins in its blood.[1] Some species, such as the Witch Flounder and the Atlantic Halibut, are found at great depths (Witch Flounder prefer the gullies between offshore banks where the bottom is clay, muddy sand or pure sand, while halibut prefer areas with a hard bottom of rock, sand, clay or gravel).[3] The Windowpane Flounder is commonly found in the inner Bay of Fundy, particularly as juveniles in tidal channels and mud-flat areas.

All groundfish are carnivores, feeding on benthic invertebrates, such as worms, molluscs and crustaceans, and on other fish, but each type of groundfish shows feeding specializations. Flatfish live near the bottom and feed on invertebrates, particularly polychaete worms. The mouths of many of the flatfish species are small and oriented side-ways, enabling them to "snip" off worms sticking out of the bottom. Gut contents often include the feeding tubes ("siphons") of clams that protrude from the surface. Atlantic Cod will eat almost anything; the species was traditionally caught by "jigging" with a shiny, multi-hooked lure dangling near the bottom. Cod frequently catch crabs, small fish, worms, clams and snails, stones (from which they digest the attached anemones and other organisms) and litter. Species such as pollock (known commercially as "Boston bluefish") that move further up into the water column in large schools can capture some of the more mobile organisms: herring, juvenile cod,

haddock and hake, as well as shrimp and squid.[4] Silver hake are viewed as a pest by some because, in addition to krill and other zooplankton, they consume the larvae and juveniles of other commercial fish species.

Patterns of Movement

All species of groundfish move in response to water temperature, and the changing temperatures in the offshore lead to particular seasonal movements. For example, Atlantic Cod on the Scotian Shelf (Region 900) prefer cool temperatures; however, preferred temperatures are influenced by time of year, geographic locations, and size of fish. On the Scotian Shelf, they prefer 3–4°C on the northeast and 7–8°C on the southwest.[1] They spawn in March and April over offshore banks and move towards shore in the summer. Although the cod move locally, there are four main areas of concentration: a Nova Scotia coastal stock, a Browns–LaHave Bank stock, a Georges Bank stock and the Banquereau–Sable Island stock (Unit 931).

In the Gulf of St. Lawrence, cod spawn on the Magdalen Shelf and move eastwards to overwinter on the southern edge of the Laurentian Channel off Cape Breton Island (Unit 932). Silver Hake, a groundfish important in fisheries at the edge of the Scotian Shelf, has a preferred temperature range of 6–8°C and moves into shallower waters as temperatures warm during the season.[1] Red Hake from the Gulf of Maine migrate into Passamaquoddy Bay on the New Brunswick side of the Bay of Fundy, but hake on the central Scotian Shelf do not appear to make significant inshore migrations, since the temperature is within their preferred range there year round.

PELAGIC FISH

Pelagic fish travel mostly in large schools, feeding mainly in surface waters or middle depths. Schools of pelagic fish are renowned for their ability to turn and manoeuver in close formation with split-second timing.[5] Pelagic fish are generally streamlined and have protective coloration, usually blue or blue-gray over their backs and silvery white underneath. Key pelagic species in marine waters are herring, mackerel, swordfish, Bluefin Tuna and Capelin, as well as many of the nearshore and estuarine species.

Pelagic species generally feed on zooplankton and smaller fish species. Herring and mackerel feed on planktonic crustaceans and fish eggs and larvae, and may also filter with their gillrakers when food is suitable.[6,7]

Patterns of Movement

Pelagic species (herring, tuna, mackerel) are some of the most migratory of fish. In a year, herring schools easily move along the entire Atlantic coast of Nova Scotia. Bluefin Tuna spend the winters in warm southerly waters and move northward to Nova Scotia as the season progresses, the smaller tuna arriving before the big ones, first at the Scotian Shelf and finally reaching the Gulf of St Lawrence. Mackerel approach the Atlantic Coast in late May in large schools and leave again in the fall for overwintering areas off the shelf edge of the eastern United States.

MESOPELAGIC SPECIES

Mesopelagic species live on the Continental Slope (District 940). They include lanternfish and Myctophids. One feature of many of these deepwater species is their vertical migration towards the surface at night. The fish therefore have to be able to withstand drastic pressure changes. Although mesopelagic fish are themselves unlikely to be seen in inshore waters, they are of interest because they constitute an important food resource for seabirds such as Storm Petrels.

EXOTIC WARM-WATER AND EASTERN-ARCTIC SPECIES

The coastal fish fauna of Nova Scotia is much enriched by a variety of exotic visitors. Many are associated with warm water brought in by currents from the continental slope. They often move in as juveniles and spend the summer in tidal inlets, taking advantage of the warmest surface temperatures between August and November, but cannot survive the winter. Studies in St. Margarets Bay and Prospect Bay (Districts 460, 850, 910) produced a collection of thirty-one species from warmer waters. These fish include flying fish, seahorses, Priacanthids and mullet. Several species of shark can also be associated with this group, including the Dusky, Silky, Whitetip, Hammerhead and Mako—all of which occur in the warm waters of the Gulf Stream. In addition, several species of eastern-arctic origin, such as the Greenland Cod, Mailed Sculpin and Arctic Eelpout, have been recorded from cold-water areas on the banks and eastern shore.[8]

LIFE HISTORIES

Fish reproduce by means of eggs laid by the females and fertilized by males, but many different strategies have evolved for egg survival. Many of the groundfish species, such as cod, lay millions of spherical eggs which float to the surface of the water. Upon hatching, the young fish larvae feed on zooplankton and remain near the surface until they are large enough to live near the bottom. The larvae are weak swimmers and drift with prevailing currents, but current patterns can keep them in certain areas (usually the shallow offshore banks but also in some estuaries) throughout development.[9] The eggs of some species (e.g., herring) sink and stick to objects on the bottom, such as rocks and algae. The young live in shallow coastal waters near the site of spawning. Redfish, a species found from near bottom to mid-water in deeper waters, gives birth to fully formed young. Species such as skates and hagfishes have large, tough egg cases. The brown, leathery, H-shaped egg purses of skates frequently wash up on Nova Scotia's beaches. Like Redfish, the Spiny Dogfish, a species common in coastal waters in the summer, gives birth to fully developed young. The 22- to 24-month gestation period is the longest of any vertebrate.[5]

Fish are food of higher vertebrates, including birds and sea mammals, and the young stages are heavily preyed upon. Of several million cod eggs laid by each individual, only one survives to reach adulthood.

In turn, fish feed on other organisms. Specific feeding habits and adaptations relate to particular constituents of the diet. The mouths of flatfish are well suited to capturing marine worms, smaller invertebrates and fish on the sand-to-mud bottoms where they live. Cod have large mouths which can engulf a wide range of bottom-dwelling prey. Rays, flounders, cod and sculpins will eat whole clams or sometimes just nip off their siphons. Pelagic species feed on zooplankton and small fish, and are adapted for speed and quick movements.

Juveniles of Red Hake and a species of snailfish use live sea scallops as shelter. These species wriggle into the internal cavity of the scallop, emerging to feed at night, and have no apparent ill effects on the scallop. The snailfish uses its ventral sucker to attach itself to the upper half of the shell. Juvenile haddock hide amid the poisonous tentacles of the Lion's Mane jellyfish, apparently not sustaining injury.[10]

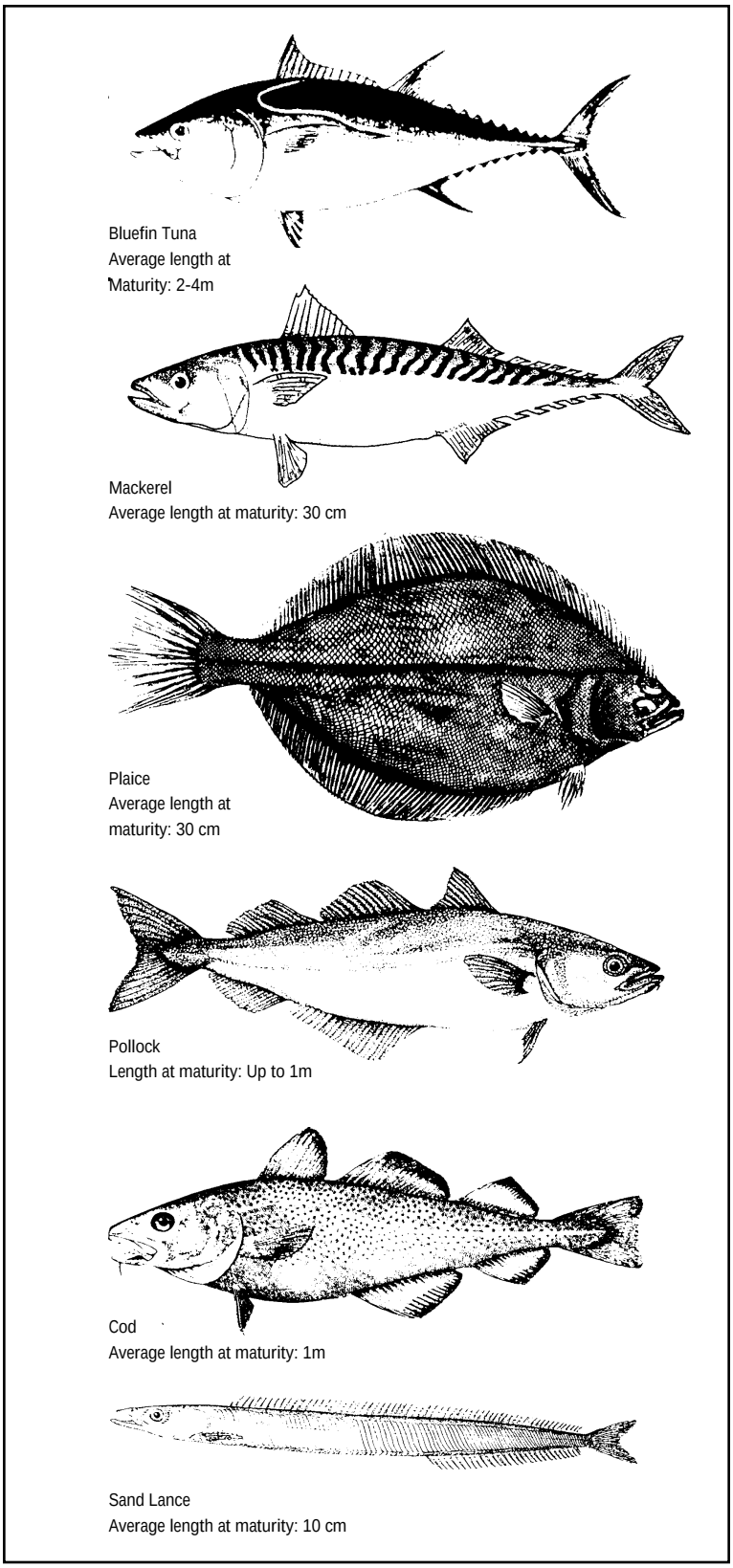

Figure T11.14.1: The general shapes of marine fish.

FORM AND FUNCTION

Fish have evolved in physical structure and behaviour to take advantage of the various food sources available in the sea, the kinds and distribution of habitat, and to the physics of the dense, watery medium in which they live (see Figure T11.14.1).The shape of a fish is a clue to its life style.

Among pelagic species, highly streamlined fish (typified by the mackerel and Bluefin Tuna) specialize in catching moving prey (small fish and zooplankton). They have a pair of pectoral (front) fins which can be held out at slow speeds to act as hydroplanes but which are withdrawn when the fish needs a burst of speed. They also lack swim bladders, which in many species provide added buoyancy. The tuna is another streamlined species which relies on speed to catch larger fish and squid. Tuna were originally classed in the same family as mackerel (the Scombridae) but now occupy a separate family, the Thunnidae. The energetic muscle action and design of the circulatory system in the tuna allows it to maintain its temperature up to 15 degrees Celsius above water temperature.[1]

Demersal species are much less streamlined. Among these species, the group known as flatfishes have lost the ability for prolonged swimming. These species, which include the commercially important Atlantic Halibut, Winter Flounder, American Plaice and Yellowtail Flounder, as well as several less-common species, start out life resembling other species and swimming in the water, but undergo a remarkable change to enable them to assume an adult life style. The eye from one side shifts to the other, as other changes in body structure take place, enabling them to lie flat on the bottom. Flatfish also typically have a protective colour pattern on the top side (pale beneath) which matches the seabed.

One of the most unusual, although common, species is the Monkfish. Found in shallow coastal waters, this camouflaged species has a lure ressembling a small fish which it wiggles above its head and engulfs prey (which can even include sea ducks and seabirds) with its gaping mouth and razor teeth. Several species of lumpfish, lumpsuckers and snailfish (found in rocky or coarse habitats near shore or on the offshore banks) have a sucker on their ventral side for clinging to stones or shells.

Fish such as pollock are pelagic species similar in general form to cod, but they spend much of their adult life in middle layers of the ocean. They are more streamlined than wholly demersal species such as cod.

The pencil-shaped Northern Pipefish, a member of the seahorse family, is common in beds of seaweed and Eelgrass in shallow coastal waters, and even seahorses occasionally enter Nova Scotian waters. The circular mouth of the Sea Lamprey is used to attach to prey species of fish.

An extreme adaption is the elongate shape of the Sand Lance which helps the up-to-30-cm-long individuals burrow into sandy bottoms on offshore banks and nearshore areas. Sand Lance larvae are the most abundant and widespread fish larvae in the northwest Atlantic early in the year.[11]

CULTURAL FACTORS

Most of the commercial fish stocks have faced overfishing at some time or another. Many key species and stocks, the most notable being the Atlantic Cod, are in trouble. Newer fishing methods and more effective gear have time and again resulted in a cycle in which fish catch has increased to a peak, and then dropped off, with disastrous consequences for local economies.

The groundfish fisheries of Nova Scotia were important in early commerce, and one of its symbols, the *Bluenose*, was built to ply the rich fishery (also for that reason Atlantic Cod has been called "Newfoundland currency"). Fish are a staple of the Nova Scotia economy and a fishing culture encompassing a wide range of fishing techniques, traditions and seasonal activities has been in existence for centuries.

Associated Topics

T6.2 Oceanic Environments, T6.3 Coastal Aquatic Environments, T6.4 Estuaries, T11.7 Seabirds and Birds of Marine Habitats, T11.12 Marine Mammals, T12.11 Animals and Resources

Associated Habitats

H1.1 Open Water, H1.2 Benthic, H2.5 Tidal Marsh, H3 Fresh Water

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T11.15 AMPHIBIANS AND REPTILES

Plate T11.15.1: Juvenile Wood Turtle on the St. Mary's River system in Guysborough County (Unit 572). Photo: R. Merrick

The amphibians and reptiles are normally treated together as herpetofauna, although they represent two different vertebrate classes with distinct characteristics and habitat requirements. There are twenty-five species recorded from Nova Scotia, including three marine turtles[1] (see Table T11.15.1). The fauna is relatively poor when compared to adjacent mainland areas of the continent.

COLONIZATION

Post-glacial colonization occurred mainly by way of the Chignecto Isthumus (Unit 523). Distribution patterns reflect the past colonization routes, climate and habitat factors. As the climate of the area cooled at the end of the hypsithermal period, several Nova Scotia species became isolated from the main continental populations. Due to this isolation, these species tend to show a higher degree of morphological variation than is seen in continental populations. The survival of amphibians and reptiles in Nova Scotia depends heavily upon climate and available habitat for breeding and hibernation. Blanding's Turtle and Northern Ribbon Snake exhibit disjunct population in southwest Nova Scotia.

FAMILY	SPECIES	DISTRIBUTION
ORDER CAUDATA		
Ambystomatidae	Blue-spotted Salamander	Common, northern mainland and C.B. (one isolated pocket in SW)
Ambystomatidae	Yellow-spotted Salamander	Common throughout
Salamandridae	Red-spotted Newt	Common throughout
Plethodontidae	Eastern Redback Salamander	Common throughout, where woodland exists
Plethodontidae	Four-toed Salamander	Locally common
ORDER ANURA		
Bufonidae	Eastern American Toad	Common throughout
Hylidae	Northern Spring Peeper	Common throughout
Ranidae	Bullfrog	Common on mainland; no breeding population on C.B.
Ranidae	Green Frog	Common throughout
Ranidae	Mink Frog	Common throughout
Ranidae	Wood Frog	Common throughout
Ranidae	Northern Leopard Frog	Common throughout
Ranidae	Pickerel Frog	Common throughout
ORDER TESTUDINES		
Chelydridae	Common Snapping Turtle	Common on mainland; no breeding population on C.B.
Emydidae	Wood Turtle	Northern mainland/southern C.B.*
Emydidae	Blanding's Turtle	South/central mainland**
Emydidae	Eastern Painted Turtle	Mainland; no breeding population on C.B.
Cheloniidae	Atlantic Ridley	Uncommon; marine visitor
Cheloniidae	Atlantic Loggerhead	Uncommon; marine visitor
Dermochelyidae	Atlantic Leatherback	Uncommon; marine visitor (annual)
ORDER SERPENTES		
Colubridae	Northern Redbelly Snake	Common throughout
Colubridae	Northern Ribbon Snake	South/central mainland*
Colubridae	Maritime Garter Snake	Common throughout
Colubridae	Northern Ringneck Snake	Common on mainland (Atlantic lowlands); 2 localities north C.B.
Colubridae	Eastern Smooth Green Snake	Common throughout

Table T11.15.1: Distribution of Nova Scotia's amphibian and reptile species.

AMPHIBIANS

There are thirteen species of amphibians, including five salamanders and eight frogs. With the exception of the Eastern Redback Salamander, these species are dependent upon water for reproduction. There is a distinct spring or early summer mating and egg-laying period, and larval development takes place throughout the summer. Metamorphosis usually takes place from mid-to-late summer. For the tadpoles of frogs, this involves a change from aquatic herbivore to largely terrestrial carnivore. Amphibians normally spend the winter either in the soil or in bottom sediments of ponds.

Dependence on water for functions other than breeding varies between species. Among the salamanders, there is a tendency towards independence from water. Adult Blue spotted and Yellow-spotted salamanders remain in the ponds for only a few days in order to breed; the Eastern Redback Salamander

does not even breed in water, whereas the newt is mostly aquatic during its adult life. The adult Eastern American Toad, Northern Spring Peeper and Wood Frog are largely independent of water except for breeding, but the Bullfrog has a prolonged larval development and spends almost all of its adult life in the water.

REPTILES

The reptiles in Nova Scotia fall into three distinct groups: five species of snakes, four species of freshwater turtles and three species of marine turtles.

Snakes

The Northern Redbelly Snake, Maritime Garter Snake and Eastern Smooth Green Snake are found throughout the province, particularly in ecotone situations which provide shelter, food and open areas for sunning. The Northern Ribbon Snake is restricted to Queens and Lunenburg counties, in habitats along the edge of water. The Northern Ringneck Snake occurs only in the granite and quartzite areas of the Atlantic Uplands and in parts of Cape Breton.

Snakes exhibit two forms of reproduction: egg-laying and live bearing of young. The two egg-laying species, the Northern Ringneck Snake and Eastern Smooth Green Snake, require adequate nesting sites (for example, under rocks, where eggs can be laid and remain protected during development). Snakes require places in which to hibernate during the winter. None of these species is poisonous.

Freshwater Turtles

The freshwater turtles spend a large part of their time in association with water, but must come ashore to find sand or gravel banks and loose-soil situations in which to lay their eggs. The Wood Turtle often spends the daytime during summers away from water but, like the other species, must hibernate under water. Turtles are most common in mainland Nova Scotia but may have limited distributions. Painted Turtles are common in the central and southwestern parts of the province, but only a few isolated populations have been reported from the northern part of the mainland. Only the Wood Turtle occurs naturally in Cape Breton Island. Common Snapping Turtles are common in mainland Nova Scotia; those recorded in Cape Breton are believed to be introductions.

Marine Turtles

Three marine turtle species have been recorded as summer visitors in Nova Scotia waters: Atlantic Ridley, Atlantic Loggerhead and Atlantic Leatherback. It is the Atlantic Leatherback that is usually brought to the attention of the public because of its large size. It is also the only "regular" summer visitor of the three. They breed in the tropics. The Leatherback is listed as endangered under COSEWIC.

SPECIAL FEATURES

1. Some species of reptiles are considered vulnerable to disturbance and require protection because of restricted distribution and particular habitat requirements.[2] The Blanding's Turtle is recognized under COSEWIC as a threatened species in Nova Scotia.[3] The Wood Turtle, which occurs in some watersheds in northern mainland Nova Scotia and Cape Breton, is vulnerable during early development, and especially during adult life, when specimens are taken as pets and later released away from the main breeding populations. Marine turtles are protected in their breeding sites in the tropics but not when they enter Nova Scotian waters as adults. Specimens caught in fishing nets are not normally released in sufficient time to survive. Blanding's and Wood Turtles may not reproduce until age twenty. It is difficult for populations to recover from any unnatural loss of adults.
2. Several species show interesting morphological variation within populations. Of particular interest are the dark or melanistic variety of the Maritime Garter Snake, colour-pattern variation on the Northern Ringneck Snake, triploid individuals of the Blue-spotted Salamander and the erythristic (all red phase) Eastern Redback Salamander.[1]
3. A goldfish pond at Mount St. Vincent University, Halifax is being transformed into an amphibian pond as a project under DAPCAN (Declining Amphibian Populations in Canada). The project was initiated under IUCN (International Union for the Conservation of Nature and Natural Areas) to monitor species' response to environmental changes such as global warming.[4]

CULTURAL FACTORS

The availability of breeding ponds close to woodland habitats is the most important ecological consideration for amphibians. The construction of isolated ponds and ditches has been of great benefit to amphibians, since the larval development can proceed at a faster rate in the warm, shallow water and there is only limited predation by fish.

The ditches created by road construction are small and shallow, and amphibian breeding and egg development is rapid.

The car becomes the population's predator on rainy nights when amphibians are active, and when adults migrate to ponds in spring and the young disperse from the ponds in late summer.

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Associated Topics

T4.1 Post-glacial Climatic Change, T4.3 Post-glacial Colonization by Animals, T8.2 Freshwater Environments, T8.3 Freshwater Wetlands

Associated Habitats

H3 Fresh Water, H4 Freshwater Wetlands

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2 Gilhen, J. and F. Scott (1981) Distributions, Habitats and Vulnerability of Amphibians, Reptiles, and Small Native Mammals in Nova Scotia. Nova Scotia Museum, Halifax. (*Curatorial Report* No. 45).

3 Herman, T.B., T.D. Power and B.R. Eaton (in press) "The status of Blanding's Turtle (*Enydoida blandingi*) in Nova Scotia." *Can. Field Nat.*

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The temperature in which eggs incubate is determined by the microclimate of an area and will influence the sex of hatchling turtles. Higher temperatures tend to produce more males. A dramatic change in climate, which would have an effect on the microclimate, could create an imbalance in sex ratio.

Additional Reading

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T11.16 LAND AND FRESHWATER INVERTEBRATES

The most diverse and numerous group of animals, the invertebrates, form a biological community more complex in species numbers and relationships than any other terrestrial community. Invertebrate animals are located nearly everywhere and consequently serve very important functions in the ecosystems which they inhabit. Invertebrates are responsible for the pollinating of many flowering plants, the leading consumers of vegetation, initiators of successional trends, the leading consumers of other invertebrates, recyclers of dead organic material, regulators of element cycles, turners of the soil, and food for higher animals. However, they are generally least fully studied, mainly due to the large number of species involved as well as their small size and obscure habitats, particularly those that inhabit the soil or bottom sediments of lakes and ponds.

In general, their roles can often be demonstrated without species identification. However, species and often life-stage identification, is necessary in cases such as parasitic infection, defoliation of trees, or where detailed environmental studies are required. Many insect species have complex life cycles, with distinct larval forms occupying a completely different habitat from that occupied by the adults. In order to make the correct associations between larva and adult, it is often necessary to observe the animals in all stages of their life cycle.

The invertebrates are generally categorized as insects, other arthropods and other invertebrates. Land and freshwater invertebrates share many characteristics and some species are associated with both terrestrial and aquatic habitats.

Representatives of most land and freshwater invertebrate groups are known to occur throughout the province; however, a comprehensive list of species is not available at present. Much of the information on the biology of invertebrates found in Nova Scotia has been drawn from scientific studies conducted elsewhere. *(Enlargements or reductions in the figures are approximate).*

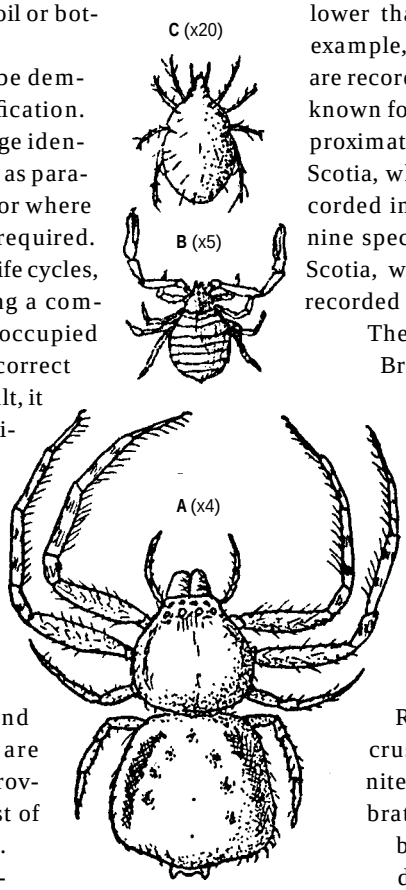

Figure T11.16.1: Examples of arachnids. The Crab or Flower Spider **A** feeds on insects. The Pseudoscorpion **B** often feeds on mites **C**, which may be decomposers or carnivores.

DIVERSITY

A general review of the collections of the Nova Scotia Museum and some published lists suggests that there are more than 15 000 species of land and freshwater invertebrates in Nova Scotia.

The insects have the most species, followed by the arachnids (spiders, mites and allies)[2] (see Table T11.16.1). Very little is known about the phyla, Protozoa through Nematoda. The low numbers generally reflect a lack of systematic study.

Nova Scotia's location and the narrowness of the Chignecto Isthmus have been, and are, a barrier to the easy natural spread of plants and animals into the province. The number of species in the province is lower than in other areas in Canada. For example, only seventeen species of rotifers are recorded, although some 362 species are known for Canada as a whole. There are approximately 13 000 species of insects in Nova Scotia, whereas there are 25 000 species recorded in Ontario. Similarly, there are only nine species of freshwater mussels in Nova Scotia, whereas there are forty-six species recorded from eastern Canada.

The insects, mites and spiders of Cape Breton Highlands National Park (Region 100) have been studied by the staff of the Biosystematics Research Centre in Ottawa.[1] The numbers recorded may reflect the probable numbers of species across the province.

DISTRIBUTION OF NATIVE SPECIES

Records of molluscs, freshwater crustaceans and insects indicate definite distribution patterns of invertebrates in Nova Scotia. There appears to be a close relationship between the distribution of species and the distribution of various elements of the flora. Food plants and climate, as well as other habitat factors, are important for all species, including many flying insects which, although

Group	Approximate Number of Species
Protozoa	?
Porifera (sponges)	10
Cnidaria	2
Platyhelminthes - *Turbellaria* (flat worms)	3
Platyhelminthes - Cestoda (tape worms)	2
Platyhelminthes - Trematoda (flukes)	?
Rotifera	17
Nematomorpha (hair and ribbon worms)	1
Nematoda (round worms)	?
Mollusca - Gastropoda (snails, slugs)	80
Mollusca - Bivalvia (clams, mussels)	18
Oligochaeta (earthworms, etc.)	15
Hirudinea (leeches)	19
Diplopoda (millipedes)	10
Chilopoda (centipedes)	10
Insecta - Lepidoptera (moths, butterflies)	2,000
Insecta - Diptera (flies)	2,500
Insecta - Coleoptera (beetles)	2,500
Insecta - Hymenoptera (bees, wasps, ants)	2,500
Insecta - Hemiptera (bugs)	1,500
Insecta - other orders	2,000
Arachnids (spiders, ticks, mites)	2,500
Crustacea (water fleas, sowbugs, etc.)	more than 60

Table T11.16.1: Approximate numbers of invertebrate species recorded or estimated for land and freshwater habitats in Nova Scotia.

capable of wide distribution, are limited by the requirements of their aquatic larval stages.

Many species are common and ubiquitous, such as the freshwater amphipod *Hyalella azteca*, the land snail *Zonitoides arboreus* and the Libellulid Dragonfly *Libellula quadrimaculata*. Other species, however, show limited distributions which reflect their mode of colonization. The freshwater isopod crustacean *Caecidotea communis* has its main population in southwestern Nova Scotia, with pockets in the Sydney River in Cape Breton.

The polygyrid land snails *Mesodon sayanus* and *Stenotrema fraternum*, found in Cumberland County (Unit 523), are examples of colonization across the Chignecto Isthmus land bridge.[3]

The original post-glacial (late Pleistocene) fauna that occupied Nova Scotia was gradually displaced by the fauna of adjacent areas. There are no large Arctic–Alpine habitats left in Nova Scotia; however, there are species of butterflies and freshwater crustacea[4] with arctic affinities that can still be found in bog and barren habitats along the Atlantic Coast (Region 800) and in the Cape Breton highlands (Region 200).

Some species are limited by the range of habitat or availability of host species. The southern pine/hemlock forest and oak forests each has its own

distinct Lepidoptera species. Many of these Acadian forest species do not extend into the spruce and fir forests, which have a characteristic boreal fauna of their own.[5]

Some species of dragonfly and damselfly oviposit in plant tissue. In some instances, they employ dead plant material, such as floating or standing dead wood in other living plants, usually floating emergents such as *Potamageton* or edge-growing species such as *Myrica gale*. The presence of suitable plants for ovipositing may, in part, dictate the distribution of some species of damselfly. The species of insects that inhabit the upper levels of salt marshes and other seashore habitats are fairly distinct and are often found on both sides of the Atlantic.

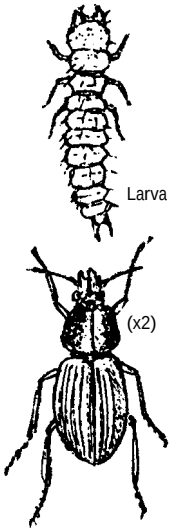

Figure T11.16.2: Carabid Beetle. There are more than 200 species of carabid or ground beetle recorded in Nova Scotia. Many were introduced in ship's ballast.

INTRODUCED SPECIES

Many species were introduced in ships' ballast, by the importation of plants for agriculture and horticulture, and transshipment of goods since at least the seventeenth century (see Figure T11.16.2). These species arrived as land was cleared for agriculture and development, activities which caused the destruction of native habitats and their associated soils, and the decline of native species. The province's history of human colonial settlement and its geographic isolation has 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, six of which 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 native forest habitats. More than twenty per cent of all terrestrial mollusc species of Nova Scotia are introduced[3]. (see Figure T11.16.4).

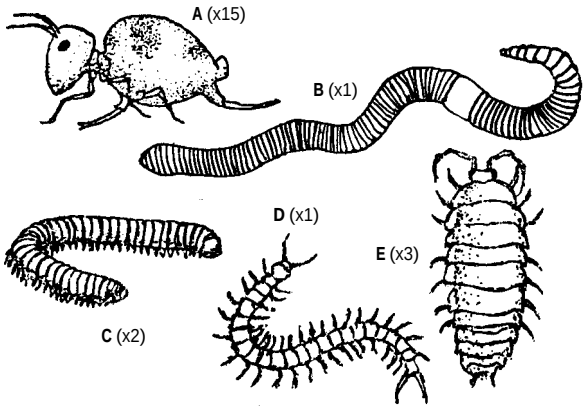

Figure T11.16.3: A: Springtail; **B**: Earthworm; **C**: Millipede; **D**: Centipede; Sowbug. These invertebrates inhabit the soil surface, acting as decomposers in the leaf litter.

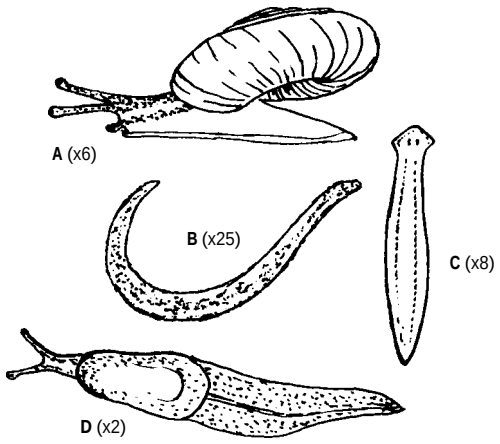

Figure T11.16.4: A: Snail; **B**: Nematode; **C**: Flatworm; **D**: Slug. Soil meso- and microfauna and flora are essential components of the detritus food web and important in the maintenance of good soil conditions (see T9.3). They convert organic material into forms available for plant use and regulate the rate of element cycles, and ultimately ecosystem productivity.

Earthworms, ground beetles, click beetles, sow or cellar bugs, centipedes, and millipedes are introduced species commonly found in gardens (see Figure T11.16.3). Familiar urban invertebrates include cockroaches, bedbugs, carpet beetles, flour beetles, clothes moths, flour moths, earwigs, fleas, lice, houseflies and booklice.

Species are often introduced without the accompanying diseases, parasites and predators which keep the populations in check. They can multiply rapidly and gain the reputation of being pests. In Nova Scotia species such as the Winter Moth, Birch Casebearer, aphids, scale insects and sawflies are notorious for damage to trees and shrubs.[6]

INSECTS AND PLANTS

Insects interact with plants in many ways. They play an important role in the pollination of flowers, not only in orchards but also in other agricultural areas and, especially, in the wild (see Figure T11.16.4).

Spruce Budworm (*Choristoneura fumiferana*) caterpillars feed upon the young shoots of fir and spruce trees, causing severe growth retardation and possibly death. The occurrence of high-level populations is cyclic and in a natural system would be controlled by predators, parasites and diseases. The natural forty-year cycle of the Spruce Budworm is disrupted by forest-management practices, which maintain artificially high populations of insects poised for reinfestation, perpetuating the infestation stage of the cycle.

Other moth larvae, such as the White-marked Tussuck (*Orgyia leucostigma*) and Forest Tent Cater-

pillar (*Malacosoma disstria*), periodically defoliate hardwoods in certain areas of the province. Many trees are killed by successive infestations; however, the effects on forest habitats are short lived.

Dutch Elm disease is a fungal parasite which is transmitted by the native Elm Bark Beetle (*Hylurgopinus rufipes*). The larvae develop under the bark of dead branches, and the adult feeds on the bark of young shoots. The beetle carries the spores from one tree to another. The disease has been spreading for many years and has killed most of the native elms in some parts of rural Nova Scotia (see T10.2).

The Beech Scale (*Cryptococus fagisuga*) is an introduced insect responsible for the spread of beech bark disease (see T10.1). Galls, such as oak apples, mossy rose galls, willow pine galls, and a great variety of often colourful growths on leaves and stems of plants, are caused by insects. The galls form in response to a chemical released by the developing larvae of gall flies (Cecidomyidae) or gall wasps (Cynipidae). The larvae feed throughout the summer and overwinter in the galls, emerging as adults the following spring.

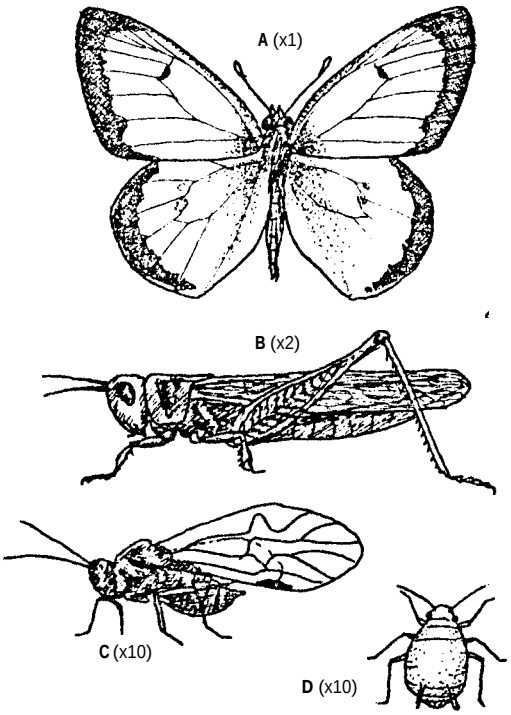

Figure T11.16.5: **A**: Butterfly; **B**: Grasshopper; **C**: Adult Winged Aduly Aphid; **D**: nymph. The niche of herbivore in land and freshwater ecosystems is largely occupied by insects, particularly the grasshoppers, leaf hoppers, leaf bugs, aphids, leaf beetles, sawflies, and larval stages of butterflies and moths. Many species are specific to certain plants, and this characteristic may cause concern when these plants are agricultural crops or commercial forest trees.

The fifteen species of Lumbricid earthworms, familiar to many people as "night crawlers", are all introductions. They live mainly in cultivated land but have also invaded second-growth forest and other habitats.

The Cinnabar Moth *Tyria jacobaeae* was introduced at Northwest Margaree in the early 1960s and in 1963 at Durham, Pictou County.[7] The gregarious, black-and-yellow-banded caterpillars completely destroy their food plants, Ragwort, and are considered to be a positive biological-control agent. The handsome, black-and-red moths are now abundant in Cape Breton and northern mainland Nova Scotia, wherever Ragwort, a plant poisonous to cattle, is most common.

SOIL INVERTEBRATES

Many important aspects of terrestrial ecology and zoogeography relate to soil fauna. Soil fauna includes burrowing mammals and amphibians. The majority of species, however, are minute invertebrates. The main groups include protozoans, flatworms, nematodes, rotifers, lumbricid and enchytraeid worms (oligochaetes), snails and slugs (molluscs), tardigrades, crustaceans, arachnids, insects and other arthropod groups. Some soil invertebrates have close affinities with aquatic invertebrates, such as worms and crustaceans, and as a result are restricted to water film in soil pores. Lack of water in the soil because of drought or disturbance can be detrimental to these organisms. Other soil fauna are confined to the air spaces.

Many of these invertebrates are very small and constitute the soil meiofauna. The great diversity of these species inhibits easy identification. The Nematoda, which inhabit the water film, include some 2000 species on a world-wide basis; a sample of one cubic decimetre (about sixty cubic inches) of forest soil could contain as many as 30 000 individuals.

Forest soil generally contains a greater number and diversity of soil fauna than agricultural soil. For example, the species of mites in an area of pasture soil may be less than half of the number and diversity found in an area of equal proportion in coniferous-forest soil.

Further studies of soil fauna could reveal important details of changes in soil character during forest succession. The invertebrates of old-forest soils and caves could also provide insight into the origin of the Nova Scotia fauna.

FRESHWATER INVERTEBRATES

Many species are considered to be freshwater invertebrates although they inhabit fresh water only during certain stages of their development (e.g. mayfly nymphs). Some terrestrial invertebrates also inhabit fresh water during their larval stage (see Figure T11.16.6). Although the adults of some insects, such as waterbugs and water beetles, may be aquatic, only the larval stage of most species inhabits fresh water. This larval development is usually the longest phase of the insect's life cycle. The adult flying stage is usually much shorter and is primarily for mating and dispersal. The larvae of caddisflies (Trichoptera), blackflies and Chironimids (Diptera), as well as mayfly nymphs (Ephemeroptera), stoneflies (Plecoptera), dragonflies and damselflies (Odonata) are the most common groups of insects found in most freshwater habitats. All of these represent a very important food source for many other invertebrates, fish, amphibians, reptiles and birds.

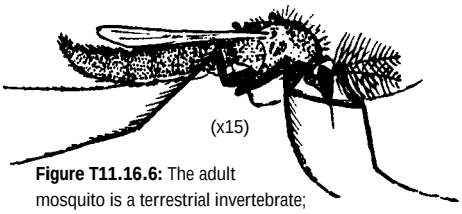

Figure T11.16.6: The adult mosquito is a terrestrial invertebrate; however, the larval stages occur in fresh water.

A number of recent studies have been carried out to determine the species distribution of benthic invertebrates in Nova Scotia streams.[4,8,9] This research has identified thirty-seven species of mayflies, approximately thirty species of stoneflies and about 100 species of caddisflies in the Medway River and the Gold River. These were then divided into distinct groups, based on geographic distribution and tolerance to acidic stream conditions. Mayfly populations were determined to be most affected by acidity, while stoneflies were the least influenced.[10] In addition, a comprehensive species list of dragonflies and damselflies found in Nova Scotia is at present being compiled with a total of 101 species identified in collections to date.[11]

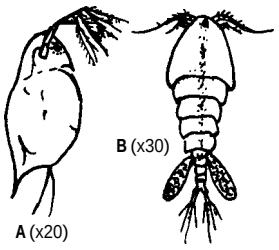

Figure T11.16.7: Both the *Daphnia* **A** and the *Cyclops* **B** are active swimmers in open water and often become food for other invertebrates.

Nova Scotia has a great number of lakes, ponds, rivers, streams, marshes and bogs which provide varied habitats for freshwater animals. Water-quality factors, such as pH, are influenced by the geology and soil conditions, as well as atmospheric input, and directly affect the abundance and diversity of species present in any aquatic habitats. Peterson determined that, although certain areas of Nova Scotia have probably been historically acidic due to high concentrations of organic acids, pH currently limits the distributions of many indigenous invertebrate species.[10] These species may also be vulnerable to the more recent influences of "acid rain". Many aquatic species, particularly molluscs with calcareous shells, are not found in waters with high acidity levels. Populations of acid-tolerant organisms, including many insect species, tend to be relatively low, due to the dystrophic waters characterized by low pH (Region 400). In waters with a comparatively high pH, the size and diversity of invertebrate populations are usually much greater (Region 500).

The conspicuous invertebrate fauna is largely composed of insects; however, many other species including crustaceans, arachnids, gastropod and bivalve molluscs, leeches, oligochaete worms, flatworms, coelenterates and sponges are also present in most freshwater habitats. Microscopic communities inhabit open water in lakes and rivers, as well as the bottom mud. These organisms, known as primary consumers, form a link between the primary producers (i.e., plants) and the secondary consumers, such as fish, and they are essential to the survival of the ecosystem (see Figure T11.16.7).

Open -water Invertebrates

The majority of planktonic animals (zooplankton) are herbivores that feed mostly on the microscopic algae (phytoplankton) (see T10.9). The dominant species are two groups of crustaceans: the cladocerans and the copepods. These small animals are significant since they provide a vital food source for numerous other animals, including many species of fish. Rotifers are also microscopic creatures which are usually found attached to vegetation near the shore. Some of the larger open-water species can be seen with the naked eye (see Figure T11.16.8).

Cladocerans (water fleas) are the best known of all the planktonic herbivores. All species extract food, usually algae, from the water by rapidly beating the tiny hairs or setae attached to their legs. These animals can often produce offspring without males being present. The eggs are laid in a pouch on the back of the female and develop into copies of the adult before being released. The most widespread species observed in Nova Scotia include *Bosmia longirostris,*

Holopedium gibberum and *Daphnia catawba.*

Copepods are comprised of three groups: the calanoids, which are usually herbivorous; the cyclopoids, which are mainly carnivorous; and harpacticoids, which live in the margins of freshwater habitats, often in damp moss and wet leaves. Some cyclopoids have become external parasites, a condition which may have derived from holding on to small fish in order to feed off the surface of their body. Other copepod species, such as *Diaptomus* and *Cyclops,* are host for the first larval stage of the Fish Tapeworm *Dibothriocephalus latus.*

The eggs of copepods hatch into larvae known as nauplii. Copepods are less adaptable than cladocerans to environmental changes, and therefore are usually less abundant. The most prevalent species found in the province include *Diaptomus minutus, Mesocyclops edax* and *Tropocyclops prasinus.*

Rotifers are tiny animals that possess a crown of cilia around their mouths for locomotion as well as feeding purposes. Like cladocerans, rotifers can reproduce asexually. Populations can fluctuate greatly according to the food supply, sometimes going from levels of tens to hundreds per litre in less than a week. Some of the frequently observed rotifers in Nova Scotia waters include *Keratella taurocephala, Keratella cochlearis* and *Kellicotia longispina.*

The community of plant and animals which is attached to or moves about on submerged surfaces is often described by the German word Aufwuchs. They may be found clinging to stems or leaves of rooted plants or other surfaces projecting above the bottom.

Edge-vegetation Invertebrates

Freshwater invertebrates are most abundant in the vegetation at the edges of ponds, lakes and slow-moving streams (see H3.5, H3.6). In addition to supplying a food source for many herbivores, plants in the hydrosere provide a link between the bottom and the surface which is essential for many air-breathing molluscs and emergent insects (e.g., dragonflies). A large number of the animals that occupy this habitat feed on a layer of living material that accumulates on leaves and stems. The submerged surfaces of plants are often heavily colonized by invertebrates, with the total surface area usually much greater than the area of the lake bottom.

Leeches are generally found in most freshwater habitats and may either be predatory or parasitic on many small animals. Nineteen species have been recorded for the province.[13] Among the most common is the medicinal leech *Macrobdella decora,* which frequently attaches itself to swimmers.

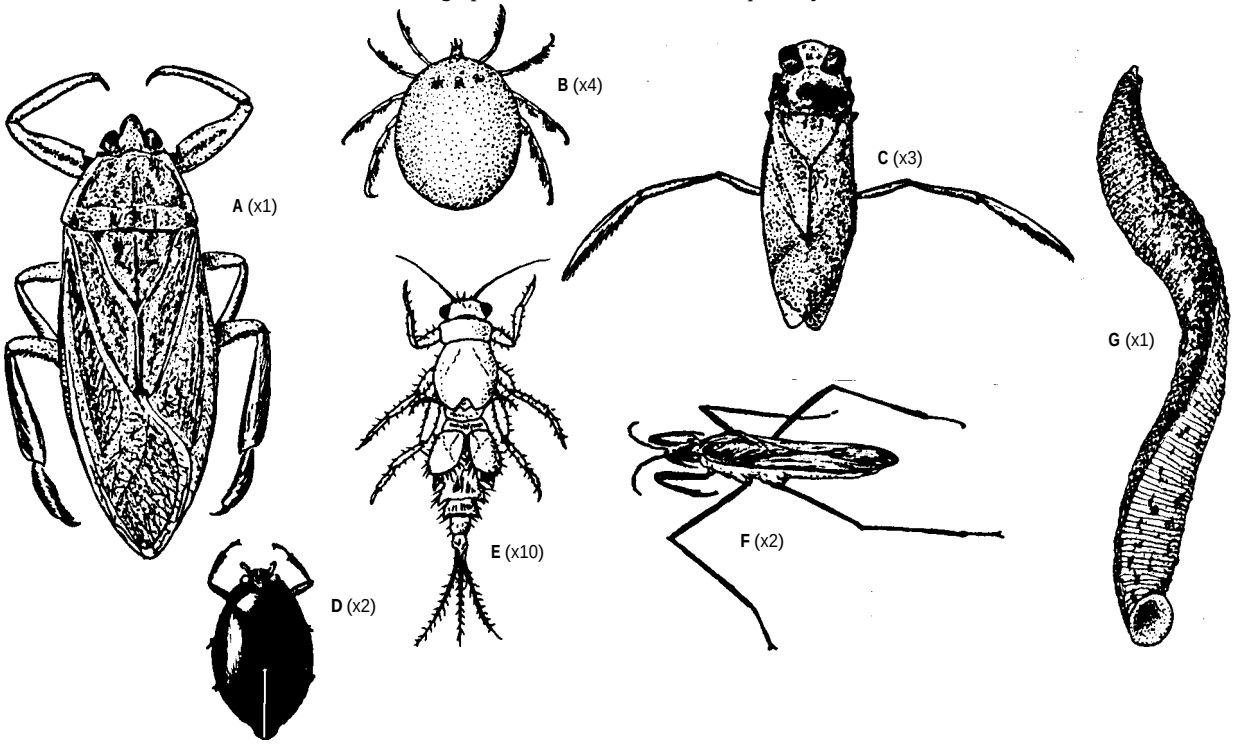

Figure T11.16.8: Examples of open-water and edgewater vegetation invertebrates. **A**: Giant Waterbug; **B**: Water Mite; **C**: Backswimmer; **D**: Whirligig; **E**: Mayfly nymph; **F**: Water Slider; **G**: Leech. Edge vegetation creates a calm-water environment offering protection to a variety of invertebrates. Some, like the Backswimmer and the Giant Waterbug, swim freely among the vegetation; others, like the Mayfly nymph, are associated with the surface vegetation.

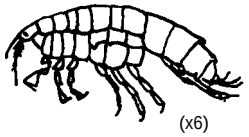

Figure T11.16.9: Benthic organisms are important because they consume decaying organic material and provide a primary food source for larger bottom-dwelling animals, mainly insect larvae and crustaceans such as the amphipod *Hyalella*.

Benthic Invertebrates

Microscopic benthic animals, sometimes called meiofauna, inhabit the bottom sediments of most lakes and slow-moving streams (see H3.3 and H3.4) and include many species of crustaceans, rotifers, nematodes and protozoans.

One of the most common group of molluscs are pond snails (gastropods), which scrape periphyton (attached microflova) with their tongues for food. The relative abundance of snails is often an indicator of 'hard- or-soft-water'. Snail shells are composed of calcium carbonate. Snails are usually more plentiful in hard water, which contains high levels of dissolved minerals. Eleven freshwater-snail species have been recorded for the province, of which the Ramshorn Snail *Menetus dilalatus,* is considered rare.[12] Freshwater mussels are important filter feeders and are usually the largest members of the lake ecosystem to feed directly on microscopic algae. Ten species of mussels are known to exist in Nova Scotia.[13] One rare species, the Yellow-lamp Mussel *Lampsilis cariosa*, has been found only in the Sydney River area within Nova Scotia. Mussels are of great biological interest, as their larvae are parasitic on freshwater-fish species.[14] Smaller bivalves known as pea clams *Pisidium sp*. are also frequently found, sometimes in large numbers. Pea clams have been found in acidic lakes (with pH of 4.6.)[4] (see Figure T11.16.10).

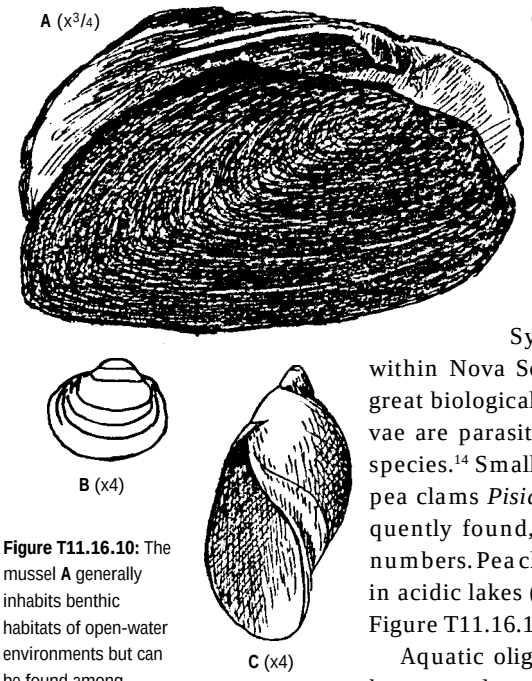

Figure T11.16.10: The mussel **A** generally inhabits benthic habitats of open-water environments but can be found among plants. The pea clam **B** is generally found among plants but may also be found in open-water situations. The Tadpole Snail **C** is found in a variety of freshwater habitats.

Aquatic oligochaete worms have been poorly studied in Nova Scotia but may play a significant role in the ecology of freshwater habitats. One of them, *Tubifex*, is an indicator of organic pollution and poor oxygenation conditions. This worm has red haemoglobin in its blood which helps trap oxygen[15]. (see Figure T11.16.11).

Adaptations

In harsh environmental conditions, such as exposure to waves in lakes or fast-flowing currents in streams, the number of invertebrates is substantially reduced. Certain animals which do inhabit these areas have adapted for their survival. Blackfly larvae and caddisfly larvae have special adaptations which enable them to become attached to rocks in fast water (see Figure T11.16.12). Other insects live under and behind rocks in fast water or burrow in gravel.

Other species, such as snails, have adapted to living in temporary ponds which may dry up completely during the summer. Reproduction and development must be completed before the habitat becomes too dry. Depending on the species, the adults, eggs or larvae will then estivate (i.e., exist in a dormant state during the summer) in the bottom sediment until conditions improve.

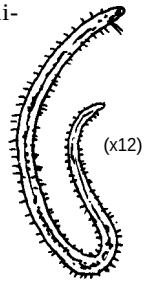

Figure T11.16.11: Aquatic oligochaetes are sometimes referred to as aquatic earthworms. They have the same fundamental structure as the common terrestial earthworm.

RARE SPECIES

Knowlege of the distribution of invertebrate species is incomplete, making it difficult to distinguish and justify rarity. In a provincial context, the preservation of representative habitats should adequately protect the soil and freshwater invertebrates, including those species not yet discovered and identified. Particular attention should be paid to the fauna of soil in old, mature forests, which is the main habitat for the undisturbed native fauna.

Two species of freshwater mollusc native to eastern North America are considered rare (a disjunct population) in a Canadian context. These are the Ramshorn Snail (*Menetus dilatatus*) from Atlantic coast waters and the Yellow-lamp Mussel *Lampsilis cariosa*, which occurs in the Sydney River and in New Brunswick.

Most of our rare native species are found in Cape Breton. For example, the Bog Horsefly (*Haematopota rara*) recently discovered on the Big Barren near Middle River, Cape Breton Island (District 210), was

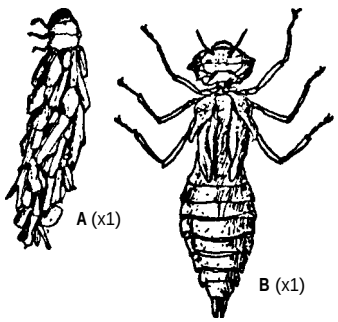

Figure T11.16.12: Caddisfly **A** and dragonfly **B** nymphs. Macromid dragonfly nymphs may have extremely long legs for gripping in high currents or compressed bodies to counteract the effects of strong currents.

previously known from only sixteen specimens collected in New Jersey, Pennsylvania and Ohio. *Syngrapha surena*, a moth, is also common on the Big Barren, though rarely encountered elsewhere. This moth, rare in collections, is also found in northern Ontario, Quebec, Labrador and Newfoundland. *Oeneis jutta*, an arctic butterfly, is found among Black Spruce trees at the margins of bogs near Mount Uniacke. Two other butterflies, rare in collections, are found in southern Nova Scotia: *Incisalia lanoraiensis* at Gold River and Bridgewater, in Lunenburg County, and *Erora laeta* in Armdale, Halifax County, and at Digby.[16]

Special Features

1. There are no known endemic invertebrate species on mainland Nova Scotia. There are endemic subspecies, however, the best known being the Short-tailed Swallowtail Butterfly (*Papilio brevicauda bretonensis*), which occurs only in northern Cape Breton Island and in Newfoundland, though its food plant, Scotch Lovage, is found on coasts around the province.

2. There is an increasing amount of evidence to suggest that Sable Island was a glacial refugium for many species of invertebrates which failed to return to, or survive on, the mainland. So far, two species of moths, *Agrotis arenarius* and an undescribed *Papaipema sp*., and a beetle, *Pyrrhalta sablensis*, have been discovered. Several subspecies and unusual forms of moths have been collected, though only one, *Orgyia leucostigma sablensis*, has been named.[17]

3. The Common Green Darner *Anax junius* is a migratory dragonfly species which flies from the New England states (and possibly New Brunswick) to Nova Scotia every year. There is also evidence of nymphs emerging in the province, and hence the possibility that the species also overwinters in the nymphal stage. The species has been recorded from Cape Breton and Sable islands but not from Newfoundland; Nova Scotia may be at the northern limit of its range.

4. There are two species of dragonfly and one of damselfly which appear to have disjunct or highly limited distributions within the province. *Libellula incesta* is recorded from Kejimkujik National Park and South Milford in the Atlantic interior, and from River Hebert in Hants County (Region 400).[18] *Libellula luctuosa* is recorded only from Mount Uniacke. *Calopteryx amata* is only known from certain rivers in Cumberland and Hants counties.[11]

5. The American Dog Tick, an unwelcome immigrant from the eastern United States, arrived in southwestern Nova Scotia during the 1930s and '40s. At present, the main population is confined west of Highway 12 between Chester Basin and Kentville, with isolated outbreaks occurring as far east as Glace Bay, wherever gravid females have dropped off their hosts, principally dogs, into suitable terrain. All stages in the life history are ectoparasites, feeding on the blood of a series of hosts, mainly mice, to which they become attached for short periods of time.

Associated Topics

T4.3 Post-glacial Colonization by Animals, T8.2 Freshwater Environments, T9.1 Soil-Forming Factors, T9.3 Biological Environment, T11.18 Rare and Endangered Animals, T12.11 Animals and Resources

Associated Habitats

H2.5 Tidal Marsh, H3 Fresh Water, H4 Freshwater Wetland, H5 Terrestrial Unforested, H6 Forests

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T11.17 MARINE INVERTEBRATES

This Topic deals with the occurrence of marine invertebrates in Nova Scotia waters. The marine environment includes the diverse intertidal habitats (H2.1–H2.5), the ocean bottom (H1.2) and water of the open sea (H1.1). Common species are included in the habitat descriptions.

The Canadian Atlantic marine fauna is generally well known, since it has been studied for more than a century. Early studies have been listed by Whiteaves in his catalogue of the marine invertebrates of the region.[1] Significantly more effort has been expended on studies in intertidal and shallow nearshore habitats than in offshore areas. Marine research in Atlantic Canada has always had a strong relationship with fisheries, and to a great extent the study of invertebrates and marine plants for their own sake was neglected. In recent years, however, much new information has been obtained through the efforts of universities and government research agencies. This reflects the realization that all commercial species interact with other species to maintain balanced ecosystems.

DIVERSITY

Nearshore marine areas include the Atlantic Coast (Region 800, Units 911, 915), Bay of Fundy (Regions 600, 700, and Units 912, 913) and the Gulf of St. Lawrence (Region 500, Unit 914). The Bras d'Or Lakes (District 560, Unit 916) form a distinct inland marine area. Within each area there is a wide range of habitats, and consequently the fauna is diverse (see Figure T11.17.1).

A general review of the literature indicates that there are approximately 1600 species present in the fauna, of which at least 400 spend some stage of their life as plankton. Table 11.17.1 lists the main groups with the approximate number of species. In several cases, the species numbers are considered to be conservative.

GROUP	APPROXIMATE NUMBER OF SPECIES
Protozoa (Foraminifera, Radiolaria)	Less than 300
Porifera (sponges)	400
Cnidaria (medusae, hydroids, sea anemones)	100
Platyhelminthes (flat worms, flukes)	Less than 20
Nemertea	10
Aschelminthes	Less than 30
Bryozoa and Brachiopoda	30
Polychaeta (Bristleworms)	300
Oligochaeta and Hirudinea (Leeches)	Less than 10
Lower crustacea (copepods, barnacles)	200
Malacostraca (shrimp, crabs)	200
Pycnogonida (sea spiders)	20
Mollusca (snails, clams, squid)	150
Echinodermata (starfish, sea urchins)	70
Chordata (salps, tunicates)	40

Table T11.17.1: Approximate number of species of marine invertebrates recorded from Canadian Atlantic waters.

DISTRIBUTION

The fauna of the Atlantic Coast of North America can be subdivided into regions influenced largely by water temperature: subarctic, boreal, temperate, and tropical. The temperate region, which lies largely south of Cape Cod, is divided into two provinces: Virginian and Carolinian. The Caribbean province lying to the south is tropical (Figure T11.17.2).

Although Nova Scotia lies completely within the boreal region, the local fauna has associations with all of the regions mentioned due partly to the nature of post-glacial colonization (see T4.3).

Subarctic Fauna

The subarctic fauna is found along the Atlantic coast as far south as northern Labrador, but during the last glacial period it extended along the edge of the ice sheet as far south as Cape Cod. The subsequent withdrawal of cold water and asso-

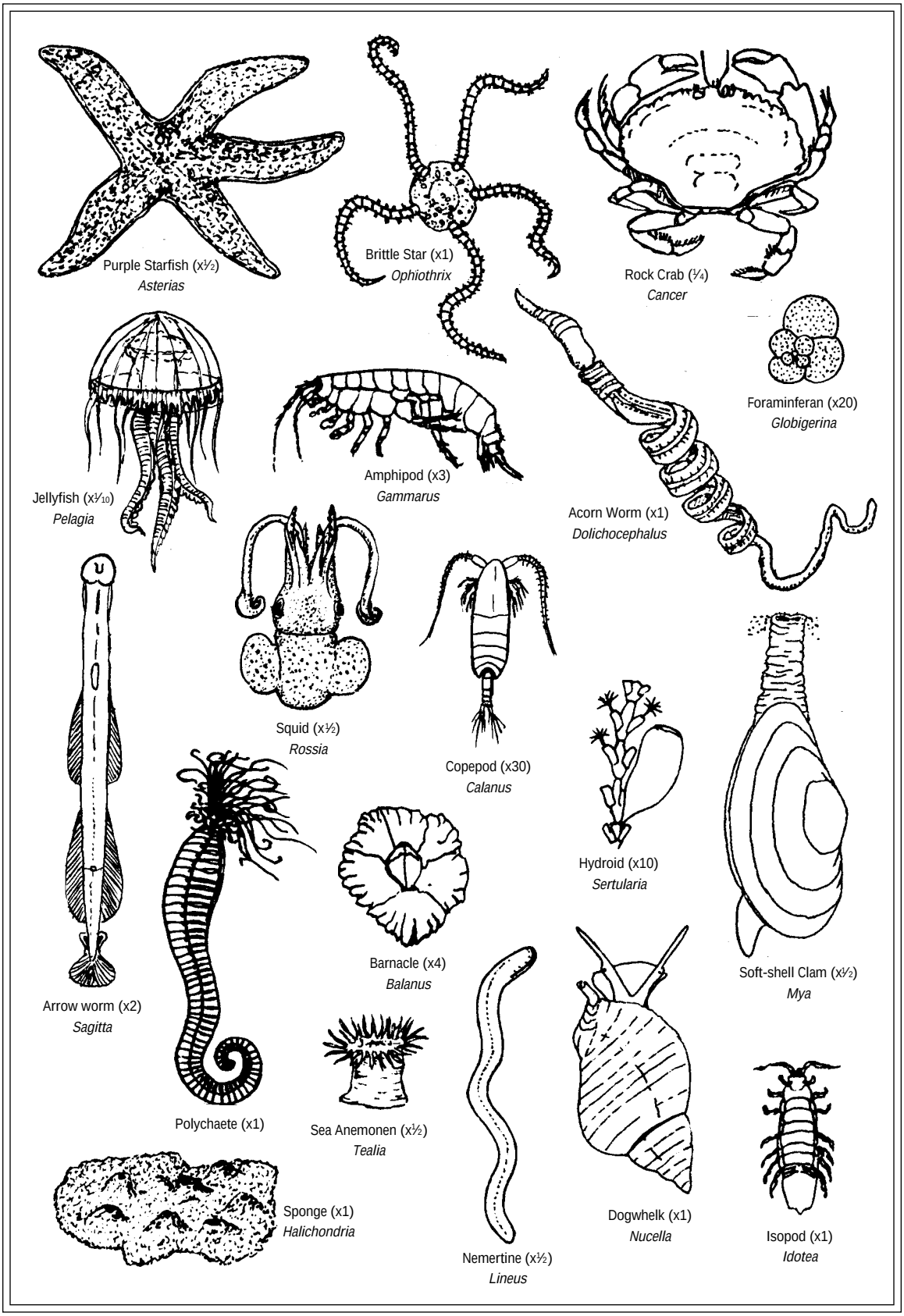


Figure T11.17.1: Examples of marine invertebrates found in Nova Scotia waters (note: enlargements or reductions are approximate).

ciated fauna to the north left small residual pockets in the Bay of Fundy, northern and southwestern Cape Breton (Districts 590, 860, 870) and the St. Lawrence estuary. An example of subarctic indicator species is the Mysid Shrimp, *Mysis gaspensis* (see Figure T11.17.3).

Boreal Fauna

The cold-water fauna dominates the region, especially in exposed situations and in offshore areas. The majority of the characteristic species of rocky shores, benthic habitats and plankton belong to this group. The Sand Dollar (shown in Figure T11.17.4) occurs from just below low water down to 150 m on sandy bottoms. Many cold-water species occur at depth at the southern end of their ranges (see Figure T11.17.4).

Temperate Fauna

During the post-glacial hypsithermal period, warm water extended northwards along the coast and adjacent continental shelf and into the Gulf of St. Lawrence. At this time, a warm-water fauna characteristic of the Virginian province of the temperate region occupied the Nova Scotia shoreline. As the temperature cooled towards the present, the warm-water fauna was largely replaced by a boreal fauna. However, the temperate fauna remains in shallow-water areas of the southern Gulf of St. Lawrence (District 520, Unit 914) and Minas Basin (Unit 913), with pockets in the Bras d'Or Lake and in the bays of the Atlantic coast (Units 833, 911).

The controlling factor for survival of this "oyster bed" fauna is a summer water temperature in excess of 20°C. The distribution of the American Oyster is

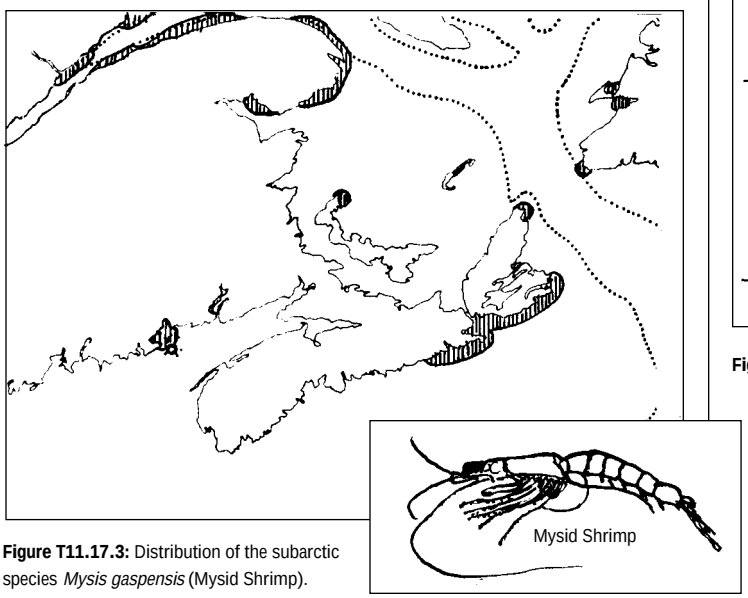


Figure T11.17.3: Distribution of the subarctic species *Mysis gaspensis* (Mysid Shrimp).

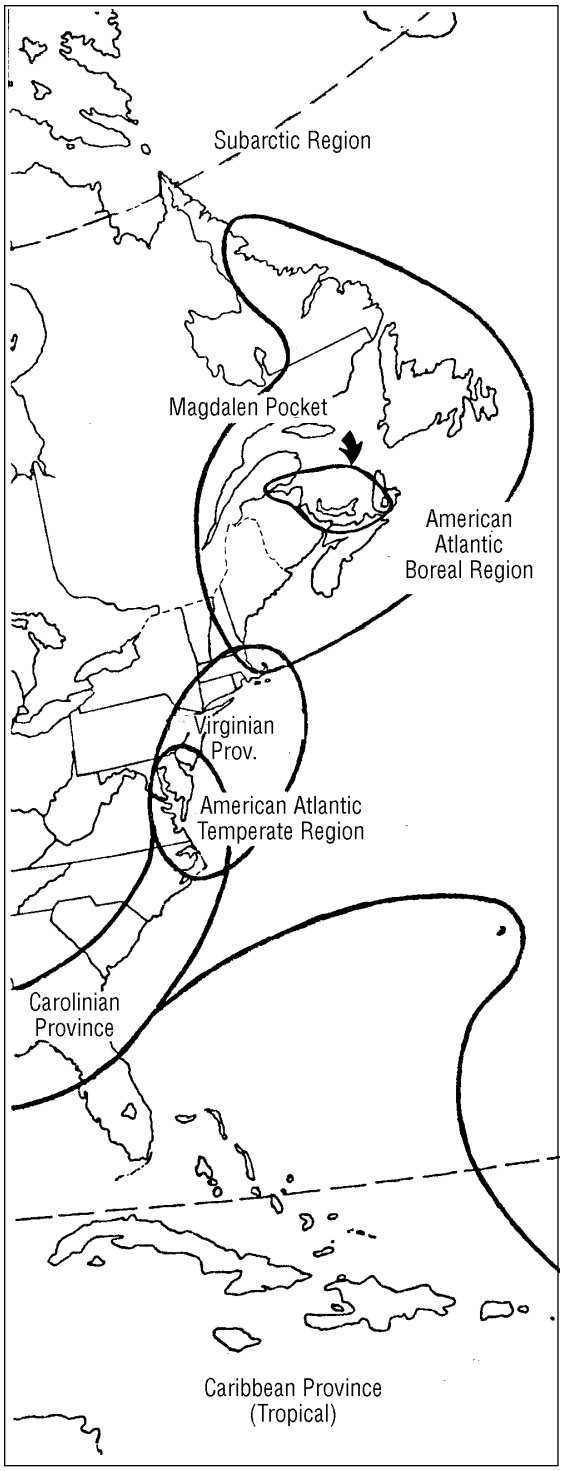


Figure T11.17.2: Faunal regions and provinces of Atlantic North America.

typical for these species (see Figure T11.17.5).

The occurrence of shells, but not living populations, in Minas Basin, Atlantic shore bays, Sable Island (District 890) and the Magdalen Islands is an indication of the wider distribution of the warm-water fauna in the past. The Minas Basin has a warm-water fauna that is slightly different from that of the Northumberland Strait, associated partly with the general absence of Eel Grass.

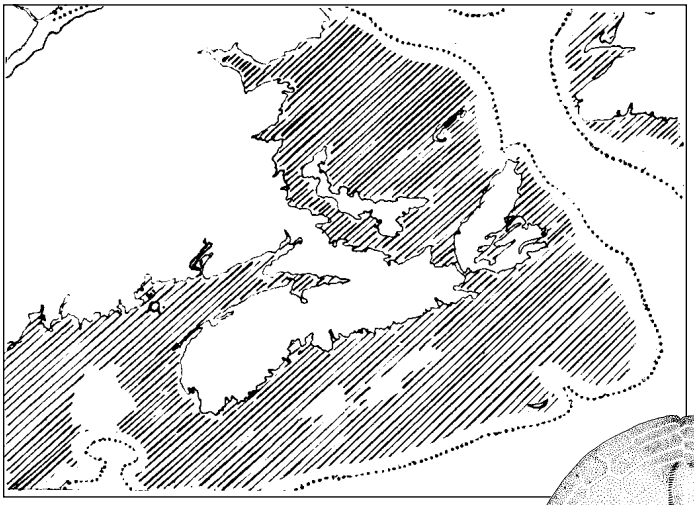
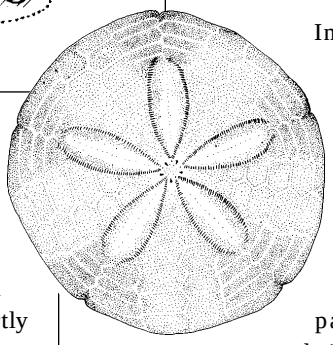


Figure T11.17.4: Distribution of the boreal species *Echinarachnius parma* (Sand Dollar).

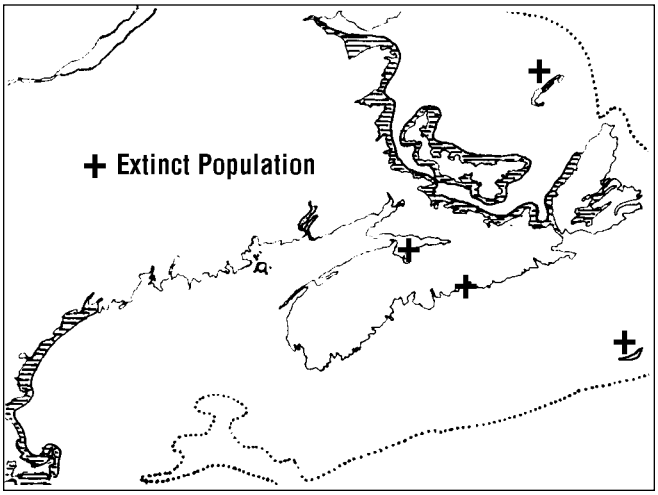


Warm Temperate and Tropical Fauna

The larvae of many warm-water fish and invertebrates are carried northwards by the Gulf Stream from the southern coast of the United States and the Caribbean. The animals reach the south shore of Nova Scotia in the late summer, through the process of slope-water exchange, metamorphose and settle. The occasional occurrences of Blue Crab and Calico Crab are due to this phenomenon. These populations are generally short-lived, as water temperatures are too low for reproduction. Associated also with the slope-water exchange and surface-water movements during the tropical-storm season are the occurrences of pelagic salps and fauna associated with Gulf Weed (*Sargassum*), including Sea Turtles, Portuguese Man-of-war and various jellyfish, Goose Barnacles and Gulf Weed Crab. These animals can often be seen inshore during August and September from Cape Sable to Halifax (Units 832, 841, 851).

ECOLOGICAL RELATIONSHIP

In the last twenty-five years, three major alterations in community state have been documented along the Atlantic coast of Nova Scotia, and there are anecdotal reports from lobster fishers of similar shifts in the more distant past.[2] In the late 1960s and early 1970s, sea urchin populations increased in St. Margarets Bay (sub-District 460b), resulting in the destruction of kelp beds and the formation of urchin-dominated barren grounds.[3] Surveys in 1979 revealed that these barren grounds extended along the entire Atlantic coast, presumably due to previous episodes of destructive grazing by sea urchins[4] (see Figure T11.17.6). In the early 1980s, recurrent outbreaks of a disease caused by an



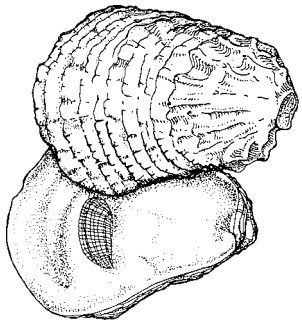


Figure T11.17.5: Distribution of the temperate species *Crassostrea virginica* (America Oyster).

In the early 1930s, large areas of Eelgrass in eastern North America and Europe were wiped out by disease. The cause of the "wasting disease", which first appeared as brownish-grey spots on the leaves and roots, was never determined, although fungal growth and water-temperature changes were investigated. The "wasting disease" and loss of Eelgrass beds led to the extinction in Nova Scotia of the Eelgrass Limpet, which lived on the blades and is the only recorded case of a marine invertebrate species extinction in the North Atlantic.

amoeba (*Paramoeba invadens*) decimated these sea urchin populations.[5] In the southwestern and central regions of the coast, sea urchins were totally eliminated in the subtidal zone, resulting in the development of kelp beds by the mid-1980s.[6] In the early 1990s, however, sea urchin populations became re-established and began to graze the kelp beds once again. The rapid increase in sea urchin abundance in recent years has led to the development of a growing commercial fishery for the roe of this invertebrate in Nova Scotia.

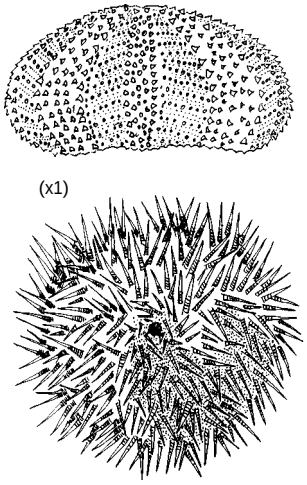


Figure T11.17.6: The Green Sea Urchin.

Disease appears to be the only type of perturbation that can cause the mass mortality of sea urchins necessary for the transition from the barren ground to the kelp-bed state. Outbreaks of disease in the early 1980s were associated with usually high seawater temperatures, which aided in the rapid progression of the disease along the coast.[7] The causes of sea urchin increase, which leads to the destructive grazing of kelp beds, are less clear. It was initially thought that the sea urchin outbreaks in the late 1960s[8] related to lobster fishing, which reduced predation on the urchins. There is little direct evidence to support this hypothesis,[2] however, and recent outbreaks have occurred during a period of lobster abundance. An alternative hypothesis is that sea urchin outbreaks occur as a result of major recruitment events that swamp predatory controls on population growth.[9]

SPECIAL FEATURES

1. **Changes in the fauna:** Although the distribution patterns of the fauna are reasonably well established, new range extensions are always being found. Our knowledge of the true range of some species is improving through research, but some species can readily disperse and thereby extend their ranges. One is the Common Periwinkle, first detected in Pictou in 1840 and progressively reported as it extended southward, eventually reaching the mouth of Chesapeake Bay in 1978. The Green Crab (see Figure T11.17.7), originally introduced from Europe, has been spreading northwards from Cape Cod since about 1900. It reached Minas Basin in the late 1950s (1958–1960), 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.

2. **Rare species:** Warm-water species that occur in the Northumberland Strait and Minas Basin, and in sheltered bays, are isolated from main populations further south. The local extinction of any of these species would not be remedied through natural recolonization. The warm-water fauna of Minas Basin is a similar situation, but in addition some disjunct species have recently been discovered there. The only Canadian population of the Truncate Borer Clam (Angel Wing), a warm-water species, occurs in the Minas Basin (Region 600, Unit 913) (see Figure T11.17.8).

3. **Jellyfish:** The larger jellyfish are the only marine invertebrates that are of major concern to people using beaches. These are all pelagic animals belonging to the phylum Cnidaria and are radially symmetrical animals which possess stinging cells (nematocysts). Only five of the fifty-six species of jellyfish that occur in

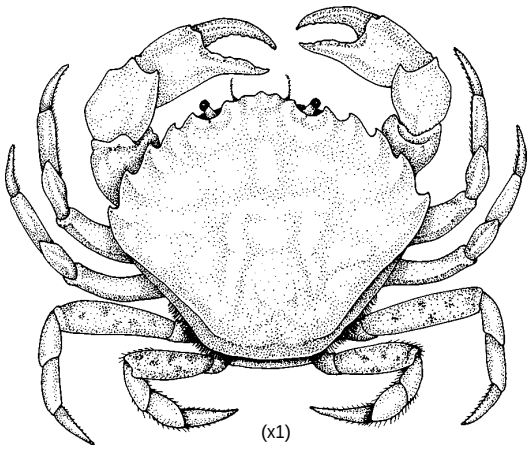


Figure T11.17.7: The Green Crab.

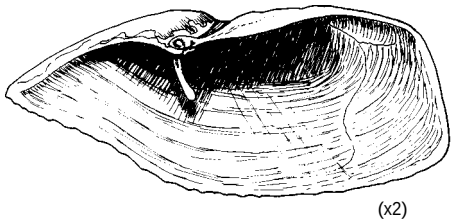


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Figure T11.17.8: Angel Wing *Barnea truncata.*

Canadian Atlantic waters are known to be harmful to man. These are Portuguese Man-of-war (*Physalia physalis*), Lion's Mane (*Cyanea capillata*), Moon Jelly and Mauve Stinger (*Pelagia noctiluca* and *Sarsia tubulosa*). The Portuguese Man-of-war, rare in Nova Scotia, is found only at the end of the summer season when specimens are blown inshore from the Gulf Stream and slope water. From the conspicuous blue floats are suspended long-stinging tentacles, which are highly poisonous to humans and pets. In most marine areas, jellyfish occur as large numbers of small individuals in the early summer, or fewer, larger individuals in late summer. The severity of stings varies with the duration of contact with tentacles, general health or age of the victim, and type of jellyfish.[10]

4. **Adaptations:** Some marine invertebrates have streamlined shapes to enable them to exist in high-energy intertidal and subtidal environments. The cone-shaped shells of limpets and the disk shape of sand dollars help these species in this way.

Waves can be felt at some depth in the ocean, and organisms in shallower areas such as the fishing banks must be capable of digging out after burial by bottom sediments moved by ocean storms. Some of the key clam species in the commercial fisheries (Arctic Surf Clam and the Ocean Quahog) have this ability. Species such as the Atlantic Surf Clam can establish themselves in sandy areas where there is heavy surf, due to their ability to burrow rapidly. On Georges Bank, bottom megaripple (sand dune) areas were found to have the lowest species diversity and biomass compared to more stable gravel and shell bottoms.[11]

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Associated Topics

T3.5 Offshore Bottom Characteristics, T4.3 Post-glacial Colonization by Animals, T6.2 Oceanic Environments, T6.3 Coastal Aquatic Environments, T6.4 Estuaries, T11.14 Marine Fishes.

Associated Habitats

H1 Offshore, H2 Coastal

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T11.18 RARE AND ENDANGERED ANIMALS

Rare animals are those nonintroduced or nondomesticated species which occur in only a few localities in the province and/or are represented by relatively few individuals. Rarity is a relative concept and is related to the physical size of the individuals as well as the pattern of their distribution. This is particularly true in the case of animals because so many are mobile for much or all of their lives. Plants can only make use of the energy and nutrients that come to them, while mobile animals can go in search of them. The larger the individuals, the more living space and resources will be needed to support each one, and the fewer individuals can occupy a unit area. Although coyotes are almost certainly the most common wild predatory mammals of their size in the province, they are probably much less numerous than most of our smaller mammals that are considered to be uncommon or rare, such as the Arctic Shrew (*Sorex arcticus*).[1]

No authoritative list has yet been published of the animals considered to be rare in Nova Scotia, though one is in preparation by staff at the Nova Scotia Museum of Natural History, in consultation with those who have any provincial expertise in the various groups concerned. Our invertebrate fauna (an estimated 10 000 species of insects alone) is much more diverse, and hence much less well known, than are the higher plants. The microinvertebrates are so poorly known that we have no idea how many species occur here, let alone how many of them are rare. COSEWIC has assigned status (endangered, threatened, vulnerable) to a much smaller portion of our animal species (all of them vertebrates) than of our plants (see Table T11.8.1 for a list of land mammals with COSEWIC status). Specific birds, fish, reptiles, and invertebrates are referred to by their COSEWIC status throughout the preceding topics.

ENDEMICS

Our only endemic vertebrate is the Atlantic Whitefish (*Coregonus huntsmani*), once found in the Tusket and Petite Riviere watersheds in southwestern Nova Scotia and now believed to have been extirpated from the Tusket (see T11.13).

On the mainland, our single known endemic invertebrate is a case-bearer moth, *Coleophora vacciniella*, known only from Point Pleasant Park in Unit 833.[2] Sable Island (Unit 890) has four endemic invertebrate species: a beetle, *Pyrrhalta sablensis* (Coleoptera: Chrysomelidae), and three species of noctuid moths, as well as an endemic subspecies of a tussock moth that is widespread on the mainland.[2,3] The freshwater sponge *Heteromeyenia macouni*, previously reported as a Sable Island endemic, has been synonymized with *Anheteromeyenia ryderi* of wider distribution.[4]

DISJUNCT SPECIES

Almost all of Nova Scotia's rare species are also disjunct, separated by many hundreds of kilometers from populations of their kind elsewhere, usually further south in the eastern United States but sometimes to the west or the north of us. This is the result of Nova Scotia's shape and its narrow central connection to the mainland, which allows north–south movement of climate zones to isolate species at either end of the province. Those of our disjunct species that have the main part of their range to the south and west of Nova Scotia are the most likely to expand their ranges here if the climate warms significantly.

Nova Scotia has an extraordinarily high proportion of disjunct animal species, especially among the vertebrates: 14 per cent of the land mammals,[5] 15.4 per cent of the amphibians 44 per cent of the aquatic and terrestrial reptiles[6] and 26 per cent of the freshwater fishes.[7] The exception is in the birds, because they are so mobile; only two of the 170 confirmed breeding species can be considered even marginally disjunct, and both are colonial seabirds

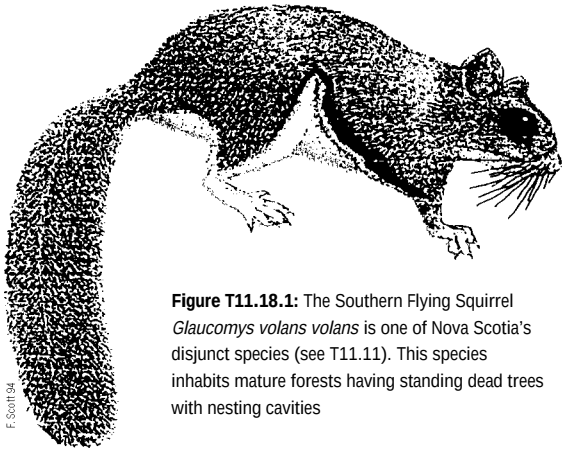

Figure T11.18.1: The Southern Flying Squirrel *Glaucomys volans volans* is one of Nova Scotia's disjunct species (see T11.11). This species inhabits mature forests having standing dead trees with nesting cavities

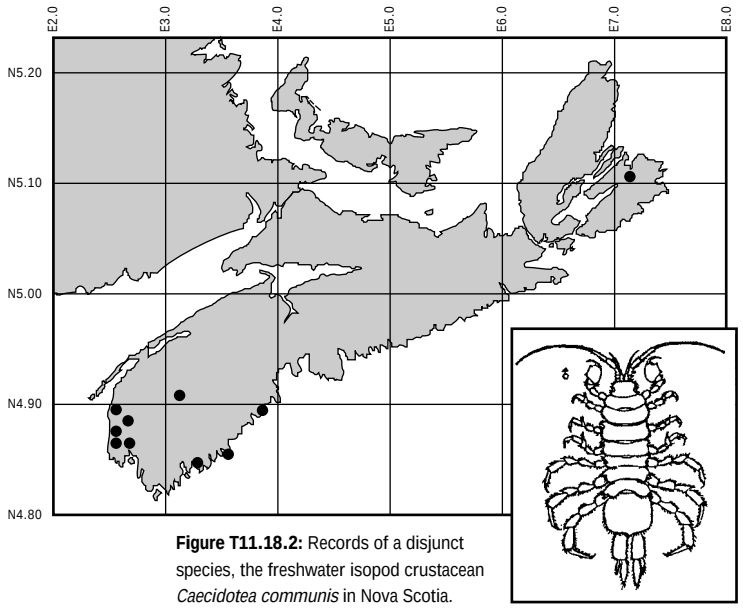

Figure T11.18.2: Records of a disjunct species, the freshwater isopod crustacean *Caecidotea communis* in Nova Scotia.

whose colonies are more often than not widely separated anyway.[8]

Nova Scotia has at least fourteen species of invertebrates with disjunct populations in Nova Scotia. These include a fairy shrimp, *Eubranchipus intricatus*;[9] a freshwater isopod, *Caecidotea communis* (see Figure T11.18.2); four species of butterflies and two of moths; six terrestrial or aquatic molluscs;[2] and two disjunct dragonflies, *Libellula incesta* and *Calopteryx amata*, restricted to central or western Nova Scotia.

PROTECTION

Federal and provincial legislation protects all native birds except the Common Raven, the American Crow and both species of cormorant. The introduced European Starling, Rock Dove and House Sparrow are not protected. In addition, a number of wildlife sanctuaries have been created by federal, provincial and nongovernment agencies specifically to provide protection for breeding and feeding habitats used by waterfowl, seabirds and migrant shorebirds. Most large and moderate-sized mammals are protected (or their harvest is controlled) by provincial legislation, but small mammals, including some of our rarest species, are mostly unprotected. With the exception of the Blanding's Turtle, our amphibians and reptiles are also unprotected. Populations of all wildlife species are protected in national and provincial parks and in ecological reserves established under the Special Places Protection Act.

Associated Topics

T4.3 Post-glacial Colonisation by Animals, T11.8 Land Mammals, T11.13 Freshwater Fishes, T11.15 Amphibians and Reptiles, T11.16 Land and Freshwater Invertebrates, T11.17 Marine Invertebrates

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Additional Reading

• Federal-Provincial-Territorial Biodiversity Working Group (1994) *Draft Canadian Biodiversity Strategy* (Discussion Paper). Biodiversity Convention Office, Hull, Quebec.