Wetlands

Wetlands are unique in that they represent habitats "in-between" that of terrestrial and aquatic ecosystems. Wetlands are important habitats for many terrestrial and aquatic organisms and in Canada these ecosystems harbour high levels of biodiversity. They also provide necessary and valuable services to humans.

This chapter identifies the five types of wetlands commonly found in Ontario and provides examples of their benefits to both humans and the ecosystem. This chapter also examines some of the common threats to wetlands and methods to protect them. A list is provided as to help students familiarize themselves with some of the common plant and animal species found living within each type of wetland.

Revised 2009

Definition of a wetland

Wetlands include areas that are seasonally or permanently covered by shallow water and areas where the water table is close to or at the surface. Usually soils are water saturated and water-tolerant or water-loving plants grow here. They sometimes form an ecotone or transitional zone between deep water and terrestrial systems.

Wetlands comprise an incredible array of landscapes. They can be found near the banks of rivers and streams, along the edges of lakes and ponds, or in open fields and wooded areas where the water table is near the surface. Some of these wetlands may be ephemeral (temporary) and can be very small or thousands of hectares in size. Particularly near cities and towns, wetlands may be the only remaining "wild" spaces.

Throughout the world many different names are used to describe wetland areas. Ephemeral wetlands, marshes, swamps, bogs and fens are the types of wetlands found in Ontario. For a list of animals and plants found in each type of wetland, see pages 6 to 10.

Marshes

These wetlands are either permanently or periodically flooded. Non-woody plants such as sedges, cattails, reeds and water lilies make up the majority of the plant community. Most marshes have some open water which may contain aquatic plants such as pondweed and duckweed. Shrubs like red-osier dogwood might be found growing in drier areas around the marsh.

Many animals such as snails, insects, fish, amphibians, reptiles, waterfowl and mammals use marshes as a feeding and reproductive site. Marshes are the most productive type of wetland in Canada since they provide resources for both marsh animals and animals from neighbouring drier areas. Of all habitats in Canada, marshes have the highest level of biodiversity and therefore their protection is essential for our ecosystem.

Swamps

Swamps are periodically flooded with snow melt and spring rains and can become dry towards the end of the summer. Woody plants such as white cedar, tamarack, black spruce, black ash, silver and black maple make up the majority of plants in the community. Shrubs like willow, dogwood and alder can also be present. Since some swamps can dry out, they usually lack "true" aquatic plants.

We usually find a combination of aquatic and terrestrial animals in swamps. Some marsh insects, amphibians, waterfowl and mammals can use this habitat provided that it remains wet long enough to allow the proper development of young. A variety of song birds will nest in swamps since it provides an abundance nesting cavities and food in the form of insects, nuts and berries.

Bogs

These wetlands are found in northern regions and are permanently flooded. Bogs are depressions which fill up with rainwater or snow melt and have poor drainage. The most predominant vegetation growing in bogs is sphagnum moss. Sedges, sundew, pitcher plants and black spruce can also be found in this wetland.

Since bogs have no outflows, dead plant material accumulates and forms a type of soil known as peat. Peat soils act like sponges in that they retain excess runoff and slowly release water to surrounding lands. Bogs do not support much animal life because they are quite acidic.

Fens

They are found in northern regions and are also permanently flooded. Fens obtain their water from rainwater, snow melt and underground springs. They are similar to bogs but have better drainage and less peat accumulation. Sedges are predominant but mosses, grasses, reeds, shrubs, sundews, pitcher plants, bladderworts, cedar and tamarack can also grow in fens.

Increased drainage in fens results in lower acidity and in many cases this habitat is alkaline. Fens can support plants and animals found in marshes but generally fen animal biodiversity is lower. This habitat supports a variety of rare plants specifically adapted to fens.

Ephemeral wetlands

These are temporary wetlands which become flooded with rainwater and snow melt and dry out in late summer. They can be found in meadows or prairies. Usually only sedges and grasses grow in these wetlands. Plant matter accumulation is minimal.

Ephemeral wetlands can be important resting areas for migrating waterfowl. Some animals such as fairy shrimp (Anostraca) will only be found in these habitats. Many mosquito species use ephemeral pools extensively for growth and reproduction; in many pools these insects comprise the majority of the invertebrate community.

Ecological functions and benefits of wetlands

Wetlands are essential to the health of our lakes, rivers and streams. The survival of hundreds of plant and animals species depends on the unique and specialized habitats found only in wetlands. Wetlands play a critical role in the maintenance of our water supply, in cleaning up polluted waters and in flood damage control. Beneficial functions of wetlands include:

1) Wetlands provide important habitat for a wide variety of wildlife species, including insects, amphibians, reptiles, migratory birds, waterfowl and mammals. They also provide spawning and nursery areas for fish.

2) Wetlands provide essential habitats to some of our rarest plants and animals such as Small White Lady's Slipper Orchid (*Cypripedium calceolus*), Least Bittern (*Ixobrychus exilis*) and Prothonotary Warbler (*Protonotaria citrea*).

3) They act as a buffer zone between terrestrial and aquatic ecosystems. They trap moderate amounts of soils (running off nearby uplands) before entering lakes and streams. They protect shorelines from erosion from flowing water and wave action.

4) They act as sponges in that they absorb large quantities of water, thereby reducing flood damage. They also renew groundwater supplies when surrounding lands become drier.

5) They maintain and improve water quality by filtering contaminants and excessive nutrients.

6) They provide a source of economically valuable products such as fuel wood, timber, wild rice, cranberries and commercial fish.

7) They support recreational activities such as fishing, hunting, bird watching and hiking. They also provide opportunities to participate in outdoor educational activities and to enjoy the aesthetic qualities of wetlands.

Threats to wetlands

There are many factors which threaten wetlands and the biodiversity associated with them. The major threats are the following:

Drainage for conversion to alternative uses

One of the major reasons why wetlands have disappeared in Ontario. Many wetlands have been drained or filled to create agricultural lands and for urban development. In many cases, once wetlands have been modified this way they can not be restored and are lost forever.

Contaminants

Although wetlands act as filters, removing contaminants from runoffs and surrounding water, an overabundance of toxic compounds will destroy them. Contaminants such as pesticides, fertilizers, cleaning products, motor oils and hydraulic fluids can find their way in wetlands and kill plants and animals. Some contaminants may even bioaccumulate in the food chain causing health problems to many animals. For example, a pesticide known as DDT (Dichloro-diphenyl-trichloro-ethane) was applied by Ontario farmers in the 1950s and 1960s on their crops to kill insect pests. This insecticide would eventually runoff into wetlands where it was consumed by insects. These insects would then be eaten by songbirds which in turn where eaten by raptors, such as falcons and hawks. The DDT accumulated in the fatty tissues of organisms and therefore top predators would have high pesticide concentrations within their bodies. These toxic concentrations inhibited proper calcification of egg shells and eggs laid by female raptors would be crushed under the parent's weight. Raptor populations dramatically decreased during this time since they could not reproduce. Once scientists discovered this, DDT use was banned in Canada and United States and raptor populations slowly increased.

Forestry and economic operations

Some forestry practices such as logging and controlling water levels have negatively affected wetlands by upsetting the natural flood cycle. Commercial harvesting of peat has destroyed many of our bogs. Overhunting and overfishing has also contributed in the decreasing biodiversity of our wetlands.

Introduction of exotic species

Animal and plants species from other continents brought here by humans have caused much damage to our wetlands. In many cases, these exotic species have established themselves in our wetlands and are proliferating greatly since no natural herbivores or predators are present to control them. These exotic species can use up resources and displace many of native wildlife. A good example of this is a plant known as Purple loosestrife (*Lythrum salicaria*). This European plant grows quite well in wetlands and outcompetes native plants for water, minerals

and space. Within a few growing seasons, Purple loosestrife can overrun an entire wetland. This causes a disruption in the wetland ecosystem since very few of our native herbivores can eat this exotic plant. Purple loosestrife eventually displaces native plant and animal species.

Approaches to protect, enhance and restore wetlands

There are many ways that you and others can protect, enhance or restore wetlands:

If the wetland is unaffected by human activity, leave it alone. Protect the habitat from any future human activities.

Restore native vegetation that grew on a wetland before it was altered. Plant a mixture of native grasses, wildflowers and shrubs around the wetland. This will create a diverse long-last plant community that will provide food, cover and nesting habitats for a wide range of animal species.

Create buffer strips which are zones around wetland areas which provide buffering from surrounding land uses. This is done in order to protect both wetlands and uplands. Encourage the growth of grasses, shrubs and trees in these buffer zones.

Restore natural hydrological functions of wetland by restoring the natural patterns of seasonal flooding and drying.

Introduce nesting structures where there is an absence of nesting opportunities for certain species, such as Wood duck (*Aix sponsa*) boxes, Osprey (*Pandion halioetus*) platforms or floating mats of vegetation for Black terns (*Chlidonias nigra*).

Control livestock access to wetlands by putting up fences.

Control exotic species by removing them or preventing their establishment in the wetland.

For more information on wetlands please refer to the two articles (Wetland Restoration and Rehabilitation & Wetlands) at the end of this chapter.

Common features and organisms found in marshes

Soil
Mainly mineral

pH
Neutral to alkaline

Hydrology
Periodically or permanently flooded

Vegetation*
Non-woody plants:
Cattails, horsetails, reeds, rushes, grasses, yellow & white waterlilies, arrowhead, pickerel weed, great burreed, water arum, sweet flag, smartweed, pondweeds, duckweed, water milfoil
Woody plants:
Red-osier dogwood

Invertebrates
Worms
Leeches
Snails
Clams
Amphipods
Crayfish
Butterflies
Dragonflies
Water striders
Water boatman
Backswimmer
Caddisfly
Mosquitoes
Predaceous diving beetle
Giant water bug
Midgefly
Rat-tailed maggot
Whirligig beetle
Water scorpions
Water mites
Wolf spider

Fish
Pike
Muskellunge
Pickerel
Carp
Shiners
Dace
Minnow
Bullhead
Perch
Sunfish
Bass

Reptiles & Amphibians
Mudpuppy
Red-spotted newt
American toad
Spring peeper
Bullfrog
Green frog
Northern leopard frog
Mink frog
Pickerel frog
Painted turtle
Snapping turtle
Blanding's turtle
Water snake
Garter snake
Ribbon snake

Birds
Pied-billed grebe
Red-necked grebe
Least bittern
American bittern
Great blue heron
Great white egret
Green-backed heron
Black-crowned night heron
Canada goose
Wood duck
Green-winged teal
Blue-winged teal
American black duck
Mallard
Northern pintail
Northern shoveller
Gadwall
American widgeon
Ring-necked duck
Hooded merganser
Yellow rail
King rail
Virginia rail
Common moorhen
American coot
Little gull
Forester's tern
Black tern
Marsh wren
Common yellowthroat
Lincoln's sparrow
Swamp sparrow
Osprey
Northern harrier
Wilson's phalarope
Common tern
Short-eared owl
Tree swallow
Sedge wren
Yellow warbler
Red-winged blackbird

Mammals
Star-nosed mole
Water shrew
Raccoon
Long-tailed weasel
Ermine
Mink
River otter
Meadow vole
Meadow jumping mouse
Muskrat
Beaver
Little brown bat
Big brown bat
Moose

* For a more complete plant list refer to **Wetland Plants of Ontario** by S. Newmaster, A. Harris & L. Kershaw.

Common features and organisms found in swamps

Soil
Mixture of mineral soil with organic matter

pH
Neutral to slightly acidic

Hydrology
Periodic flooding sometimes non-permanent

Vegetation*
Non-woody plants:
Ferns, bracken ferns, mosses, marsh marigold, white-fringed orchids
Woody plants:
White cedar, willow, red & silver maple, black ash, black spruce, tamarack, buttonbush, dogwoods, speckled alder

Invertebrates
Worms
Leeches
Snails
Clams
Amphipods
Crayfish
Butterflies
Dragonflies
Water striders
Water boatman
Backswimmer
Caddisfly
Mosquitoes
Predaceous diving beetle
Giant water bug
Midgefly
Rat-tailed maggot
Whirligig beetle
Water scorpions
Water mites
Wolf spider

Fish
Pike & muskellunge spawn in the springtime

Reptiles & Amphibians
Red-spotted newt
Yellow-spotted salamander
Spring peeper
Green frog
Wood frog
Pickerel frog
Gray tree frog
American toad
Mink frog
Chorus frog
Water snake
Garter snake
Ribbon snake

Birds
Great-blue heron
Green-backed heron
Black-crowned night heron
American black duck
Mallard
Hooded merganser
Olive-sided flycatcher
Alder flycatcher
Common yellowthroat
Swamp sparrow
Osprey
Bald eagle
Broad-winged hawk
Barred owl
Northern Saw-whet owl
Yellow-bellied sapsucker
Brown creeper
Hairy woodpecker
Blue-grey gnatcatcher
Yellow-throated vireo
Yellow warbler
Cerulean warbler
Prothonotary warbler
Mourning warbler
Canada warbler
White-throated sparrow

Mammals
Raccoon
Mink
Beaver
White-tailed deer
Little brown bat
Big brown bat

* For a more complete plant list refer to **Wetland Plants of Ontario** by S. Newmaster, A. Harris & L. Kershaw and to **Trees in Canada** by J. Farrar.

Common features and organisms found in fens

Soil
Organic; composed of surface layers of peat

pH
Neutral to alkaline

Hydrology
Permanently flooded; water

slowly moving

Vegetation*
Non-woody plants:
Grasses and sedges dominate, beaked spike rush, buckbean, sundews, pitcher plants, orchids, sweet gale
Woody plants:
Tamarack, willow, red-osier dogwood, white cedar

Invertebrates
Worms
Leeches
Snails
Clams
Amphipods
Crayfish
Butterflies
Dragonflies
Water striders
Water boatman
Backswimmer
Caddisfly
Mosquitoes
Predaceous diving beetle
Giant water bug
Midgefly
Rat-tailed maggot
Whirligig beetle
Water scorpions
Water mites
Wolf spider

Fish
Pike
Carp
Chubs
Dace
Minnow

Reptiles & Amphibians
Blue-spotted salamander
Red-spotted newt
Four-toed salamander
American toad
Spring peeper
Mink frog
Leopard frog
Spotted turtle
Snapping turtle
Painted turtle
Water snake
Garter snake

Birds
Common loon
Pied-billed grebe
American bittern
Great blue heron
American black duck
Mallard
Blue-winged teal
Common merganser
Osprey
Northern harrier
American kestrel
Yellow rail
Sora rail
Killdeer
Spotted sandpiper
Common snipe
American woodcock
Ruby-throated hummingbird
Belted kingfisher
Eastern kingbird
Tree swallow
Gray jay
Sedge wren
Eastern bluebird
Common yellowthroat
Red-winged blackbird
Savannah sparrow
Swamp sparrow

Mammals
Common shrew
Water shrew
Pygmy shrew
Eastern mole
White-footed mouse
Meadow jumping mouse
Meadow vole
Southern red-backed vole
Muskrat
Northern bog lemming
Coyote
Raccoon
Ermine
Long-tailed weasel
Mink

* For a more complete plant list refer to **Wetland Plants of Ontario** by S. Newmaster, A. Harris & L. Kershaw and to **Trees in Canada** by J. Farrar.

Common features and organisms found in bogs

Soil
Organic; composed of peat

pH
Acidic

Hydrology
Permanent; no drainage

Vegetation*
Non-woody plants:
Sphagnum moss, sundew, pitcher plant, Labrador

teas, leatherleaf, bladderwort, blueberry, clubmoss, bog laurel, ferns
Woody plants:
Black spruce, tamarack, white cedar

Invertebrates
Very few are found since the habitat is very acidic

Fish
Few fish species

Reptiles & Amphibians
Blue-spotted salamander
Red-spotted newt
American toad
Mink frog
Wood frog
Spotted turtle
Painted turtle
Water snake
Garter snake
Ribbon snake

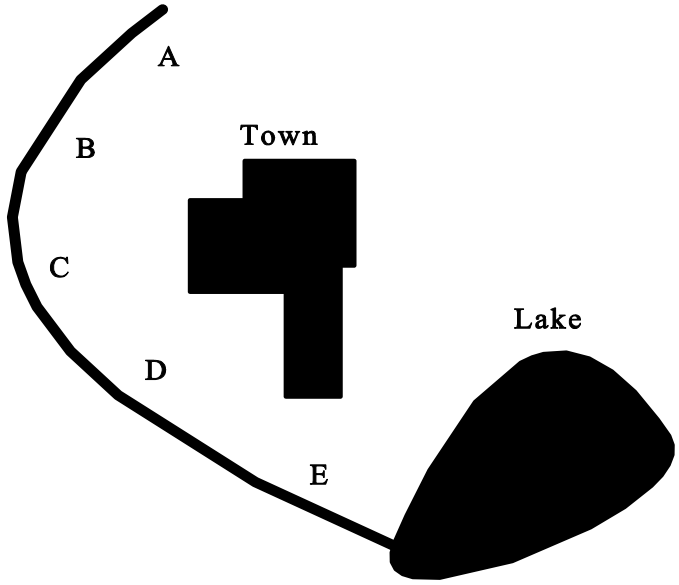
Birds
Northern harrier
American kestrel
Common snipe
Ruby-throated hummingbird
Eastern kingbird
Tree swallow
Gray jay
Sedge wren
Eastern bluebird
Yellow-rumped warbler
Savannah sparrow
Henslow's sparrow

Mammals
Common shrew
Water shrew
Pygmy shrew
Beaver
Deer mouse
Meadow vole
Bog lemming
Meadow jumping mouse
Ermine
Long-tailed weasel
Moose

* For a more complete plant list refer to **Wetland Plants of Ontario** by S. Newmaster, A. Harris & L. Kershaw and to **Trees in Canada** by J. Farrar.

Common features and organisms found in ephemeral wetlands

Soil
Mainly mineral



pH
Neutral

Hydrology
Periodic flooding; non-permanent

Vegetation
Mainly grasses and sedges

Invertebrates
Worms
Snails
Isopods
Fairy shrimp
Tadpole shrimp
Butterflies
Dragonflies
Water striders
Water boatman
Backswimmer
Caddisfly
Mosquitoes
Predaceous diving beetle
Giant water bug
Midgefly
Rat-tailed maggot
Whirligig beetle

Fish
No fish

Reptiles & Amphibians
Spring peeper
Wood frog
Leopard frog
Garter Snake

Birds
Most migratory waterfowl use these wetlands as rest areas

Mammals
Not specifically used as a habitat; possible source of food and water by most species

Case study: Effect of a municipality on a river

A municipality hires your consulting firm to determine the water quality of a local river. The river is about 15 km long and drains into a nearby lake. The average water velocity of the river is approximately 0.6 m/s.

You know that the town is releasing untreated sewage effluent into the river but unfortunately you do not know where exactly. During the summer, your firm has set up five sampling stations to perform biological, physical and chemical surveys of the river. Using the data collected (Table 4-2) at each sampling station, answer the following questions:

Account for the differences in species composition at each station along the river. Does the town have an effect on the benthic community? If so, how?

Assuming that the town has an effect on water quality, where would you find the point source of pollution? Describe the sanitary quality of the river in this area (justify your response with reference to all pertinent data).

What would you expect the relative populations of algae to be at the five stations?

The municipality wants to open a beach area near station D. Would you agree with the municipalities choice (why or why not)? If you do not agree, where would you recommend the municipality to build a beach area?

What recommendations would you offer the community in order to increase the water quality of their river?

Table 4.2 Data collected at each sampling station

Benthic invertebrate abundance (number/m^2)

Organism	A	B	C	D	E
Blackfly larvae	440	445	45	150	350
Caddisfly larvae	150	160	5	50	100
Isopoda	45	50	35	45	45
Mayfly nymphs	200	220	40	100	230
Midgefly larvae	30	30	225	135	40
Riffed beetle larvae	80	85	15	45	70

Stonefly nymphs	120	140	10	80	130
Tubifex worms	10	15	335	190	35

Chemical and physical data

Properties	A	B	C	D	E
Dissolved Oxygen (mg/l)	6.50	6.40	2.10	4.10	5.60
Nitrate (mg/l)	0.22	0.25	2.13	1.02	0.60
Phosphate (mg/l)	0.01	0.02	0.80	0.10	0.09
River depth (m)	2.50	2.60	2.50	2.70	2.80
River width (m)	7.50	7.60	7.40	7.50	7.70
Total colioforms (number/100 ml)	4.00	2.00	180.00	50.00	18.00
Turbidity (m)	1.80	1.60	0.50	0.80	1.00

Table 3-1: Inhabitants of streams

1 Names in brackets indicate order or famly names. "Spp." indicates more than one species for the given genus name.

Organism	Scientific name1	Adaptations to water currents
Plants		
Algae Moss	Chlorophyta Bryophyta	Low growth; attachment to rocks
Snails		
Non-operculate	Gastropoda (Pulmonata)	Uses fleshy parts to stick to rocks; hides underneath rocks
Crustaceans		
Sowbug	Isopoda	Digs in substrate and hides underneath rocks
Insects		
Blackfly	Diptera (Simuliidae)	Terminal sucker at posterior end that sticks insect to rocks
Caddisfly	Trichoptera	Build homes (cases) out of detritus and stones; hides underneath rocks
Dobsonfly	Megaloptera (Corydalidae)	Strong grasping legs to cling onto rocks; hides underneath rocks
Mayfly	Ephemeroptera	Dorsal-ventrally flattened bodies; strong grasping legs to cling onto rocks

Riffle beetle	Coleoptera (Psephenidae)	Dorsal-ventrally flattened bodies; strong grasping legs to cling onto rocks
Stonefly	Plecoptera	Dorsal-ventrally flattened bodies; strong grasping legs to cling onto rocks
Fish		
Alewife	*Alosa pseudoharengus*	
Brook stickleback	*Culaea inconstans*	
Brook Trout	*Salvelinus fontinalis*	
Brown bullhead	*Ictalurus nebulosus*	
Brown Trout	*Salmo trutta*	
Creek Chub	*Semotilus atromaculatus*	Streamlined body; hides in between rocks away from current
Dace	Chrosomus spp.	
Darter	*Etheostoma spp.*	
Redfin Pickerel	*Esox americanus*	
Sculpin	*Cottus spp.*	
Shinner	Notropis spp.	
Sucker	*Catostomus spp.*	

Table 3-2: Inhabitants of rivers

1 Names in brackets indicate order or famly names. "Spp." indicates more than one species for the given genus name.

* Indicates organisms found in rivers with moderate or slow currents.

Organism		Scientific name1	Adaptations to water currents
Plants			
Algae		Chlorophyta	
Arrowhead	*	Sagittaria spp.	
Bulrush	*	Scirpus spp.	
Burreed	*	Sparganium spp.	
Calla lily	*	*Calla palustris*	
Cattail	*	Typha spp.	
Common waterweed	*	Elodea spp.	
Coontail	*	*Ceratophyllum demersum*	
Eelgrass	*	*Vallisneria americana*	Rooted plants; anchored to substrate
Moss		Bryophyta	
Pickerel weed	*	*Pontederia cordata*	
Pondweed	*	Potamogeton spp.	
Purple loosestrife	*	*Lythrum salicaria*	
Sedge	*	Carex spp.	
Stonewort	*	Chlorophyta	
Water lily	*	Nymphaea spp.	
Water milfoil	*	Myriophyllum spp.	
Water milkweed	*	Asclepias spp.	
Annelids			
Earthworms	*	Oligochaeta (Lumbriculidae)	Buries in substrate and detritus
Leeches	*	Hirudinea (Hirudinidae)	Attaches to solid surfaces with suckers
Tubifex worms	*	Oligochaeta (Tubificidae)	Buries in substrate and detritus

Snails		
Non-operculate	Gastropoda (Pulmonata)	Uses fleshy parts to stick to rocks; hides underneath rocks
Operculate	Gastropoda (Operculata)	

Table 3-2 (continued): Inhabitants of rivers

1 Names in brackets indicate order or famly names. "Spp." indicates more than one species for the given genus name.

* Indicates organisms found in rivers with moderate or slow currents.

Organism		Scientific name1	Adaptations to water currents
Clams			
Clam/mussels	*	Bivalva (Unionidae or Dressenidae)	Attachment to solid surfaces or burying themselves in substrate
Fingernail clam	*	Bivalva (Sphaeridae)	
Crustaceans			
Copepod	*	Copepoda	Found among plants, eddies or bays where water current is low
Crayfish	*	Decapoda	Buries in substrate, detritus and hides among rocks
Sideswimmer	*	Amphipoda	Buries in substrate and detritus
Sowbug		Isopoda	Buries in substrate and detritus
Water flea	*	Cladocera	Found among plants, eddies or bays where water current is low
Insects			
Backswimmer	*	Hemiptera (Notonectidae)	Found among plants, eddies or bays where water current is low
Blackfly		Diptera (Simuliidae)	Terminal sucker at posterior end that sticks insect to rocks
Caddisfly		Trichoptera	Build homes (cases) out of detritus and stones; hides underneath rocks
Cranefly	*	Diptera (Tipulidae)	Found among plants, eddies or bays where water current is low
Damselfly	*	Odonata	Grip to plants or hide in substrate
Dobsonfly		Megaloptera (Corydalidae)	Strong grasping legs to cling onto rocks; hides underneath rocks
Dragonfly	*	Odonata	Grip to plants or hide in substrate
Giant water bug	*	Hemiptera (Belostomatidae)	Found among plants, eddies or bays where water current is low
Mayfly		Ephemeroptera	Dorsal-ventrally flattened bodies; strong grasping legs to cling onto rocks
Midgefly	*	Diptera (Chironomidae)	Found among plants, eddies or bays where water current is low
Predaceous diving beetle	*	Coleoptera (Dytiscidae)	Found among plants, eddies or bays where water current is low
Rat-tailed maggot	*	Diptera (Syrphidae)	Found in detritus where water current is low
Riffle beetle		Coleoptera (Psephenidae)	Dorsal-ventrally flattened bodies; strong grasping legs to cling onto rocks

Water boatman	*	Hemiptera (Corixidae)	Found among plants, eddies or bays where water current is low
Water scavenger beetle	*	Coleoptera (Hydrophilidae)	Found among plants, eddies or bays where water current is low
Water scorpions	*	Hemiptera (Nepidae)	Grip to plants or hide in substrate
Water strider	*	Hemiptera (Gerridae)	Found among plants, eddies or bays where water current is low
Whirligig beetle	*	Coleoptera (Gyrinidae)	Found among plants, eddies or bays where water current is low

Table 3-2 (continued): Inhabitants of rivers

1 Names in brackets indicate order or famly names. "Spp." indicates more than one species for the given genus name.

* Indicates organisms found in rivers with moderate or slow currents.

Organism		Scientific name1	Adaptations to water currents
Arachnids			
Water mite	*	Hydracarnia	Found among plants, eddies or bays where water current is low
Wolf or water spider	*	Arachnia	
Fish			
Bass/Perch	*	Morone spp.	
Black crappie	*	*Pomoxis nigromaculatus*	
Bluegill	*	*Lepomis macrochirus*	
Bowfin	*	*Amia calva*	
Brook silverside		*Labidesthes sicculus*	
Brook Trout		*Salvelinus fontinalis*	
Brown Trout		*Salmo trutta*	
Burbot	*	*Lota lota*	
Carp	*	*Cyprinus carpio*	
Channel catfish	*	*Ictalurus punctatus*	
Creek Chub		*Semotilus atromaculatus*	Streamlined body; hides in between rocks away from current Found among plants, eddies or bays where water current is low
Dace		Chrosomus spp.	
Gar	*	*Lepisosteus spp.*	
Golden shiner		*Notemigenus crysoleucas*	
Largemouth bass	*	*Micropterus salmoides*	
Muskellunge	*	Esox spp.	
Ninespine stickleback		*Pungitius pungitius*	
Pike	*	Esox spp.	
Redhorse	*	*Moxostoma spp.*	
Shinner		Notropis spp.	
Smallmouth bass	*	*Micropterus dolomieui*	
Threespine stickleback		*Gasterosteus aculeatus*	
White perch	*	*Morone americana*	
Yellow perch	*	*Perca flavescens*	

Table 3-2 (continued): Inhabitants of rivers

1 Names in brackets indicate order or famly names. "Spp." indicates more than one species for the given genus name.

* Indicates organisms found in rivers with moderate or slow currents.

Organism		Scientific name1	Adaptations to water currents
Amphibians			
Frogs	*	Amphibia	Found among plants, eddies or bays where water current is low
Salamanders	*	Amphibia	
Repitles			
Snakes	*	Reptilia	Found among plants, eddies or bays where water current is low
Turtles	*	Reptilia	
Birds & mammals			
Mammals		Mammalia	Found among plants, eddies or bays where water current is low
Waterfowl (ducks, geese, ect)		Aves	

Table 3-3: Inhabitants of ponds

1 Names in brackets indicate order or famly names. "Spp." indicates more than one species for the given genus name.

Organism	Scientific name1	Adaptations or reasons for using habitat
Plants		
Algae	Chlorophyta	
Arrowhead	Sagittaria spp.	
Bulrush	Scirpus spp.	
Burreed	Sparganium spp.	
Calla lily	*Calla palustris*	
Cattail	Typha spp.	
Common waterweed	Elodea spp.	Rooted plants; lots of minerals and dissolved chemicals needed for growth; access to sunlight
Coontail	*Ceratophyllum demersum*	
Eelgrass	*Vallisneria americana*	
Moss	Bryophyta	
Pickerel weed	*Pontederia cordata*	
Pondweed	Potamogeton spp.	
Purple loosestrife	*Lythrum salicaria*	
Sedge	Carex spp.	
Stonewort	Chlorophyta	
Water lily	Nymphaea spp.	
Water milfoil	Myriophyllum spp.	
Water milkweed	Asclepias spp.	
Bladderwort	Utriculaire spp.	Lack of water current permits them to use surface tension; direct access to sunlight
Duckweed	Lemna spp.	
Platyhelminthes		
Flatworms	Turbellaria	Lack of water current permits them to swim throughout habitat; access to lots of food

Table 3-3 (continued): Inhabitants of ponds

1 Names in brackets indicate order or famly names. "Spp." indicates more than one species for the given genus name.

Organism	Scientific name1	Adaptations or reasons for

		using habitat
Annelids		
Earthworms	Oligochaeta (Lumbriculidae)	Presence of lots of detritus; access to lots of food
Leeches	Hirudinea (Hirudinidae)	Access to lots of food
Tubifex worms	Oligochaeta (Tubificidae)	Presence of lots of detritus; access to lots of food
Snails		
Non-operculate	Gastropoda (Pulmonata)	Lack of water current permits them to use surface tension; access to lots of food
Clams		
Fingernail clam	Bivalva (Sphaeridae)	Access to lots of food in the water column
Crustaceans		
Copepod	Copepoda	Lack of water current permits them to swim throughout habitat; access to lots of food
Sideswimmer	Amphipoda	Presence of lots of detritus; access to lots of food
Sowbug	Isopoda	Presence of lots of detritus; access to lots of food
Water flea	Cladocera	Lack of water current permits them to swim throughout habitat; access to lots of food

Table 3-3 (continued): Inhabitants of ponds

1 Names in brackets indicate order or famly names. "Spp." indicates more than one species for the given genus name.

Organism	Scientific name1	Adaptations or reasons for using habitat

Insects

Backswimmer	Hemiptera (Notonectidae)	Lack of water current permits them to swim throughout habitat; access to lots of food
Caddisfly	Trichoptera	Standing water species have more efficient gills; access to lots of food (plant & detritus); immature development occurs better and more quickly in warm water
Cranefly	Diptera (Tipulidae)	Lack of water current permits them to use surface tension; access to lots of food
Damselfly	Odonata	Standing water species have more efficient gills; access to lots of food; immature development occurs better and more quickly in warm water
Dragonfly	Odonata	Standing water species have more efficient gills; access to lots of food; immature development occurs better and more quickly in warm water
Giant water bug	Hemiptera (Belostomatidae)	Lack of water current permits them to swim throughout habitat; access to lots of food
Mayfly	Ephemeroptera	Standing water species have more efficient gills; access to lots of food; immature development occurs better and more quickly in warm water
Midgefly	Diptera (Chironomidae)	Lack of water current permits them to swim throughout habitat; access to lots of food
Mosquitoes	Diptera (Culicidae)	Lack of water current permits them to swim throughout habitat; access to lots of food
Predaceous diving beetle	Coleoptera (Dytiscidae)	Lack of water current permits them to swim throughout habitat; access to lots of food
Rat-tailed maggot	Diptera (Syrphidae)	Lack of water current permits the accumulation of lots of organic material, their primary food source; shallow water permits the use of respiratory tube
Water boatman	Hemiptera (Corixidae)	Lack of water current permits them to swim throughout habitat; access to lots of food

Water scavenger beetle	Coleoptera (Hydrophilidae)	Lack of water current permits them to swim throughout habitat; access to lots of food
Water scorpions	Hemiptera (Nepidae)	Lots of plants to grip onto; access to lots of food
Water strider	Hemiptera (Gerridae)	Lack of water current permits them to use surface tension; access to lots of food
Whirligig beetle	Coleoptera (Gyrinidae)	Lack of water current permits them to use surface tension; access to lots of food
Arachnids		
Water mite	Hydracarnia	Access to lots of food
Wolf or water spider	Arachnia	

Table 3-3 (continued): Inhabitants of ponds

1 Names in brackets indicate order or famly names. "Spp." indicates more than one species for the given genus name.

Organism	Scientific name1	Adaptations or reasons for using habitat
Fish		
Black crappie	*Pomoxis nigromaculatus*	Warm water fish; access to lots of food
Bluegill	*Lepomis macrochirus*	
Carp	*Cyprinus carpio*	
Largemouth bass	*Micropterus salmoides*	
Pumpkinseed	*Lepomis gibbosus*	
Rockbass	*Ambloplites rupestris*	
Sauger	*Stizostedion canadense*	
Shinner	*Notropis spp.*	
Smallmouth bass	*Micropterus dolomieui*	
Sucker	*Catostomus spp.*	

Sunfish	Lepomis spp.	
White bass	*Morone chrysops*	
White perch	*Morone americana*	
Yellow perch	*Perca flavenscens*	
Amphibians		
Frogs	Amphibia	Lack of water current permits them to swim throughout habitat; access to lots of food; permits larval development
Salamanders	Amphibia	
Reptiles		
Snakes	Reptilia	Lack of water current permits them to swim throughout habitat; access to lots of food
Turtles	Reptilia	
Birds & mammals		
Mammals	Mammalia	Lack of water current permits them to swim throughout habitat; access to lots of food
Waterfowl (ducks, geese, etc)	Aves	

Table 3-4: Inhabitants of lakes

1 Names in brackets indicate order or famly names. "Spp." indicates more than one species for the given genus name.

Organism	Scientific name1	Lake zone	Adaptations or reasons for using habitat
Plants			
Algae	Chlorophyta	Littoral/Limnetic	Access to sunlight
Arrowhead	Sagittaria spp.	Littoral	
Bulrush	Scirpus spp.	Littoral	
Burreed	Sparganium spp.	Littoral	
Calla lily	*Calla palustris*	Littoral	
Cattail	Typha spp.	Littoral	
Common waterweed	Elodea spp.	Littoral	
Coontail	*Ceratophyllum demersum*	Littoral	
Eelgrass	*Vallisneria americana*	Littoral	
Moss	Bryophyta	Littoral	
Pickerel weed	*Pontederia cordata*	Littoral	
Pondweed	Potamogeton spp.	Littoral	
Purple loosestrife	*Lythrum salicaria*	Littoral	
Sedge	Carex spp.	Littoral	
Stonewort	Chlorophyta	Littoral	

Water lily	Nymphaea spp.	Littoral	
Water milfoil	Myriophyllum spp.	Littoral	
Water milkweed	Asclepias spp.	Littoral	
Duckweed	Lemna spp.	Littoral/Limnetic	Lack of water current permits them to use surface tension; direct access to sunlight
Bladderwort	Utriculaire spp.	Littoral	
Platyhelminthes			
Flatworms	Turbellaria	Littoral	Lack of water current permits them to swim throughout habitat; access to lots of food

Table 3-4 (continued): Inhabitants of lakes

1 Names in brackets indicate order or famly names. "Spp." indicates more than one species for the given genus name.

Organism	Scientific name1	Lake zone	Adaptations or reasons for using habitat
Annelids			
Earthworms	Oligochaeta (Lumbriculidae)	Littoral/Profundal	Presence of detritus; access to lots of food
Leeches	Hirudinea (Hirudinidae)	Littoral	Access to lots of food
Tubifex worms	Oligochaeta (Tubificidae)	Littoral/Profundal	Presence detritus; access to lots of food; species in profundal zones have hemoglobin-like compounds in their blood that efficiently absorb low levels of oxygen
Snails			
Operculate	Gastropoda (Operculata)	Littoral/Neuston	Lack of water current permits them to use surface tension; access to lots of food
Clams			
Clam/mussels	Bivalva (Unionidae or Dressenidae)	Liitoral/Profundal	Access to lots of food in water column
Crustaceans			

Copepod	Copepoda	Littoral/Limnetic	Lack of water current permits them to swim throughout habitat; access to lots of food
Sideswimmer	Amphipoda	Littoral/Profundal	Presence of lots of detritus; access to lots of food
Sowbug	Isopoda	Littoral/Profundal	Presence of lots of detritus; access to lots of food
Water flea	Cladocera	Liitoral/Limnetic	Lack of water current permits them to swim throughout habitat; access to lots of food

Table 3-4 (continued): Inhabitants of lakes

1 Names in brackets indicate order or famly names. "Spp." indicates more than one species for the given genus name.

Organism	Scientific name1	Lake zone	Adaptations or reasons for using habitat
Insects			
Backswimmer	Hemiptera (Notonectidae)	Littoral	Lack of water current permits them to use surface tension; access to lots of food
Caddisfly	Trichoptera	Littoral	Standing water species have more efficient gills; access to lots of food
Cranefly	Diptera (Tipulidae)	Littoral	Lack of water current permits them to use surface tension; access to lots of food
Damselfly	Odonata	Littoral	Standing water species have more efficient gills; access to lots of food
Dragonfly	Odonata	Littoral	Standing water species have more efficient gills; access to lots of food
Giant water bug	Hemiptera (Belostomatidae)	Littoral	Lack of water current permits them to swim throughout habitat; access to lots of food
Mayfly	Ephemeroptera	Littoral	Standing water species have more efficient gills; access to lots of food
Midgefly	Diptera (Chironomidae)	Littoral/Profundal	Lack of water current permits them to swim throughout habitat; access to lots of food; species in profundal zones have hemoglobin-like compounds in their blood that efficiently absorb low levels of oxygen

Mosquitoes	Diptera (Culicidae)	Littoral	Lack of water current permits them to swim throughout habitat; access to lots of food
Predaceous diving beetle	Coleoptera (Dytiscidae)	Littoral	Lack of water current permits them to swim throughout habitat; access to lots of food
Rat-tailed maggot	Diptera (Syrphidae)	Littoral	Lack of water current permits the accumulation of lots of organic material, their primary food source; shallow water permits the use of respiratory tube
Water boatman	Hemiptera (Corixidae)	Littoral	Lack of water current permits them to use surface tension; access to lots of food
Water scavenger beetle	Coleoptera (Hydrophilidae)	Littoral	Lack of water current permits them to swim throughout habitat; access to lots of food
Water scorpions	Hemiptera (Nepidae)	Littoral	Lots of plants to grip onto; access to lots of food
Water strider	Hemiptera (Gerridae)	Littoral	Lack of water current permits them to use surface tension; access to lots of food
Whirligig beetle	Coleoptera (Gyrinidae)	Littoral	Lack of water current permits them to use surface tension; access to lots of food

Table 3-4 (continued): Inhabitants of lakes

1 Names in brackets indicate order or famly names. "Spp." indicates more than one species for the given genus name.

Organism	Scientific name1	Lake zone	Adaptations or reasons for using habitat
Arachnids			
Water mite	Hydracarnia	Littoral	Access to lots of food
Wolf or water spider	Arachnia	Littoral	
Fish			
Pumpkinseed	Lepomis spp.	Littoral/Limnetic	Stay in shallows since they are warm water fish
Smallmouth bass	*Micropterus dolomieui*		
Sunfish	Lepomis spp.		
Yellow perch	*Perca flavenscens*		
Black crappie	*Pomoxis nigromaculatus*		
Bluegill	*Lepomis macrochirus*		
Brown bullhead	*Ictalurus nebulosus*		
Channel catfish	*Ictalurus punctatus*		
Largemouth bass	*Micropterus salmoides*		
Longnose sucker	*Catostomus spp.*		
Muskellunge	*Esox spp.*		
Pike	*Esox spp.*		
Pumpkinseed	*Lepomis gibbosus*		
Rockbass	*Ambloplites rupestris*		
Smallmouth bass	*Micropterus dolomieui*		
White bass	*Morone chrysops*		

White perch	*Morone americana*		
Yellow perch	*Perca flavescens*		
Alewife	*Alosa pseudoharengus*		
Cisco	*Coregonus spp.*		
Gar	*Lepisosteus spp.*	Profundal/Limnetic	Found in deep water since they are cold water fish
Lake trout	*Salvelinus namaycush*		
Sclupin	*Cottus spp.*		
Shinner	*Notropis spp.*		

Table 3-4 (continued): Inhabitants of lakes

1 Names in brackets indicate order or famly names. "Spp." indicates more than one species for the given genus name.

Organism	Scientific name1	Lake zone	Adaptations or reasons for using habitat
Amphibians			
Frogs	Amphibia	Littoral	Lack of water current permits them to swim throughout habitat; access to lots of food; permits larval development
Salamanders	Amphibia	Littoral	
Repitles			
Snakes	Reptilia	Littoral	Lack of water current permits them to swim throughout habitat; access to lots of food
Turtles	Reptilia	Littoral	
Birds & mammals			
Mammals	Mammalia	Littoral	Lack of water current permits them to swim throughout habitat; access to lots of food
Waterfowl (ducks, geese, ect)	Aves	Littoral/Limnetic	

Sideswimmer	Amphipoda	Benthos	Detritivores	Detritus	Important food source for insects and fish
Sowbug	Isopoda	Benthos	Detritivores	Detritus	
Water flea	Cladocera	Plankton	Grazers or Filter-feeders	Phytoplankton	Usually found in clean waters

Table 3-5: Habitat location, trophic level and food preferences of aquatic invertebrates

Common name	Scientific name	Habitat location	Trophic Level	Food	Comments
Platyhelminthes					
Flatworms	Turbellaria	Neuston/Benthos	Grazers	Algae and detritus on solid surfaces	Usually found in well oxygenated waters

Table 3-5 (continued): Habitat location, trophic level and food preferences of aquatic invertebrates

Common name	Scientific name	Habitat location	Trophic Level	Food	Comments
Annelids					
Earthworms	Oligochaeta (Lumbricidae)	Benthos	Detritivores	Detritus	
Backswimmer	Hemiptera (Notonectidae)	Neuston/Nekton	Predators	Zooplankton and insects	
Leeches	Hirudinea (Hirudinidae)	Benthos/Nekton	Predators	Snails, insects, amphibians, reptiles and mammals; some are parasitic	Usually found in well oxygenated waters
Blackfly	Diptera (Simuliidae)	Benthos	Filter-feeders	Phytoplankton and detritus	Found in clean, oxygen rich running waters
Caddisfly	Trichoptera	Benthos	Grazers or Shredders	Plant material	Important food source for insects and fish
Tubifex worms	Oligochaeta (Tubificidae)	Benthos	Detritivores	Detritus	Species in profundal zones have hemoglobin-like compounds in their blood that efficiently absorb low levels of oxygen; found in great numbers in polluted environments
Cranefly	Diptera (Tipulidae)	Benthos	Detritivores	Detritus	
Damselfly	Odonata	Benthos	Predators	Zooplankton, insects, fish and amphibians	
Dobsonfly	Megaloptera (Corydalidae)	Benthos	Predators	Insects	
Dragonfly	Odonata	Benthos	Predators	Zooplankton, insects, fish and amphibians	Major invertebrate predators of ponds
Clams					
Giant water bug	Hemiptera (Belostomatidae)	Nekton/Benthos	Predators	Zooplankton, insects, fish and amphibians	Usually found in shallow waters
Fingernail clam	Bivalva (Sphaeridae)	Benthos	Filter-feeders	Detritus and plankton suspended in water	
Clam/mussels	Bivalva (Unionidae or Dressenidae)	Benthos	Filter-feeders	Detritus and plankton suspended in water	Can be found in both shallow and deep waters
Mayfly	Ephemeroptera	Benthos	Grazers or Shredders	Plant material	Important food source for fish; pollution intolerant
Snails					
Midge	Diptera (Chironomidae)	Nekton/Benthos	Filter-feeders or Shredders	Phytoplankton and plant material	Species in profundal zones have hemoglobin-like compounds in their blood that efficiently absorb low levels of oxygen (gives them a red appearance); found in great numbers in polluted environments
Operculate	Gastropoda (Operculata)	Neuston/Benthos	Grazers	Algae and detritus on solid surfaces	More abundant in large lakes and rivers
Non-operculate	Gastropoda (Pulmonata)	Neuston/Benthos	Grazers	Algae and detritus on solid surfaces	More abundant in shallow waters
Crustaceans					
Copepod	Copepoda	Plankton	Grazers or Predators	Phytoplankton and zooplankton	Important food source for insects and fish

Mosquitoes	Diptera (Culicidae)	Neuston/Nekton	Filter-feeders	Phytoplankton and detritus	Mainly found in fishless habitats
Predaceous diving beetle	Coleoptera (Dytiscidae)	Nekton/Benthos	Predators	Zooplankton, insects, fish and amphibians	Major invertebrate predators
Rat-tailed maggot	Diptera (Syrphidae)	Benthos	Detritivores	Detritus	Found in polluted systems with lots of organic matter
Riffle beetle	Coleoptera (Psephenidae)	Benthos	Grazers	Algae	

Table 3-5 (continued): Habitat location, trophic level and food preferences of aquatic invertebrates

Common name	Scientific name	Habitat location	Trophic Level	Food	Comments
Insects					
Water scavenger beetle	Coleoptera (Hydrophilidae)	Benthos	Shredders or Detritivores	Dead animal and plant material	
Water scorpions	Hemiptera (Nepidae)	Benthos	Predators	Zooplankton and insects	
Water strider	Hemiptera (Gerridae)	Neuston	Predators	Zooplankton and insects	
Whirligig beetle	Coleoptera (Gyrinidae)	Neuston	Predators	Zooplankton and insects	
Arachnids					
Water mite	Hydracarnia	Neuston/Benthos	Predators	Insects, fish, amphibians and mammals; often parasitic	
Wolf or water spider	Arachnia	Neuston/Benthos	Predators	Insects, fish, and amphibians	Not truly aquatic; closely related to terrestrial spiders

Dobsonfly	Megaloptera (Corydalidae)	Benthos	Predators	Insects	
Dragonfly	Odonata	Benthos	Predators	Zooplankton, insects, fish and amphibians	Major invertebrate predators of ponds
Giant water bug	Hemiptera (Belostomatidae)	Nekton/Benthos	Predators	Zooplankton, insects, fish and amphibians	
Mayfly	Ephemeroptera	Benthos	Grazers or Shredders	Plant material	Important food source for fish; pollution intolerant
Midgefly	Diptera (Chironomidae)	Nekton/Benthos	Filter-feeders or Shredders	Phytoplankton and plant material	Species in profundal zones have hemoglobin-like compounds in their blood that efficiently absorb low levels of oxygen (gives them a red appearance); found in great numbers in polluted environments
Mosquitoes	Diptera (Culicidae)	Neuston/Nekton	Filter-feeders	Phytoplankton and detritus	Mainly found in fishless habitats
Predaceous diving beetle	Coleoptera (Dytiscidae)	Nekton/Benthos	Predators	Zooplankton, insects, fish and amphibians	Major invertebrate predators
Rat-tailed maggot	Diptera (Syrphidae)	Benthos	Detritivores	Detritus	Found in polluted systems with lots of organic matter
Riffle beetle	Coleoptera (Psephenidae)	Benthos	Grazers	Algae	

Table 3-5 (continued): Habitat location, trophic level and food preferences of aquatic invertebrates

Common name	Scientific name	Habitat location	Trophic Level	Food	Comments
Insects					
Backswimmer	Hemiptera (Notonectidae)	Neuston/Nekton	Predators	Zooplankton and insects	
Blackfly	Diptera (Simuliidae)	Benthos	Filter-feeders	Phytoplankton and detritus	Found in clean, oxygen rich running waters
Caddisfly	Trichoptera	Benthos	Grazers or Shredders	Plant material	Important food source for insects and fish
Cranefly	Diptera (Tipulidae)	Benthos	Detritivores	Detritus	
Damselfly	Odonata	Benthos	Predators	Zooplankton, insects, fish and amphibians	

Table 3-5 (continued): Habitat location, trophic level and food preferences of aquatic invertebrates

Common name	Scientific name	Habitat location	Trophic Level	Food	Comments
Insects					
Water scavenger beetle	Coleoptera (Hydrophilidae)	Benthos	Shredders or Detritivores	Dead animal and plant material	
Water scorpions	Hemiptera (Nepidae)	Benthos	Predators	Zooplankton and insects	
Water strider	Hemiptera (Gerridae)	Neuston	Predators	Zooplankton and insects	
Whirligig beetle	Coleoptera (Gyrinidae)	Neuston	Predators	Zooplankton and insects	
Arachnids					
Water mite	Hydracarnia	Neuston/Benthos	Predators	Insects, fish, amphibians and mammals; often parasitic	
Wolf or water spider	Arachnia	Neuston/Benthos	Predators	Insects, fish, and amphibians	Not truly aquatic; closely related to terrestrial spiders

Table 3-5 (continued): Habitat location, trophic level and food preferences of aquatic invertebrates

Common name	Scientific name	Habitat location	Trophic Level	Food	Comments
Insects					
Backswimmer	Hemiptera (Notonectidae)	Neuston/Nekton	Predators	Zooplankton and insects	
Blackfly	Diptera (Simuliidae)	Benthos	Filter-feeders	Phytoplankton and detritus	Found in clean, oxygen rich running waters
Caddisfly	Trichoptera	Benthos	Grazers or Shredders	Plant material	Important food source for insects and fish
Cranefly	Diptera (Tipulidae)	Benthos	Detritivores	Detritus	
Damselfly	Odonata	Benthos	Predators	Zooplankton, insects, fish and amphibians	

Dobsonfly	Megaloptera (Corydalidae)	Benthos	Predators	Insects	
Dragonfly	Odonata	Benthos	Predators	Zooplankton, insects, fish and amphibians	Major invertebrate predators of ponds
Giant water bug	Hemiptera (Belostomatidae)	Nekton/Benthos	Predators	Zooplankton, insects, fish and amphibians	
Mayfly	Ephemeroptera	Benthos	Grazers or Shredders	Plant material	Important food source for fish; pollution intolerant
Midgefly	Diptera (Chironomidae)	Nekton/Benthos	Filter-feeders or Shredders	Phytoplankton and plant material	Species in profundal zones have hemoglobin-like compounds in their blood that efficiently absorb low levels of oxygen (gives them a red appearance); found in great numbers in polluted environments
Mosquitoes	Diptera (Culicidae)	Neuston/Nekton	Filter-feeders	Phytoplankton and detritus	Mainly found in fishless habitats
Predaceous diving beetle	Coleoptera (Dytiscidae)	Nekton/Benthos	Predators	Zooplankton, insects, fish and amphibians	Major invertebrate predators
Rat-tailed maggot	Diptera (Syrphidae)	Benthos	Detritivores	Detritus	Found in polluted systems with lots of organic matter
Riffle beetle	Coleoptera (Psephenidae)	Benthos	Grazers	Algae	

Table 3-5 (continued): Habitat location, trophic level and food preferences of aquatic invertebrates

Common name	Scientific name	Habitat location	Trophic Level	Food	Comments
Insects					
Water scavenger beetle	Coleoptera (Hydrophilidae)	Benthos	Shredders or Detritivores	Dead animal and plant material	
Water scorpions	Hemiptera (Nepidae)	Benthos	Predators	Zooplankton and insects	
Water strider	Hemiptera (Gerridae)	Neuston	Predators	Zooplankton and insects	
Whirligig beetle	Coleoptera (Gyrinidae)	Neuston	Predators	Zooplankton and insects	

Arachnids					
Water mite	Hydracarnia	Neuston/Benthos	Predators	Insects, fish, amphibians and mammals; often parasitic	
Wolf or water spider	Arachnia	Neuston/Benthos	Predators	Insects, fish, and amphibians	Not truly aquatic; closely related to terrestrial spiders

Samplers and collection methods in lentic and lotic systems

Samplers fall under two major categories: quantitative and qualitative. Qualitative samplers are those which are used to sample a habitat to determine the species living in the ecosystem. Quantitative samplers are those which collect a certain volume or area of a habitat and determine the number of individuals of each species. Qualitative samplers are used to figure out what is 'out there', whereas quantitative samplers are used to calculate the abundance of species in a habitat.

Each aquatic sampler has been designed to function in specific habitats and to collect particular organisms. Therefore, choosing the right sampler is important if you wish to study a certain group of organisms.

Samplers for lotic environments

Qualitative samplers

The best qualitative sampler to collect benthos in streams and shallow rivers is the kick net. It consists of a net attached to two rods. Usually two people are required to use this sampler. The kick net is stretched and held flush to the substrate. A person standing upstream in front of the sampler, kicks the substrate as to dislodge benthos which are then carried by the stream and become trapped in the net.

Another sampler sometimes used along river edges is the D-frame net. This net is swept in front of the person and is used to collect organisms on the substrate and in the water column. This sampler is often used to collect organisms in areas where there are lots of vegetation.

Quantitative samplers

The Surber sampler is the most commonly used sampler to collect benthos in streams with rocky bottoms. It consists of a metal frame with netting material attached to one end. The open end of the sampler is placed directly on the substrate. Rocks found within the area enclosed by the open end are rubbed by hand to dislodge benthos which are then carried by the current into the net. Care must be taken not to disturb too much

debris since the net is fragile and can clog up. This sampler can be used to determine the total number of species per unit area (open end).

The Hester-Dendy multiple plate sampler and the rock basket sampler are devices used to measure the abundance of organisms which attach themselves to solid surfaces. These samplers can be placed directly on the substrate or can be left hanging in the water column.

Samplers for lentic habitats

Qualitative sampler

The D-frame dip net is commonly used to collect organisms in the margins of ponds or lakes. It is used to collect organisms found on plants, on the substrate and in the water column.

Quantitative sampler

The plankton net is used to capture plankton found in the water column. The net is towed by boat and placed at a specific depth. Plankton abundance is determined by dividing the total number of organisms collected by the volume of water sampled by the net.

The Macan sampler is used to collect aquatic plants and associated organisms. It is only used in shallow areas. It consists of a box which has sharp jaws at one end that can be opened and closed. To collect organisms, the opened sampler is placed directly on the substrate and then it is closed to cut the aquatic plants. One can determine abundances based on the total area sampled by the device.

The Ekman grab is used to collect benthos found on the soft substrate of shallow waters. It consists of a metal box with two spring mounted jaws which can open and close at one end. With the jaws opened, the sampler is lowered onto the substrate. A messenger (weight) is then released down the rope to which the Ekman grab is attached causing the jaws to collect some substrate as they shut. It is important that no large solid objects are found in the substrate since these will prevent the jaws from closing completely. This sampler is used to determine the abundance of benthos per unit area of substrate.

Similar to the Ekman grab, the Ponar grab is used to collect benthos in deep waters in both hard and soft substrates. The jaws of the Ponar grab are powerful enough to crush clams and break rocks. This device is mounted on a winch in a boat. This sampler is also used to determine the abundance of benthos per unit area of substrate.

The Hester-Dendy multiple plate sampler and the rock basket sampler can also be

used in lentic habitats. Just as in lotic systems, these devices used to measure the abundance of organisms which attach themselves to solid surfaces.