Reference

1. Glossary of Science Terms

(for your reference throughout the BioKIDS curriculum)

abundance – The number of animals seen in an area.

adaptation –A characteristic (a physical feature or a behavior) of an organism that has evolved to help the organism survive and reproduce. Each species has its own set of different adaptations that help it persist. Often species in the same community have different kinds of adaptations to deal with the same environmental factor. For example, adaptations to deal with cold winters include thick fur, migration to warmer climates, and/or hibernation. Some other examples of physical adaptations are color patterns for camouflage, sharp claws or teeth for killing prey, and different bird beak shapes for different kinds of food. Some behavioral adaptations include migration, hibernation, social cooperation, and mating displays. Sometimes loosing a characteristic is an adaptation. For instance, animal species that live in caves have no light and little food. These species adapt by reducing or completely preventing the growth of eyes. This lets them use the valuable energy that goes into eyes for other growth and reproduction.

animal behavior – The ways in which an animal acts or reacts in order to survive and reproduce. For example, how an animal finds and eats food would be called feeding behavior.

biodiversity – The variety of living things.

brood parasite – An animal that lays eggs in the nests of another animal, of the same or different species, called the host. The host then cares for the offspring. Cowbirds and Cuckoos are well-known examples. For example, in Michigan Brown-Headed Cowbirds lay eggs in Indigo Bunting nests. The Indigo Buntings raise the baby Cowbirds, even though they look different from their own babies.

carnivores – Animals that mostly eat other animals

commensalism – Literally means "eating at the same table." One partner takes advantage of and benefits from the feeding habits of another and gives little or nothing in return. The other species does not gain or lose anything. For example, pilot fish swim with sharks and eat the scraps that sharks do not.

community – The set of species (animals, plants, fungi, etc.) that occur together in the same place at the same time. The species that make up a community can be very different from place to place and do not necessarily all interact with each other except, perhaps, indirectly.

competition – Competition occurs when two or more species need the same resource, but there is not enough for both of them. Animals also might compete for nesting spots, shelter or other resources.

conclusion - Your decision. Did you answer your question? If so, what was the answer?

consumer – An organism or species that gets its energy for life by eating other organisms or their remains. All organisms are either consumers or producers.

data analysis - Thinking about your data and doing calculations to help you decide whether you have answered your experimental question.

data collection - The part of an experiment where data are collected.

decomposers – Animals that eat the wastes and remains of other living things. They break down wastes and dead organisms and release nutrients that are food for plants. Some bacteria and fungi are examples of decomposers.

direct effect – Any kind of interaction that species can have by directly interacting with each other. Predation, competition, and mutualism are all ways that animal species have direct effects on other organisms.

energy – The capacity to do work; involves heat, light, motion or chemical energy.

energy flow – The passage of energy into or out of an organism, population or system; the passage of energy through a food chain. Energy in a food chain usually flows in one direction, from prey to predator.

experimental question - A question that you would like to find an answer to and that you can answer with an experiment.

food chain – A model of how the energy in food is passed from organism to organism in an ecosystem.

food web – The combination of many overlapping food chains in an ecosystem.

generalist – Animals that eat a variety of different foods

group (as used in curriculum) – An assemblage of organisms that are related at about the same level; thus a genus is a group of evolutionarily related species or an order is a group of evolutionarily related families. Members of a group all arose from a single ("common") ancestor, and all descendants of that ancestor are by definition members of the group.

habitat – The type of environment in which a plant or animal lives. A patch of weeds or a forest of pine trees are habitats, so is a pond or a coral reef in the ocean, and even a city street. Some animals live in lots of different habitats; some live their whole life in one habitat. Habitats are usually classified by the types of plants and soils present, and some-

times the weather where that habitat is. From an animal's point of view, a good habitat has plenty of all the things the animal needs to survive. A poor habitat is missing some of those things, or only has a little of them.

herbivores – Animals that mostly eat plants

host - An animal that parasites feed on. Some parasites live on or in their host. Others, like mosquitoes, come to their host to feed but leave when they are done.

hypothesis - A prediction of what the answer to your question is.

indirect effect – A kind of effect that one species can have on another species that only happens through the influence of a third species. For example, if a carnivore eats many herbivores, and the herbivores aren't eating as many plants, then the carnivore is having an indirect effect on the plants.

invertebrate – The animal is "not a vertebrate." In other words, it has no vertebral column made of bone, or more generally, no internal skeleton made of bone. So there are no characteristics that unite invertebrates, just the absence of a characteristic. The vertebrates are fish, amphibians, reptiles, birds, and mammals. Kids already know what those are, so it might be easiest just to say that if an animal isn't one of those 5 groups, and it's multicelled, it's an invertebrate (single-celled things like protozoa aren't usually considered invertebrates, even though they lack a spine).

materials/methods - The measurements and observations that you will make to answer the experimental question and the materials that are needed to do your experiment.

mutualism – A relationship where both species benefit. For example, lichen is a combination of algae and fungus. The fungus gives the algae protection and retains a store of water. The algae use the water and make food for themselves and the fungus by photosynthesis. Both greatly benefit from their mutual arrangement. Mutualist relationships can be "obligate," meaning one species cannot survive without the other, or "facultative," meaning the two are not totally dependent on each other. An example of an obligate relationship is the yucca moth and yucca plant: the moth feeds only on yucca fruits, and the moth is the only pollinator of the yucca plant.

nest predator – Eats eggs from nests; however, it does not eat the adult of the same species. For example, foxes, weasels, or even mammals as small as mice and red squirrels, often eat eggs out of nests.

niche – The unique role or way of life of a plant or animal species. Beavers and otters live in the same pond habitats in Michigan. While they live in the same pond habitats, they eat different things and so do not complete for food. Therefore, beavers and otters have different roles or niches in the pond habitat.

omnivores – Animals that eat both plants and animals.

parasite – A species that feeds or otherwise helps itself by hurting another organism (its host). Unlike a predator, it does not need to kill its host to live and reproduce. In fact, a parasite rarely kills the host, since that would result in its own death. Tapeworms, lice, and fleas are all parasites.

population - Any group of individuals of the same species that occupies a specific area at the same time.

predators – Animals that kill and eat other animals.

prey – Animals that are eaten by predators

producer – An organism or species that gets its energy from sunlight or dissolved minerals, not from eating other organisms or their remains. Most producers are plants, including algae, that get their energy from the sun, but there are also some bacteria that get energy from minerals. All living organisms are producers or consumers.

richness – The number of kinds of animals seen in an area.

specialists – Animals that eat only one specific kind of food

species – A species is a kind of animal. All the animals of this kind look very much alike and have the same way of life because they all had the same ancestors -- they are related to each other. There may be some small differences in how they look or behave depending on where exactly they live, but in most cases they are enough alike they can breed with each other. For the most part, animals in one species can't breed with animals of other species.

symbiosis – Really means any relationship between organisms, beneficial or otherwise: mutualism, commensalisms, and parasitism.

zoologists – Are scientists who study animals, while ecologists study the interactions between animals, plants, and non-living things in the environment. One of the things zoologists and ecologists do is to count all the species they can find in a given location in order to decide what areas most need protection.

2. Tips for Outdoor Lessons

(For use in Learning Sets 1 and 2)

Safety

Before the collecting day, remind students to dress appropriately: closed shoes, long pants, long sleeves. Another reminder for students is to be careful where they put their hands. It is not a good idea to place your hands where you cannot see. These are good hiding places for animals that may feel threatened and bite.

Before the activity begins, instructors should carefully check the study area for potentially dangerous trash, such as broken glass and needles. Avoid poisonous plants, such as poison ivy, poison oak or poison sumac, bee and hornet nests, and areas where it is possible to encounter ticks and venomous spiders. Let students know that they are only to collect small invertebrates (not birds, mammals, frogs or other vertebrates) and that they should not try to collect stinging or poisonous insects.

Observation

Students should be reminded that they are doing what real field biologists do, observing and recording features of the natural environment in order to learn more about it and finding appropriate ways to capture and record the occurrence of animals. They must remember that they are to make their observations carefully and quietly and take care not to disturb the natural environment more than is necessary.

Encourage students to look not only for animals themselves, but also for signs of animals. This includes things like tracks and footprints, burrows and nests, scat, and other evidence of activity (such as chewed up nuts below a walnut tree). Animal tracks are best found on soft substrates, such as loose soil or mud, before they have been disturbed. Alert students to that possibility so that they don't obscure tracks unnecessarily. All kinds of animals leave tracks, they may see bird or mammal footprints, the tracks of insects as they crawl across a surface or slime trails of slugs and snails. It is possible to identify mammal tracks by using online guides or images in the Track and Sign Guide.

Scat (feces or poop!) is a useful way of discovering the presence of animals. You should caution students not to pick up or handle scat as they can be exposed to various diseases this way. Students can look for accumulated bird droppings to discern where birds like to perch at night. Other kinds of signs include things like the lines of soft, mounded earth left by a mole as it burrowed through the soil looking for insect prey, a hole in the ground that is the home of a snake, spider webs of many varieties, the soft droppings left by earthworms, holes in a tree where a woodpecker searched for food, ant hills or the discarded exoskeleton of a cicada pupa. Once students begin looking closely they will probably find plenty of evidence of animal activity!

Invertebrate Collection/Tools

Most invertebrates are very small, and most of them like to hide in the shade or dark places. Many can only live in places where it is damp. So looking in dead leaves, on the ground in tall grass, underneath things on the ground, and around puddles and other wet places are always good ideas. There are so many invertebrates, and they eat so many kinds of things, that even the grossest things might attract them. Dead things, animal poop, and other gross stuff might have special animals on it or near it. Also, many of the animals that live on plants hide underneath leaves and branches so birds can't see them as easily. The kids should try to imagine they were as big as their littlest fingernail. Where could they hide?

There are several suggested ways for collecting invertebrates for study in the classroom. Some can simply be picked up with tweezers and placed in a collection container. Hand nets are a useful way of collecting flying insects such as moths, butterflies, beetles, and flies. Students can also use hand nets to dip in small bodies of water (provided it is safe and free of dangerous trash). Encourage students to carefully look under leaf litter, logs, or other objects on the ground. Shovels also provide a good way of finding unique invertebrates, if students are allowed to dig in the schoolyard.

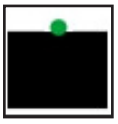
3. Habitats

(For use throughout the curriculum)

Habitat: The type of environment in which a plant or animal lives. A patch of weeds or a forest of pine trees are habitats, so is a pond or a coral reef in the ocean, and even a city street. Some animals live in lots of different habitats; some live their whole life in one habitat. Habitats are usually classified by the types of plants and soils present, and sometimes the weather where that habitat is. From an animal's point of view, a good habitat has plenty of all the things the animal needs to survive. A poor habitat is missing some of those things, or only has a little of them.

Habitat is not too hard to understand, but harder to define in simple terms. This is because habitat types are strongly determined by what kind of animal you are talking about. For instance, a single fruit tree could be the habitat for population of fruit flies. They would all live around the tree, feeding on fallen fruit, with many generations living and dying under that one tree. For a passing bird however, that fruit tree is just a small part of the bird's area of activity and is too small to be the complete habitat.

For practical purposes we are using a very simple and limited list of possible habitats in the CyberTracker data collection program. Many small animals are likely to be much more particular in their choices. Here is the list we will use with a description:



bare ground — Not much food here, often very dry, with no shelter. Might be a place where puddles are found – and larger animals could drink. Seeds sometimes accumulate on bare ground, and when they do, they're easy to see and collect.

in the soil — Some food (roots, small animals, worms, insect larvae), lots of moisture, lots of places to hide. Not easy to move around though and hard to find mates.

short grass — This is mowed grass that doesn't get a chance to go to seed. Not much to eat except grass leaves or dead grass and a few very small animals. Ok shelter but only if you are very small. At least a little moister than bare ground, and stays moister longer. Can dry out though, faster than leaf litter.

tall grass — More to eat than short grass (seeds, flowers, more kinds of plants), and moister than short grass. Lots of places for small animals to hide.

leaf litter or mulch — Lots of decaying plant stuff and small animals to eat. Holds moisture, so stays damp. Lots of places for very small creatures to hide.

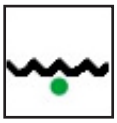
bushes — The bushes themselves might be edible to some animals, especially if they have flowers or fruit or seeds. But it is pretty dry up there in the breezes. Some places to hide if you can climb or fly into the branches, and you can see and smell things further away as you get higher above the ground (may have leaf litter, grass or bare ground underneath, see above).

under something — A great place to hide, if you can fit. Not much to eat except other hiding animals. Usually moist, unless the rock or log is off the ground.

in the air — Only other flying animals for food, nothing to drink except during a rain, and very dry compared to the ground. It's hard work to stay in the air, but if you can, not many other animals can get you there. But animals that fly can see you easily during the day.

single tree — Leaves and small animals on the tree to eat. Fruit, seeds, or flowers too. Good hiding places. Water is little to none.

trees together — Like the single tree, but even better hiding. There could be different kinds of trees, which would provide more kinds of things to eat.



in water — Probably good for food (algae, bigger plants, lots of very small animals swimming in the water), and drink is no problem as long as things don't dry out. Good place to hide if you can breathe underwater. If you can't breathe underwater you're going to be very obvious at the surface and probably easy prey. Many puddles and small ponds are temporary, forming in the spring and then drying up over the summer. These are sometimes called "vernal pools," and sometimes things live in them that can't live in ponds with fish (e.g. salamanders and frogs).

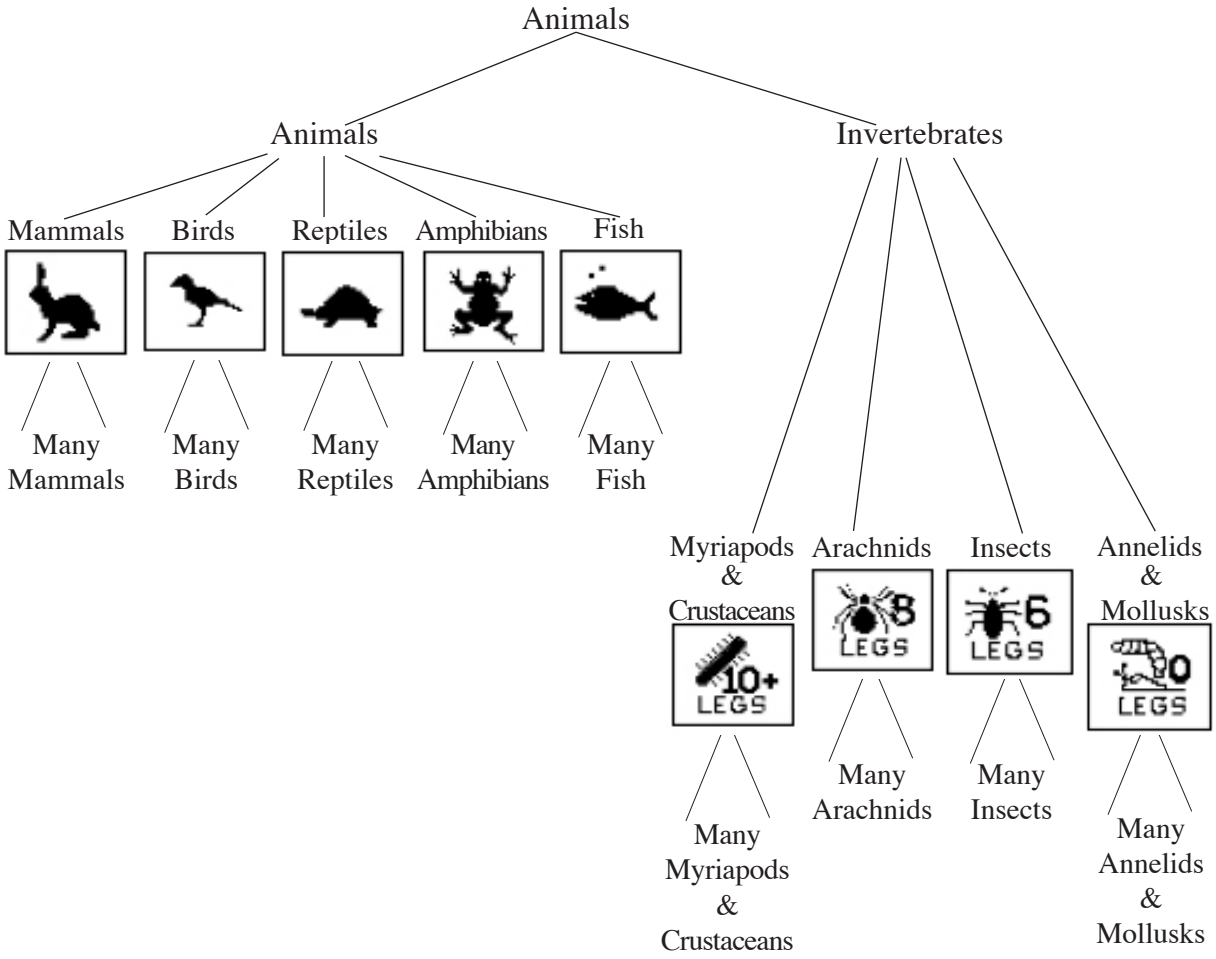
near water — This might be the edge of a puddle, stream or pond; it should usually be combined with another habitat type. Here things are moist and there are probably a variety of things to eat because plants grow well. The plants attract herbivores and also animals that come to drink. Some creatures can hide in the water. Some land predators take advantage of aquatic animals that come too close to the edge, and vice versa. A dragonfly hovering over a pond would be recorded as both "in air" and "near water."

4. Animal Organization

(For use in Learning Set 1)

The grouping system used for animals in the **Critter Catalog** can be described using a diagram such as the one below. All animals can be classified as either a vertebrate or invertebrate. **Vertebrates** all have a backbone, while **invertebrates** lack one. The five vertebrate animal groups include mammals, birds, reptiles, amphibians, and fish. In the Critter Catalog, invertebrates have been divided into the four groups: myriapods & crustaceans, arachnids, insects, and annelids & mollusks. A longer description of what is in the Critter Catalog for each animal group can be seen below.

A **species** is a kind of animal. All members of a species look very much alike and have the same way of life because they all had the same ancestors – they are related to each other. There may be small differences in how members of a species look or behave depending on where they live, but in most cases they are enough alike that they can **breed** with each other (make babies). For the most part, animals in one species cannot breed with animals of another species. All species have characteristics that scientists can use to place them in one of the nine Critter Catalog **animal groups**. This means that all species in an animal group share certain characteristics.



BioKIDS Critter Catalog Animal Groups

Critter Catalog: http://www.biokids.umich.edu/critters

The BioKIDS Critter Catalog is an online identification and information guide of Michigan animals.

Invertebrates

While vertebrates are more familiar to most people, there are many, many more species of invertebrates. In Michigan alone there are over 20,000 species, mostly insects, but also snails, clams, worms, arachnids, crustaceans, and other creatures. There are many more that have never been seen and are unknown to science. Around the world, there are millions of species of invertebrates, again mostly insects, but at most tens of thousands of vertebrates.

For simplicity's sake, we have presented four main groups of invertebrates, distinguished by the number of legs they have. Two of these groups, the six and eight-legged groups, reflect actual evolutionary groups (the insects and the arachnids). The "no legs" and "many-legs" groups are combinations of several different kinds of very different animals. The descriptions below are brief overviews; you can find more complete information in the Critter Catalog.

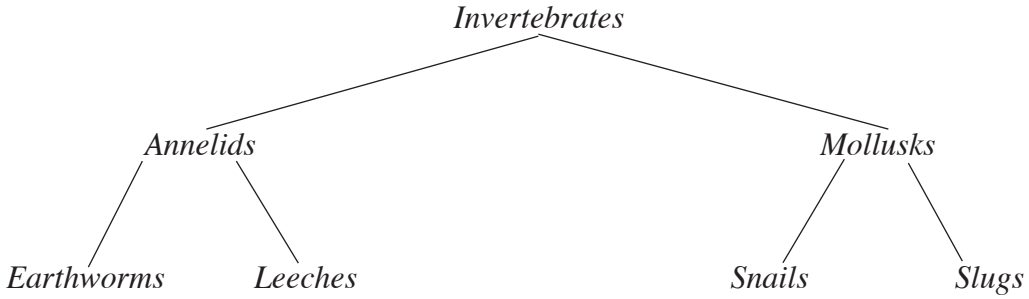
Annelids & Mollusks (no legs) — This group contains two main kinds of creatures, annelids & mollusks. Although annelids and mollusks are really very different kinds of animals, they are grouped together in the critter catalog because all annelids and all mollusks are invertebrates with no legs.

Annelids are segmented worms that have visible rings along the body, showing their segmentation. The Critter Catalog divides annelids into just two groups, earthworms and leeches. There are actually dozens of species of **earthworms**, and many are very small (only a centimeter or two in length). All earthworms are worm-shaped; pointed at both ends with segments between, with no other visible structures except a smooth ring around one part of the body. This smooth ring is called the clitellum and is used for reproduction. Earthworms are decomposers, eating soil and decaying plant matter. They are found burrowing in the ground or crawling on the surface of the ground when it is wet.

Leeches are segmented worms that also have visible rings, but have a flattened body and an attachment sucker at one end of the body. In southeast Michigan there is one species of terrestrial leech and several aquatic species. Most leeches are predators on small invertebrates, but some leeches are parasites that suck blood from vertebrate hosts. Leeches are found in water or in very damp places.

Mollusks include **snails** and **slugs**. There are many species, and the Critter Catalog de-

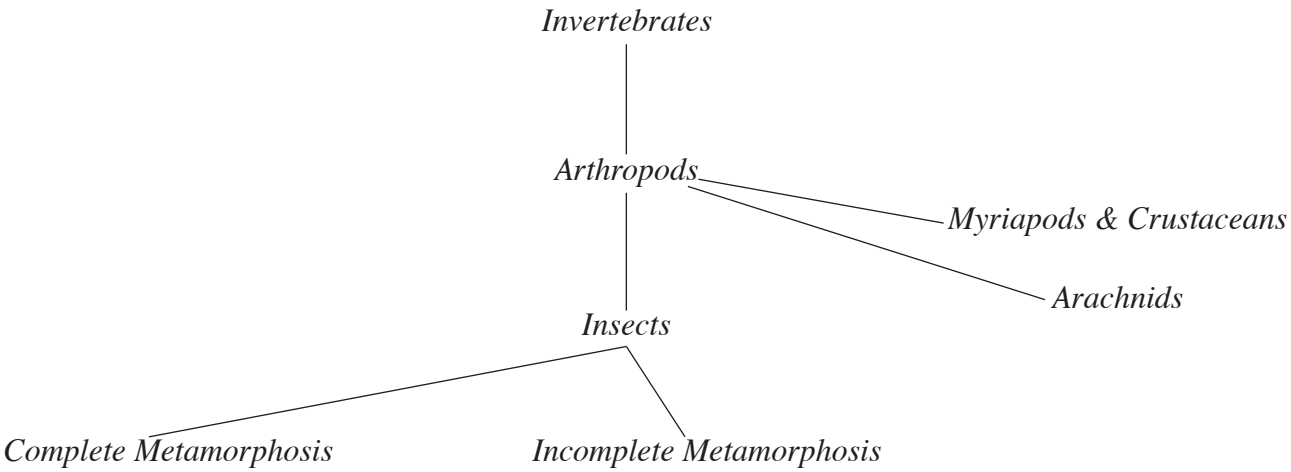
scribes in detail a few species local to southeast Michigan. All mollusks have a soft body with no bones, but some do secrete shells for protection. Snails and slugs move by rippling a muscular "foot" under their body, but just like the annelids, they do not have legs. As they move, they secrete mucus to help them slide along and the mucus leaves a shiny trail as they pass. Most snails and slugs eat plants, algae or fungi, some help decompose dead animals or animal waste, and a few are predators on other snails or slow moving prey.



Insects is the most diverse and ecologically important animal group on land. There are more species of insects than all other land animals put together. Some members of the insect group live in all habitats and occupy almost any microhabitat you can imagine. They can be predators, prey, parasites, hosts, herbivores or decomposers.

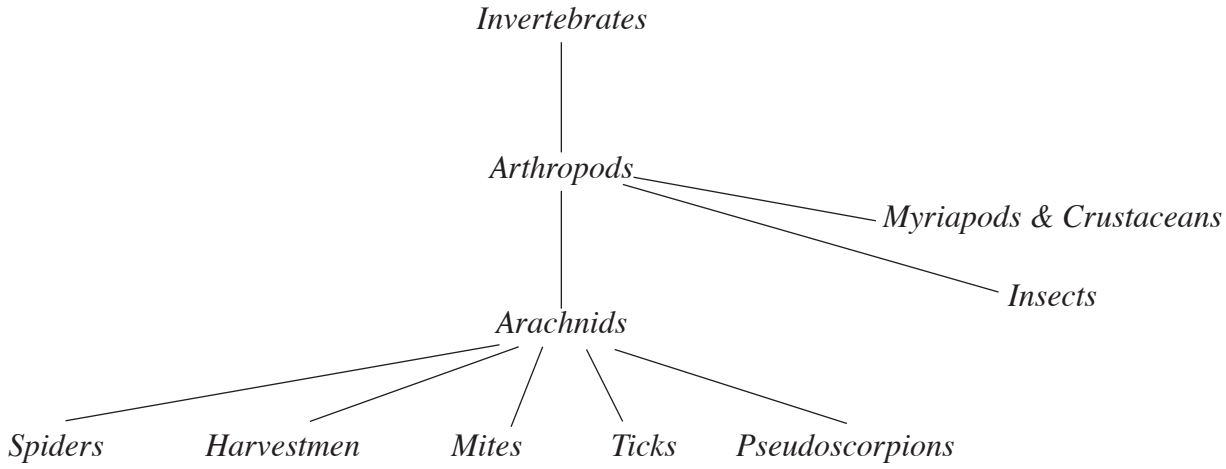
All insects have bodies that are divided into three sections: the head, thorax, and abdomen. In some insects these sections are fused together so they may be hard to tell apart, and some baby insects (called immature) do not have all three sections until they become adults. In all insects, six legs attach to the thorax of the body. Insects are members of a larger group called **arthropods** (which also includes arachnids, myriapods, and crustaceans). All arthropods have a rigid exoskeleton and legs that are jointed (arthropod means "jointed foot"). In order to grow arthropods must shed their whole exoskeleton at once in a process called molting. Insects are the only arthropods that have wings, and the wings are always attached to the thorax.

There are two main patterns of insect growth: complete and incomplete metamorphosis. Insects that have **complete metamorphosis** hatch from eggs as babies that look very different from the adults and often eat very different foods than adults. Butterflies, beetles, and true flies are some of the groups that have complete metamorphosis. The babies are called larvae. Caterpillars and maggots are examples. Larvae are often soft-bodied and go through a resting stage called a pupa before emerging as an adult. Insects that have **incomplete metamorphosis** have babies that look like small adults with no wings and usually eat the same kind of food as the adults do. Grasshoppers and cockroaches are two insects that have incomplete metamorphosis.



Arachnids are **spiders**, **harvestmen**, **mites**, **ticks**, and **pseudoscorpions**. There are hundreds of thousands of species of arachnids and hundreds of thousands of species of mites alone. Arachnids are found in nearly every terrestrial habitat, and there are some in water as well. Arachnids need liquid food, so they inject digestive chemicals into their prey and suck out the juice. Except for mites (which feed on all kinds of things like fungus, plants, dead animals, bacteria, and other invertebrates), all arachnids are predators on insects and other invertebrates.

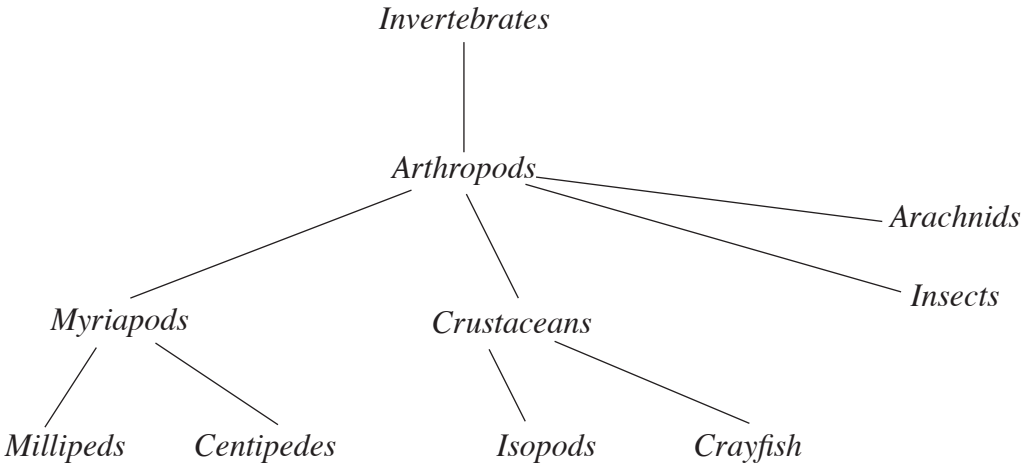
All arachnids have eight legs and bodies divided into two sections, the cephalothorax and the abdomen. No arachnids have wings, although some spiders can float on the wind using long strands of silk. Many arachnids use silk, either to catch prey or as part of the reproductive process. Most arachnids have a simple development where babies look like small adults and just get bigger as they grow. But some, especially the mites, go through more substantial changes during growth. Arachnids are part of a larger group called **arthropods** (which also includes insects, myriapods, and crustaceans). All arthropods have a rigid exoskeleton and legs that are jointed (arthropod means "jointed foot"). In order to grow arthropods must shed their whole exoskeleton at once in a process called molting.



Myriapods & Crustaceans (many legs) — This group contains two main kinds of creatures, myriapods and crustaceans. Although myriapods and crustaceans are really very different kinds of animals, they are grouped together in the critter catalog because all myriapods and all crustaceans are invertebrate arthropods with many legs (10 or more legs). **Arthropods** (a group which also includes insects and arachnids) all have an exoskeleton and legs that are jointed (arthropod means "jointed foot"). In order to grow, arthropods must shed their whole exoskeleton at one time in a process called molting.

Myriapods are millipedes and centipedes. Both millipedes and centipedes need a damp place to live and mostly stay on or under the ground. Millipedes and centipedes look similar but have important differences. Both are long and thin like segmented worms with many legs. **Millipedes** are round in cross-section (like a hotdog) and have two pairs of legs on each body segment. Millipedes are slow moving, often burrow in the ground, and act as decomposers by eating dead leaves, detritus, and fungi. If threatened they can curl up, and some species exude bad-tasting chemicals to protect themselves from predators. **Centipedes** are flatter with only one pair of legs on each body segment. Centipedes are quick moving predators, eating any small animals they can catch. They have a venomous bite like some snakes, but no Michigan species are dangerous to people.

Crustaceans are the most diverse animal group in the oceans. There are only a few crustaceans that have evolved the ability to live on land, but as with amphibians these terrestrial crustaceans still need access to water or damp places to live. Two groups included in the critter catalog are isopods and crayfish. Terrestrial isopods have the common names: pillbug, sowbug, and roly-poly. These little creatures have oval-shaped bodies with 14 legs and a hard exoskeleton of overlapping plates. The overlapping plates allow the animal to roll into a ball for protection from predators. Isopods feed on detritus and can live in any place they can find some moisture and a dark place to hide. **Crayfish** look like small lobsters and are closely related to lobsters. They have a pair of big claws and 10 walking legs. Most crayfish live in freshwater, though a few species come out of the water at night to look for food or new places to live. Crayfish are omnivores, eating algae, small animals, and scavenging on larger dead animals too.



Vertebrates

Mammals, birds, reptiles, amphibians, and fish are all vertebrates – they have a "spinal column" made up of many bones.

Birds are vertebrate animals that have feathers, wings, and beaks. Most birds are able to fly, but some (like ostriches and penguins) cannot fly even though they still have wings. Other kinds of animals like insects and bats can fly too, but birds are the only animals with feathers. Like mammals, birds are warm-blooded which means that they make their own body heat and can stay warm even when the sun is not out. All birds reproduce by laying eggs with hard shells and most birds build nests to protect the eggs from weather and predators. Adult birds almost always sit on the eggs to keep them warm until they hatch. Birds mostly eat high-energy foods like seeds and fruits, insects and other animals, nectar, or meat from dead animals. Very few birds eat other plant parts, like leaves or roots, which are more difficult to digest. Many birds feed insects to their babies to help them grow fast even if the adult birds eat seeds or fruits. The shape and size of bird beaks are adapted to the kinds of food they eat. Birds can be found in all habitats above ground, and there are even some species that make nests in underground burrows.

Mammals are vertebrate animals that have hair on their bodies. Hair can take many forms, including whiskers, spines, fur, and even horns. All mammals have lungs, so even those living in water must come to surface to breathe air. Although two mammal species lay eggs, all others give birth to live babies. All female mammals feed their babies with milk from their own bodies and therefore always care for their babies for a period of time after they are born. Like birds, all mammals are warm-blooded, which means that they can make their own body heat and can stay warm even when the sun is not out. Mammals can be predators, herbivores or omnivores. Different species eat different kinds of food, including other vertebrates (living or dead), invertebrates, green plants, nuts, seeds or fruit. Most mammals live on the ground, but there are many that live in trees or make burrows under the ground, and some mammals like dolphins and whales live their entire lives in the oceans.

Amphibians include **frogs**, **toads**, and **salamanders**. Most species live part of their lives underwater and part on land. Amphibians reproduce by laying eggs that do not have a hard shell. Most females lay eggs in the water, and the babies live in the water, using gills to breathe and finding food as fish do. As the babies grow, most amphibians develop the legs and lungs that allow them to move onto land. This big change is called "metamorphosis." Most amphibians never lose their ability to stay underwater for a long time and almost all have to live in damp places because they lose water easily through their skin. All amphibians are cold-blooded, like the fish and reptiles. Cold-blooded animals are animals that cannot control their temperature and must rely on the sun to heat their bodies. All amphibians are predators on other animals

and will often eat any animal that is small enough to be swallowed whole. Most can only eat invertebrates, but some larger amphibians will eat fish, other amphibians or even small mammals. Most amphibians live on the ground in wetlands or forests, but some live up in the trees and a few species can survive in deserts and other dry habitats.

Reptiles are vertebrates that have scales and lay eggs with soft, leathery shells. **Snakes**, **lizards**, and **turtles** are reptiles. Scales help prevent reptiles from losing water through their skin and the leathery shells give the same protection to eggs. So, unlike fish and amphibians, most reptiles can live their entire lives on land and reproduce in dry habitats. Some types of reptiles (such as sea turtles) are adapted to living in water, but even these species come onto land to lay their eggs. All reptiles also have lungs, so even those living in water must come to the surface to breathe air. Just like fish and amphibians, reptiles are "cold-blooded" which means that they rely on the sun to keep their bodies warm. All baby reptiles look like small adults. There are no flying reptiles, but one snake and one lizard species are expert gliders. Reptile hearing is not well developed, so sight or sense of smell are more often used when hunting for food. Nearly all reptiles are predators on invertebrates or vertebrates, though some turtles are omnivores and a few reptiles eat only plants. Reptiles are found living in all habitats but are more common in warm places.

Fish are vertebrates that live in the water. Fish are the most diverse group of vertebrates with more species in the oceans than any other vertebrate group. They use fins to help them swim and breathe underwater with gills. The gills are usually found in one or more slits in the skin behind their heads. Like reptiles, their bodies are often covered with scales. Some fish lay eggs while others give birth to live babies. Most fish are "cold-blooded" which means that they rely on the sun to keep their bodies warm. In addition to the senses of sight, smell, and taste, almost all fish have a special sensory organ called the "lateral line system" that lets the fish feel vibrations in the water. Many fish can also detect the weak electricity given off by other animals. There are fish that eat just about every kind of food. The freshwater fish included in the critter catalog are predators on smaller fish or invertebrates and a few eat plants. Freshwater fish are found in ponds, lakes, streams, rivers or swamps. Marine fish are found in oceans, estuaries, tidal pools or salt marshes.

5. Animal Needs

(For use in Learning Set 3)

One goal is to encourage students to make the connection between an animal's characteristics and its specific habitat needs. Seeing this connection may be facilitated if students begin their research with the understanding that a suitable habitat for any animal needs to have at least three things: (1) **food/water**, (2) **cover**, and (3) a **place to raise young**.

> **Cover** may mean protection from sun or other elements as well as protection from other animals (called predators) that may eat the animal. **Places to raise young** can mean a protected spot, like a bird's nest, or an area with specific qualities that enable babies to survive. For example, monarch butterflies lay their eggs on milkweed plants, which provide some cover as well as a food source for monarch caterpillars. The things an animal needs *change* over the animal's lifetime, both as it grows and as the seasons change throughout the year. For example, monarch butterfly caterpillars need milkweed leaves to eat in the summer, but the adults get their food from flower nectar.

Some questions require students to go beyond simply summarizing facts, to thinking about how physical and behav¬ioral characteristics of animals help them to survive in their environments.

- Camouflage: combines appearance, habitat, and predators.
- Extreme weather: combines appearance and behavior.
- Finding food: combines appearance and food habits.

Some of these research items will be useful when building food webs (Activity 9). You may need to help students think through these relationships as they answer the questions. The definitions for many of these relationships can be found in the Glossary in section 1.

- "About how many could live in your schoolyard?" question gets at relative abundance of different animals, which will be useful in the food web discussion. If you wipe out an abundant animal, it will stop eating its food, and the food (plants or animals) is likely to increase. Competitors that eat the same food are likely to increase since they will have more food available. However, predators will lose part of their food source, and may be negatively affected.
- "How many babies?" will be useful in considering how different animal species respond to changes (changes in environment, changes in interactions – such as abundance of predators, etc.). Animals that have more offspring can respond more quickly.
- "How long does it live?" may also be useful to consider when thinking about the response of animal populations to changes.

6. Animal Interactions

(For use in Learning Set 3)

There is a large body of terms used to describe particular dietary habits of animals, but, in general, animals can be divided into **carnivores**, **herbivores**, and **decomposers**. Within these broad categories we can more finely characterize the food types that an animal species consumes. So, for instance, many bats eat almost exclusively flying insects. We identify them as insectivores, a type of carnivorous animal. Carnivorous animals might specialize on many kinds of animal foods, such as eggs, fish, blood, carrion, frogs, snails, etc. Herbivorous animals could eat many kinds of plant foods, including seeds, fruit, nectar, leaves, roots or bark (see the Critter Catalog for examples). Decomposers simply consume organic matter not in the form of living organisms. Some animals are dietary specialists; they might eat only certain kinds of food. Other animals are dietary generalists; they might eat many types of food. A common type of generalist is an omnivore. Omnivorous animals eat both plants and animals.

It is important to remember that animal species can interact with each other in many ways; few animal interactions will be characterized solely by a single, general category described above. Animals that are competitors can also interact through predation. For example, hawks and large snakes will both eat small mammals, competing for the same food resource. However, hawks may also eat snakes and some snakes may climb into a hawk's nest and prey on the nestlings.

Organisms can interact either directly or indirectly. When two species interact directly with each other through predation, competition, mutualism or parasitism, they are said to have a direct effect on each other. For example, spiders capture flies in their webs and eat them. As a result the population of spiders will have a direct effect on the population of flies in an area. Indirect effects of one species on another are mediated through their interactions with another species, or perhaps through their interactions with multiple, intermediate species. For example, adding more hognose snakes to an area might reduce the population of toads, which are their favorite prey items. A reduction in toad populations would result in less predation pressure by toads on crickets. Thus the presence of hognose snakes has an indirect, positive effect on crickets. Indirect effects are not restricted to effects through multiple trophic levels, indirect effects can occur between species in the same trophic level as well. Often a change in or the abundance of prey species can change the relationship between competitors. For instance, there are parasitic fly species that attack certain ants. When the flies aren't around, these ants are dominant competitors, chasing off other ants from food supplies. But when these flies are present, the ants hide and other ant species can successfully compete for food. The presence of a predator of one ant species changes the competitive relationship between ant species. It is important to remember that both direct and indirect effects can be either positive or negative.

As you explore the diversity of animal interactions in food webs with your students, remember that the natural world is full of surprises. For convenience we create categories that help us to describe the dizzying complexity around us but rarely do single terms or classification schemes accurately encompass all these possibilities.

7. Animal Biodiversity

(For use in Learning Set 4)

The biodiversity of animal species and communities on earth is truly amazing. More than one million animal species are currently known to science, but that is just a fraction of the estimated 10 million or more animal species existing on earth today. Today, animals live in virtually every habitat on earth, from the deepest ocean trenches to the frigid polar regions, from the searing heat of deserts to forests high on mountains. Some are smaller than the period at the end of this sentence. Others, such as whales, can be huge, weighing thousands of times more than a person. Some are very simple, shapeless lumps of tissue that float in the ocean; others are highly complex creatures capable of rapid motion, complicated social behavior, and even thought and emotion.

The diversity of life is sometimes called biodiversity. But biodiversity can mean different things to different people. It sometimes refers, for example, to numbers of organisms, sometimes to numbers of species, and sometimes to how different the kinds of organisms in a community are from one another. In BioKIDs, students will learn two aspects of biodiversity: abundance and richness:

Abundance

Abundance is simply the number of animals in a particular location. Comparing abundance means comparing these numbers across animal kinds. The abundance of honeybees at a hive is very high (hundreds or thousands of individuals) compared to the abundance of wolves in a pack (usually less than 10).

Richness

Richness is the total number of species recorded in a given location. If a community consists of 3 grasshoppers, a fly, 2 mice, and five starlings, then the richness of that community is 4 because there are four kinds of animals.

Taken by itself, each aspect (abundance and richness) gives us an incomplete notion of biodiversity, but together, they are very informative. Richness is commonly used in comparing the biodiversity of different places. It is sometimes the only measure of biodiversity available. But most people would agree that a community that includes 20 starlings, 20 bluejays, and 10 cardinals is somehow more diverse than a community of 48 starlings, 1 bluejay, and 1 cardinal, even though the richness of each community is the same. For that reason, discussions of biodiversity are most meaningful and interesting when both abundance of individual species and richness are considered.