MANITOBA ENVIROTHON

Wildlife

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THINKTREES
MANITOBA FORESTRY ASSOCIATION

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Introduction to wildlife

Wildlife is defined as animals that are undomesticated and most commonly free-living. They include more than just the mammals and birds living in a wilderness area. Every form of virus, soil organisms, insect, no matter where it lives, is a wild species. The basic habitat needs of food, water, cover, and space are essential to maintaining healthy populations of diverse species in their respective ecosystems. Maintaining a healthy, biodiverse environment is the key to species survival. Biodiversity means the variety of life on Earth. It is most commonly measured as the variety within a species (known as genetic diversity), the variety between species, and the variety of ecosystems. Education and good management practices are needed to ensure a future in maintaining healthy, biodiverse ecosystem.

Canada and Manitoba in particular, has a vast abundance of wildlife resources. The diversity of habitat types has paved the way for diverse ecosystems. The commercial, game, aesthetic, ethical, scientific and ecological values of wildlife have captivated everyone's interest in these organisms and their naturally associated environments.

Ecology

Ecology is the study of the inter-relationships among and between organisms (including wildlife) and all the aspects (living and non-living) of the environment. Organisms compete with other individuals for food and other resources. They also prey upon others, parasitize them, provide them food, and change their physical and chemical environment. Interactions between species can take various forms. Neutral interactions will have no effect on individuals or populations. Positive interactions will benefit either individuals or populations. These interactions are known as mutualism (+/+). In some situations the relationships are one sided where one group or species or individual is benefited while the other is neither benefited nor harmed. This is known as commensalism (+/0). An example of a commensalism is between trees and epiphytes, small plants that grow on the branches of trees. Amensalism (-/0) refers to a relationship where one population or individual is negatively affected while the other remains unaffected. Predation and parasitism (+/-) are two other relationships in which one group is positively affected while the other is negatively affected. Predation involves the killing and consumption of the prey whereas parasitism is an interaction where on (usually small) organism lives on or in another (the host) from which it obtains nutrients. Relationships between populations or species can also have a negative effect on both parties. <u>Inter</u>specific competition represents a negative interaction between two different species. <u>Intra</u>specific competition represents a negative interaction between two individuals of the same species.

Ecosystem – a community of living things interacting with each other and the physical environment. An ecosystem can be a planet, the boreal forest, a stand of trees, a lake, or a fallen log.

Organism – any living individual system (e.g. animal, fungus, microorganism, plant, etc.)

Population – a group of organisms, all of the same species, that live in a particular area

Community – any group of populations of different organisms that are found living together in a particular environment. The organisms interact and give the community a structure.

Habitat

All living things have basic habitat needs, four of which are: food, water, cover, and space. When these needs or habitat factors are in good supply, they contribute to the well-being of wildlife. A short supply of any factor will limit the number and distribution of wildlife and is called a limiting factor. An animal's habitat must provide these basic needs in the proper 'arrangement', which is known as the fifth basic habitat need. Each species of animal has its own habitat requirements.

Food – all animals need food to meet their energy needs: to grow, reproduce, escape predators, and survive chilling winters or long migrations. Each species selects particular foods from the foods that are present in its environment. Some species are more specific about their food selection than others (e.g. specialist versus generalist).

Cover – many animals need shelter or cover to hide in, to raise young, and to protect them from harsh conditions. Dense vegetation is the most common kind of cover, but cover may also include rock piles, burrows in the ground, holes in logs, or bodies of water. Some small animals such as beaver and muskrats, build their own cover in the form of houses.

Water – all animals need water. Many wildlife species get enough water from the food they eat, such as succulent plants, but some also need to drink water.

Space – animals need space to survive. Overcrowding leads to severe competition for food and breeding sites, and eventually to malnutrition and rapid spread of parasites. Most animals are territorial to some extent; that is, they will occupy specific sites sometimes known as their home range. Their territoriality tends to ensure spacing and prevent over-crowding. Because of the need for space, a given area will only support so many animals. Many species have very particular needs for breeding sites. Dense forest cover is needed by moose to conceal newborn calves and by tree-nesting birds to hide their nests. Bald eagles need large old trees to support their bulky nests and these trees must be near the shorelines where they feed. Hole-nesting birds need snags and old trees in which to excavate nests, falcons need cliff ledges, and seabirds that nest in colonies need secluded islands. Some mammals, like foxes, wolves and bears, need particular soil conditions for digging their maternity dens.

Arrangement – the arrangement of food, cover, water and space is important in determining the numbers and distribution of wildlife. For many species of wildlife, the best arrangement is in small blocks that produce edges. For other species, they need large tracks of land that are undistributed by any development for survival.

Carrying capacity

Every region has a limited amount of resources. Due to its limit in resources, it can only support so many animals. The number of animals that an area can support without damage to the habitat or animals is called the **carrying capacity**. The uppermost limit on the size of a population is often determined by the availability of food. For example, the growth of plants depends on the supply of nutrients and solar energy. The quantity of plant material produced determines, in turn, the maximum possible population of herbivores. The number of these animals will then set a limit to the number of carnivores. Food is not the only limiting factor on the growth of a population and so the maximum size of the population may never be reached. For example, there may be enough food to sustain thousands of birds in a region but not enough nesting sites.

Some animals can increase in numbers very quickly and may exceed their carrying capacity temporarily. This results in severe depletion of resources, environmental deterioration, social stress, increased competition for food and possible starvation, and greater exposure to parasites (leading to increased disease), predation, poor reproductive success, and damage to the habitat. For example, multiplying muskrats can very quickly eat all the vegetation in a marsh and then die out. The few individuals that were able to find food while it was scarce will then represent the surviving population. The vegetation will recover and the population will increase again.

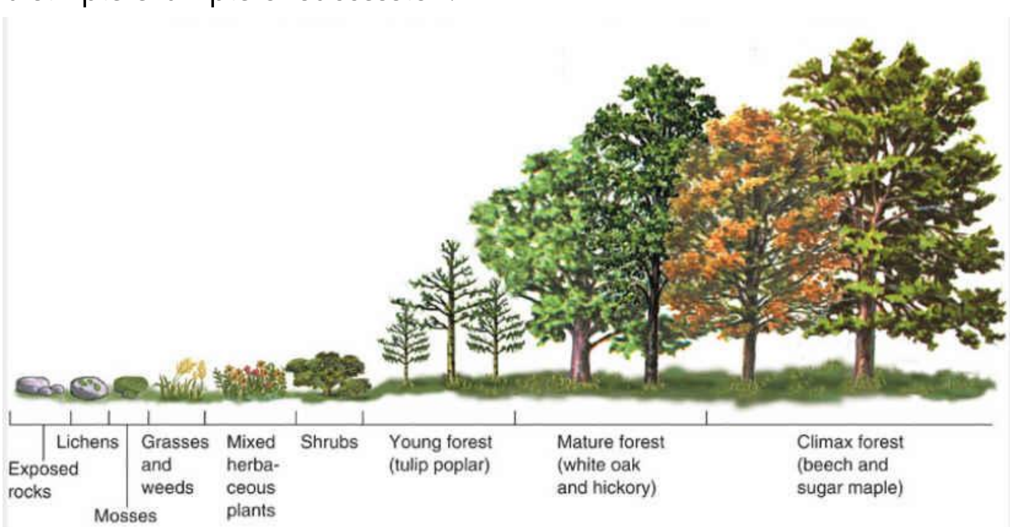
Most animals are food (prey) for other animals, and when their population increases, so does the number of predators. Once the prey population has been reduced, there may be less food for some predators; their numbers will decline and a balance may again be restored. An example of this ‘cyclic population’ is the relationship between the snowshoe hare and the lynx. Lynx, because of their large well-furred feet, are physically adapted to pursuing snowshoe hare and selectively feed on them. Both populations follow a ten-year cycle of boom and bust. The cycle of lynx follows that of the snowshoe hare by one or two years. For example, when snowshoe hare numbers reach their 'low', the lynx population responds with a lower survival rate of young and a lower reproductive rate in females because of the reduced food source.

Succession

Habitat, the complex association of soil, water and plants is in itself dynamic and ever changing. These changes can be subtle or dramatic. A forest fire causes a dramatic habitat change. The coniferous forest, cool and shady, disappears. Eventually, on the blackened, but now sunlit ground, grasses and other plants appear. Each type of plant appears, grows, matures, and disappears to be replaced by others, which also go through their stages and are replaced by still other varieties. This series of changes taking place is not random or haphazard but a predictable, sequential chain of events called succession. **Succession** is the orderly replacement of one biotic community with another. With each successional stage, be it subtle or dramatic, habitat is changed. With changes in habitat come changes in the forms of wildlife using that particular habitat.

The coniferous forest, burned or logged, is replaced by a low ground cover of grass and flowering plants. Over the next few years – shrubs, bushes, willows, aspens and coniferous trees, each in turn, make their appearance. Finally, the forest is once again as it was, composed almost entirely of coniferous trees. This final or climax stage will remain until, as a result of fire or logging, the successional cycle is triggered once again. Each species of wildlife has unique habitat requirements. Therefore, changes in habitat will change the kinds of wildlife associated with it.

Below is a simple example of succession:



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Population dynamics

A population is a group of animals of the same species that occupy a particular area. Dynamics refers to motion or change from within. **Population dynamics** means the changes that occur in a population over time. The study of population dynamics helps explain why wildlife populations must be managed and how. Two major factors affect the population dynamics of wildlife - the birth rate and the death rate.

Birth Rate:
Generally the smaller species of wildlife have higher birth rates than the larger species. The most important factors that affect the birth rate are:
- Age at which breeding begins
- Number of births per year for each breeding female (how many times each year young are born)
- Number of young born per litter

Death Rate:
The smaller species of wildlife have higher death rates than the larger species (in general). The principal factors affecting the death rate of wildlife:
- Availability of food
- Predation and cover
- Weather
- Parasites and disease
- Human activities

Basic groups of wildlife

Wildlife includes all non-domesticated animals within a region. Animals are multicelullar, eukaryotic species that ingest other organisms or their products for sustenance (heterotrophs). They include species that range from small multicellular copepods to the large bison that roam the prairies. Wildlife includes animals from many different groups including vertebrates and invertebrates. There are 35 known phyla, or groups of animals, that are currently found on earth. Below is a brief listing of some common phyla and their distinguishing characteristics.

Porifera – have the most simple cellular organization of animals and a system of pores, with collar cells, through which water passes and they obtain nutrients from this filter feeding. e.g. sponges

Cnidaria – have tissue level organization but no true organs and a gastrovascular cavity that serves as both the mouth and anus. They also have tentacles surrounding this opening, often containing nematocysts (for hunting and predator defence). Cnidarians have two basic body forms, the medusa, like sea jellies, and the polyp, like corals. e.g. corals, sea anemones, sea jellies, and hydra

Mollusca – large diverse group of animals (over 50 000 species) that have soft bodies with a 'head' and 'foot' region. Often they have a hard exoskeleton made from calcium carbonate, secreted by their mantle. e.g. clams, snails, slugs, squid, and octopus

Platyhelminthes – also known as flatworms, they are unsegmented, bilaterally symmetrical worms. They have many species' in this group that are parasitic. They have no respiratory or circulatory systems as they perform these functions through their body wall. e.g. tapeworms, flukes

Nematoda – also known as round worms, nematodes are worm-like species that are surrounded by a strong, flexible layer called a cuticle. It has been suggested that there may be over 500 000 species in this phylum. e.g. hookworms, pinworms

Annelida – segmented worms, where the segments form subdivisions in the body cavity. Each segment contains parts of many body systems including circulatory, nervous, and excretory tracts. e.g. earthworms, leeches, red velvet worms

Arthropoda – This phyla has more species than all the other phyla combined, with the insects (a large group of arthropods) being suggested to have over ten million species still undescribed. Arthropods are strongly segmented affecting both the external and internal structures. They have an exoskeleton made primarily of chitin. Each body segment has a pair of jointed appendages, although these appendages may be modified or even lost. They grow by molting their exoskeletons. Further, many species of arthropods have highly developed eyesight. e.g. insects, crustaceans (lobsters and crabs), spiders, scorpions, and centipedes.

Chordata – characterized by having a structure called a notochord during some part of their development. They are bilaterally symmetrical and have a brain. Chordates also have a tail posterior to their anus at some point of development, a heart, complete digestive system, and a bony or cartilaginous endoskeleton. e.g. birds, mammals, amphibians, fish, and reptiles

Wildlife anatomy and identification

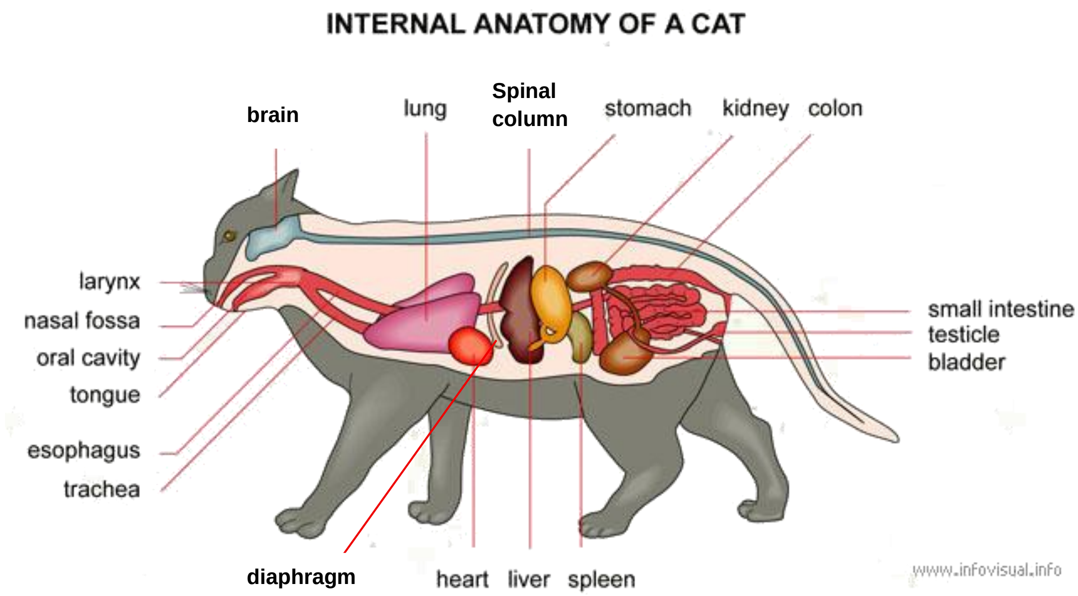
A broad understanding of basic anatomy and identification of wildlife is key when trying to understand their behaviour, abundance, diversity, as well as making management decisions within a region.

Basic anatomy

Mammals are a group of vertebrate species that share a number of characteristic features. They are endothermic homeotherms, meaning they remain at a near constant temperature (most of the time, excluding during torpor or hibernation – see 'Wildlife and Winter' document) with the capacity for internal temperature control. Mammals also have hair at least at some point in their lives. This hair often aids in the control of internal temperature. Mammals also possess mammary glands that they use for nourishing their young. With a few exceptions, they give birth to live young. A few other characteristics define mammals, including a middle ear with three bones, the lower jaw is made from a single bone, and a single muscular diaphragm which splits the body cavity into two sections. The skeleton of a mammal is split into three sections, the cranium (including the skull), axial skeleton (including the vertebrae, spinal column, and rib cage), and the appendicular skeleton (including the girdles and limbs).

Mammals vary in their mode of locomotion. Most move quadrupedally, using all four limbs, although there are a few exceptions to this like humans who can walk upright. Mammals can be cursorial, spending much of their time running to escape predators, catch prey, or possibly migrating (e.g. pronghorns). They could also be ambulatory, spending most of their time walking (e.g. bears). How the mammal contacts the ground also varies based on the species'. Digitigrades run on one or more toes (e.g. carnivores). Unguligrades use their fingernails or hooves to contact the ground (e.g. deer and cattle). If an animal is plantigrade, the ankles to the tips of the toes are imprinted (e.g. rabbits, raccoons, and skunks). Bats are a unique as they are the only mammal to truly fly.

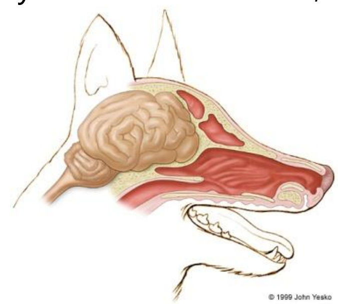
Below is a diagram and description of the major organs within a mammal:



The mammalian body has 11 main organ systems. Each organ system uses various organs to perform its main functions. All 11 organ systems are outline below, followed by a brief description of some of the major organs.

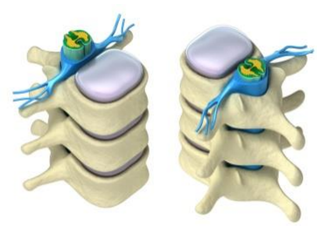
Organ system	Main components	Main functions
Digestive	Mouth, pharynx, esophagus, stomach, intestines, liver, pancreas, anus	Food processing (ingestion, digestion, absorption, elimination)
Circulatory	Heart, blood vessels, blood	Internal distribution of materials
Respiratory	Lungs, trachea, other breathing tubes	Gas exchange (uptake of oxygen, disposal of carbon dioxide)
Immune and Lymphatic	Bone marrow, lymph nodes, thymus, spleen, lymph vessels, white blood cells	Body defence (fighting infections, pathogens, disease)
Excretory	Kidneys, ureters, urinary bladder, urethra	Disposal of wastes and maintenance of osmotic balance of blood
Endocrine	Pituitary, thyroid, pancreas	Coordination of body activities
Reproductive	Ovaries, testes, and associated organs	Reproduction
Nervous	Brain, spinal cord, nerves, sensory organs	Coordination of body activities
Integumentary	Skin and its derivatives (e.g. hair, claws, skin glands)	Protection against mechanical injury, infection, drying out, thermoregulation
Skeletal	Skeleton (bones, tendons, ligaments, cartilage)	Body support, protection, movement
Muscular	Skeletal muscles	Movement, locomotion

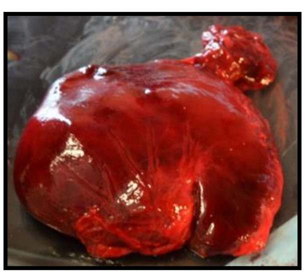
Brain – The brain is the center of the nervous system. It is generally located in the head, close to primary sensory organs (for vision, hearing, taste, and smell). It is the most complex organ in the body and is composed of neurons that communicate with connections called synapses and glial cells, which give structural support, metabolic support, insulation, and development guidance. It is the centralized control over all the other organs of the body, allowing for rapid and coordinated responses. The image to the right is the brain and head of a canid (e.g. dog).



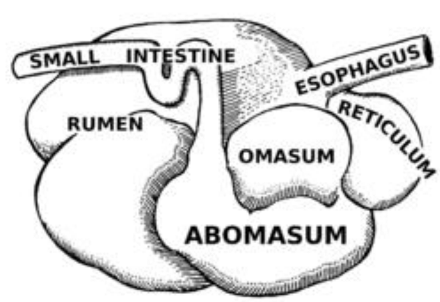
Lungs – the lungs is the mammals' essential organ for respiration. They have two lungs located near the backbone on either side of the heart. The lungs are composed of millions of specialized cells that form tiny, thin walled air sacs called alveoli. Once the air is brought through the mouth it moves through the larynx, trachea, bronchi, and bronchioles until it reaches the alveoli where the gas exchange of carbon dioxide (from the bloodstream to the air) and oxygen (from the air to the bloodstream). This breathing is driven by the muscular diaphragm which is located at the bottom of the thorax. The image to the left is a set of lungs from an arctic fox.

Spinal cord and vertebral column – The spinal cord is a long thin, tubular bundle of nervous tissues and their supporting cells that extends from the brain. With the brain, the spinal cord is part of the central nervous system. The vertebral column (also known as the backbone) is formed from the vertebrae and protects and holds the spinal cord. It is split into the cervical, thoracic, lumbar, and sacral sections.





Stomach – The stomach is a muscular, hollow part of the digestion system which functions in the second phase of digestion. It is located between the oesophagus and small intestine. It secretes enzymes, such as protease, and strong acids aiding in food digestion. It also uses smooth muscular contractions (called peristalsis) to further digest the food. The food (now known as chyme) then is sent into the small intestines for further digestion. The image to the left is a stomach from an arctic fox. The stomach of some species of mammals has

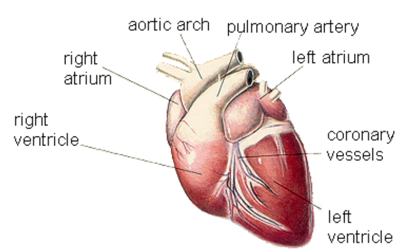


evolved with their diet. For example, ruminants are a group of mammals that digest plant-based food by first softening the food in the first compartment of the stomach through bacterial digestion and then regurgitating the semi-digested solution (known as cud) to be chewed again. The image to the right roughly illustrates a ruminant digestive system. Ruminants include cattle, white-tailed deer, elk, moose, and bison.

Kidney – the kidneys (each mammal has a right and left kidney) are organs that assist in essential regulatory functions. They are essential in the urinary system and assist with homeostatic functions like the regulation of electrolytes, blood pressure regulation (through water and salt balance) as well as maintaining the pH of blood. The kidneys act as a natural filter of blood, removing wastes that are then moved into the urinary tract and excreted through the bladder. They also take up or participate in the reabsorption of sugars (glucose), water, and amino acids. Large amount of fat stores generally surround the kidneys and are one of the last places an animal will lose fat when they are starving. Wildlife biologists often use the amount of fat around the kidney as an index of the condition of the animal. The image on the right is the kidney (split down the middle) from an arctic fox.

Diaphragm – this large sheet of flexible skeletal muscle that extends across the bottom of the ribs separates the thoracic cavity (heart, lungs, and ribs) from the abdominal cavity (includes the liver, stomach, intestine, kidneys, etc.). It is a key muscle in respiration. As the diaphragm contracts it increases the volume of the thoracic cavity and air is drawn into the lungs. The image on the left is a diaphragm from a red fox.

Heart – the heart is one of the key organs in the circulatory system. It is a hollow muscle which is responsible for pumping the blood throughout the blood vessels through its repeated rhythmic contractions. The heart is primarily made from cardiac muscle and connective tissue. Mammalian hearts have four chambers, two atria and two ventricles.



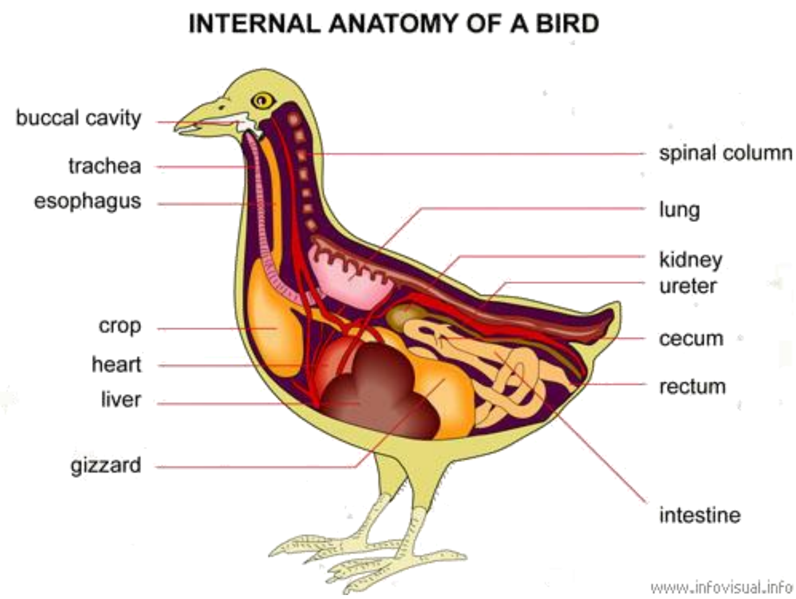
Liver – the liver is the largest internal organ that serves a wide variety of functions, including detoxification, glycogen storage, protein synthesis, hormone production and the biochemicals necessary for digestion. It is an essential organ for survival. It consists of four lobes of unequal size and shape. The gall bladder (seen here in green) is closely associated with the liver. The bile is produced in the liver and collected in the bile ducts and then store in the gall bladder.

Spleen – the spleen is a small organ located in the abdominal cavity, often near the intestine. It is important for the functioning of the immune system and blood filter. It removes the old red blood cells, recycles iron, and has a reserve of blood. Since the spleen is involved in the immune system, wildlife biologists often use its mass and the proportion of white pulp mass to red pulp mass as indices of immune function. The image to the right is a spleen from an arctic fox. Note, this spleen in the image has a lesion (abnormality in tissue) on the right side.

Intestine – the intestine is a portion of the digestive system, extending from the stomach to the intestine, commonly considered to be split into two main segments, the small and large intestines. Food passes through the intestine and nutrients from this food is absorbed. The large intestine hosts many different types of bacteria that assist the mammals in breaking down molecules that they can not alone. The large intestine is also concerned with the absorption of water from the food which has been digested. The length of the intestine is often associated with the diet of the species. Herbivorous species tend to have longer, more developed intestines, whereas carnivores have shorter, small intestines. The image to the left is an intestine (with stomach attached) of a red fox.

Reproductive Organs – The reproductive system is a group of organs within an individual that work together to assist in reproduction. Sexes of mammals have different organ systems. The major organs include the external genitalia (penis in males and vulva in females), as well as internal organs including the gonads (testicles in males and ovaries in females) where gametes are found. In mammals, most males also have a baculum, or a penis bone, with humans being one exception. The uterus and vagina (found in females) are unique to mammals with nothing similar seen in any other vertebrate (e.g. birds, reptiles, amphibians, fish). The image to the right is of the ovaries, two-horned uterus, and vagina of a red fox.

Birds, also known as Aves (their class), are feathered, winged, bipedal, endothermic vertebrate animals. There around 10 000 living species of birds. They range in size from the bee hummingbird (5 cm long) to the ostrich (2.75 m long). They are characterized by their feathers, a beak that lacks teeth, laying hard-shelled eggs, high metabolic rate, and a lightweight but strong skeleton.



Many of the organs are similar between birds and mammals, including the heart, liver, brain, spinal cord, kidneys, and intestine. Birds also have crops, gizzards (both part of the digestive system) as well as a cecum.

Crop – the crop is an extension of the oesophagus that is used for food storage prior to digestion. It is particularly developed in birds that eat grains. It is not present or well developed in all birds. In some birds (e.g. pigeons and doves) the crop produces "crop milk" that is used to feed their young for the first two weeks after hatching. In many other species (e.g. ospreys) the birds will regurgitate food located in the crop and feed this to their young.

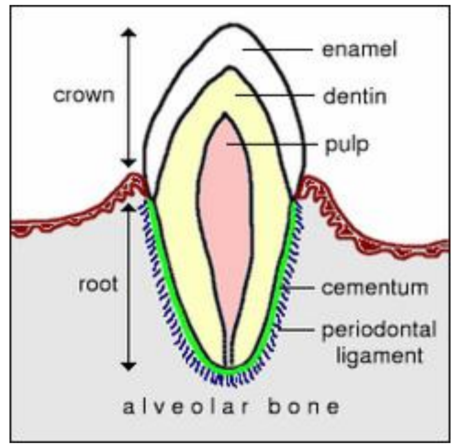
Gizzard – the gizzard is a very muscular portion of the digestive tract (part of their stomach) that can be stones or other grit that assists the bird to break down its food into small particles. It serves the same function as mammalian teeth.

Cecum – the bird cecum is a pair of small pouches that project from the large intestine where it meets the small intestine. They range in size from very long to short or entirely absent. It can serve various functions, including the digestion of small food particles, absorption of nutrients and water.

Skulls and teeth

Skulls and teeth are important tools we can use not only to identify the species of specimen in the field but also can give us insights into the life of the animal, what it eats, how it forages, or even special adaptations to its environment.

Birds, reptiles, fish, and amphibians have homodont teeth (if teeth are present), meaning all the teeth are the same relative shape and morphology. Mammals are unique in the fact that they have heterodont teeth, generally including incisors, canines, premolars, and molars. They suggest that the animal has some level of hunting and or feeding specialization. Differences in the structure of mammalian teeth give some clues to the foraging activities of the species.



To the left is an image of the basic structure of a mammalian tooth. As the cementum layer is added annually in most species of mammals, analyzing teeth can also provide the age of the individual.

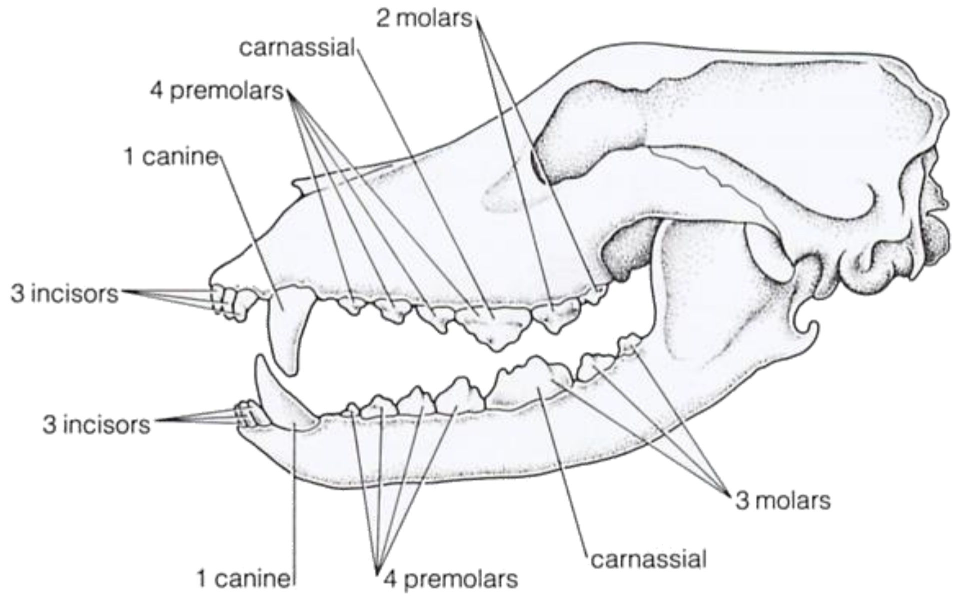
Dental formula:

The number of different tooth types found in a skull can be expressed using the dental formula. It can then be used to identify a skull. To find the dental formula of an individual skull you must identify the number of teeth of each type (incisors, canine, premolars, and molars) on the top and bottom of one HALF of the skull (either left side or right side). Upper numbers in the fraction are for the upper teeth; lower numbers in the fraction are for the lower teeth. The "2" in the front of the formula indicates that this arrangement of teeth is the same for both sides of the mouth.

I – Incisors, C – Canines, P – Premolars, M- molars

$$2(I\frac{upper\ teeth}{lower\ teeth}\ C\frac{upper}{lower}P\frac{upper}{lower}M\frac{upper}{lower})$$

For example in a dog skull,



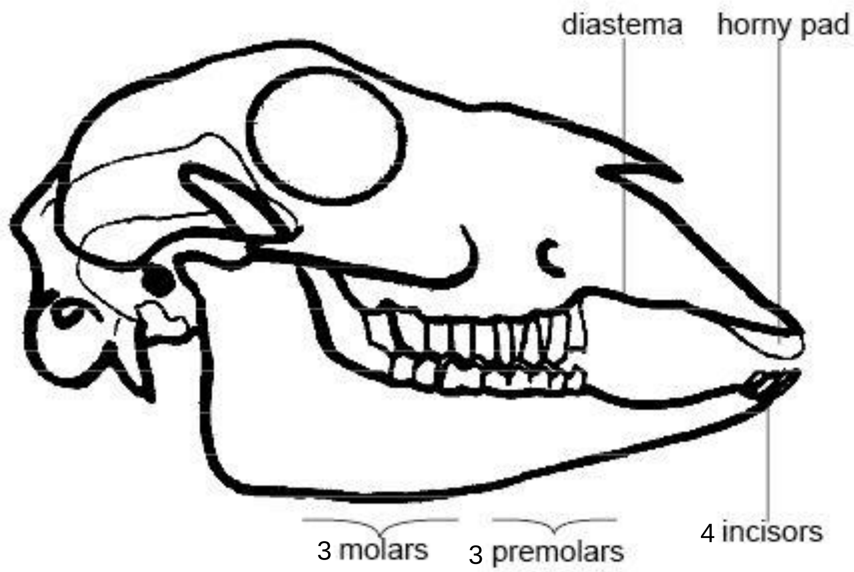
$$2\left(I\frac{3}{3}+C\frac{1}{1}+P\frac{4}{4}+M\frac{2}{3}\right)$$

$$2\left(\frac{3+1+4+2}{3+1+4+3}\right)=2\left(\frac{10}{11}\right)=2(21)=42$$

The calculation of the total dental formula involves the addition of the number of all the upper teeth plus the combination of all of the lower teeth. This is then multiplied by two (to account for the two sides of the skull) to calculate the total number of teeth in the skull. The dental formula of the individual is then reported as below:

(3/3,1/1,4/4,2/3)=42

A second example of a sheep's skull,



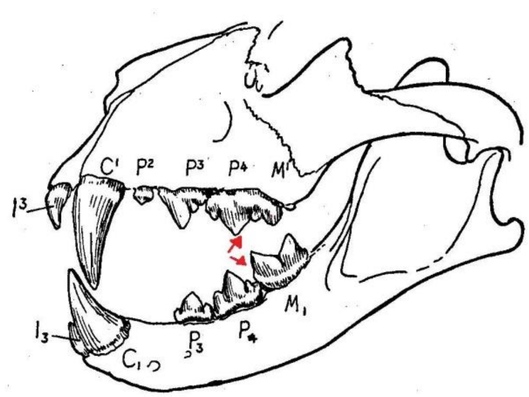
$$2\left(I\frac{0}{4}+C\frac{0}{0}+P\frac{3}{3}+M\frac{3}{3}\right)$$

So the dental formula for a sheep would be (0/4, 0/0, 3/3, 3/3) =32

Specialized mammalian dentition:

<u>Carnassial Pair</u>

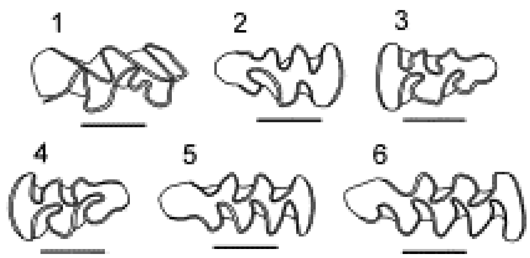
The carnassials are a pair of teeth on each side of jaw (4th upper premolar and 1st lower molar) that do most of the shearing action when a carnivore is eating meat. This tooth specialization is only found in the order Carnivora.



Cheek Teeth

These teeth (including premolars and molars) do most of the mastication of the food so they display a high amount of variation and adaptation. Examples of cheek teeth modifications include: microtine, brachyodont, hypsodont, euthemorphic, bunodont, lophodont, and selenodont.

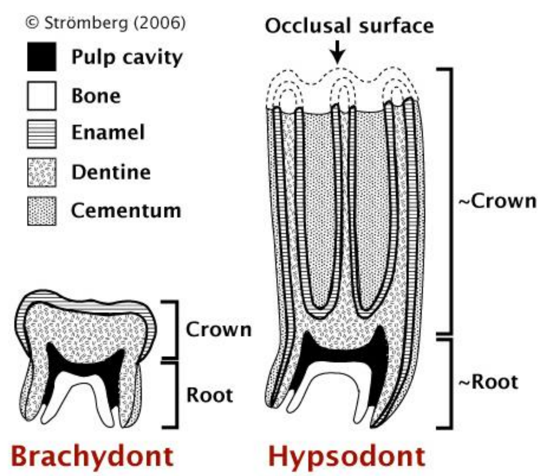
Microtine teeth are zig-zag prisms with loops. They are characteristic of many species of rodents including lemmings and voles.



Storer 2003

Brachyodont teeth are low crowned teeth that are associated with species that are omnivorous or carnivorous, like coyotes, lynx, primates or humans.

Hypsodont teeth are high crowned check teeth that are generally seen in herbivores. In some species these teeth may be rootless and continuously grow. They are found in species such as deer, cattle, and horses.



Euthemorphic teeth are square shaped teeth that are found in most living mammals although their form may vary.

Bunodont teeth are euthemorphic, brachyodont teeth that are found in bears, raccoons, primates, and pigs.

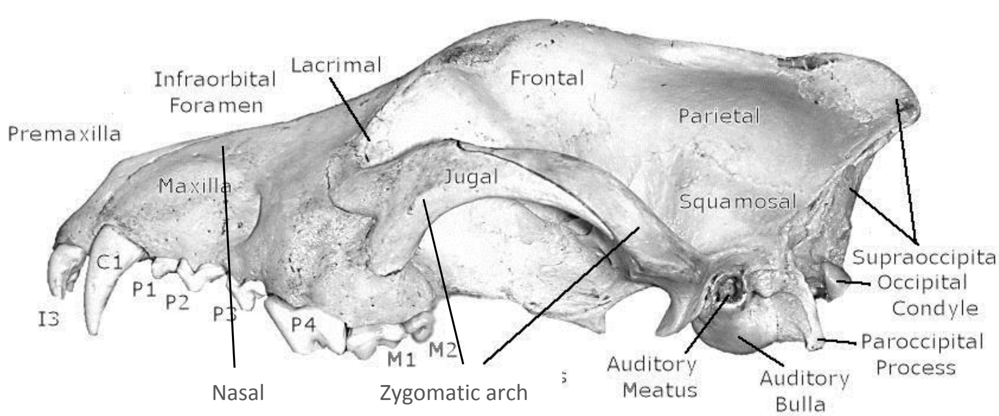
Lophodont teeth have fused cusps to form lophs or ridges. They are seen in herbivores, including many species of rodents, as the ridges create abrasive surfaces for grinding plant material

Selenodont teeth have ridges that are created by the lengthening of a single cusp with each ridge being crescent-shaped. This type of tooth is usually seen in herbivores such as deer, elk, caribou, and cattle.

Skull identification and measurements

Mammal Skulls

The identification of a skull (species) can be determined by several methods. The use of a dichotomous key allows a person, through a series of questions, to identify an organism to species by process of elimination. Other measurements of the skull can be taken to help in this process. Common measurements include **Condylo-basal length** (from the occipital condyle to the furthest edge of the premaxilla) for the length of the skull, **zygomatic breath** (greatest distance between the outer edges of the zygomatic arches (or process)) for the width of the skull, and **nasal length** (distance from the edge of the premaxilla to end of the nasal bone) for the length of the nose.



In combination with the structure of the teeth, a mammal skull can tell you a lot about the diet and lifestyle of its owner. Above is a picture of a canid (carnivore) skull. Below are diagrams of some basic mammal skulls from major mammalian groups.

Beaver (Rodent) skull

Bat skull (note reduced incisors)

Shrew (Insectivore) skull

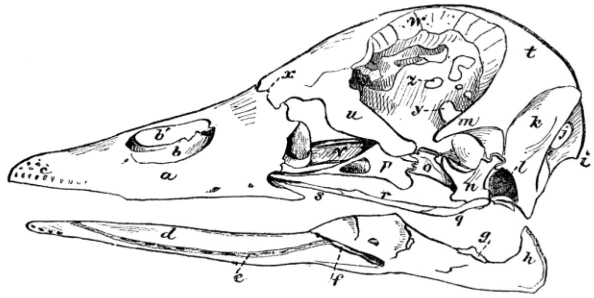
Beluga (cetacean) skull

Snowshoe hare (Lagomorph) skull

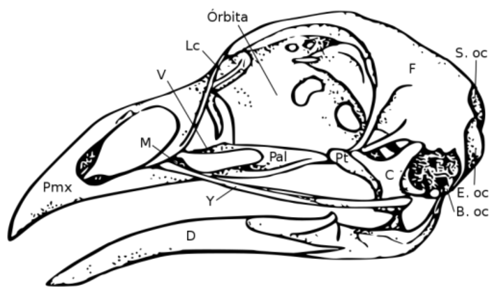
Moose (Artiodactyla) skull

Bird Skulls

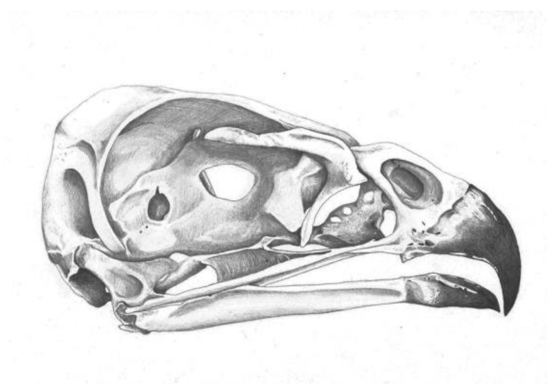
The beak of a bird is an extension of its skull and is designed for feeding. Some beaks have evolved to specialize in feeding specific items. A duck, hawk, hummingbird and sparrow are all birds, but their beaks are very different due to their different diet. A duck has a wide flattened "bill" used for eating aquatic plants and mosses. A hawk has a sharp hooked beak used in tearing flesh from its prey or carrion. A hummingbird uses its long narrow beak to lap nectar from flowers and a sparrow has a small powerful beak used for picking berries and cracking seeds. As you can see, a bird's beak can tell you a lot about not only the diet, but also the lifestyle of its owner. Below are diagrams of basic bird skulls.



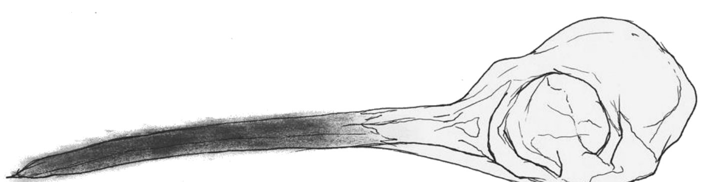
Duck Skull



Crane Skull



Hawk Skull



Hummingbird Skull

Horns and Antlers

Horns or antlers found on a skull bear evidence of how an animal communicated, defended its self and possibly the animals sex. Animals can protect themselves or attack other animals by goring them with their horns or antlers. Bighorn sheep, muskox and deer use their horns or antlers for establishing territory and winning mates. Horns are permanent structures that grow year after year. Depending on the species, both male and female bovid animals (cattle, gazelle, antelope, etc.) can have horns. Antlers, however, are temporary. Antlers grow, develop and shed from the animal once a year. Antlers are branched and only found in the cervid family (deer, moose, elk, etc.). With the exception of the female caribou, only male cervids have antlers.

Bighorn Sheep
with horns

White-tailed Deer
with antlers

Animal acclimation and adaptation

Adaptation is any behavioural, morphological, or physiological trait that is a result of natural selection. This inherited characteristic should enhance an organism's ability to survive and reproduce in their environment. Some individuals, who often possess these adaptations, will leave more offspring than others. These individuals are considered to be more 'fit' than others because they contribute the most to the entire population's gene pool. Differences in the reproductive success of individual organisms come about through the process of natural selection. Under a specific set of environmental conditions, the individuals that survive the best or have adaptations to best survive those conditions are selected for. Any individuals that either do not have adaptations to survive and reproduce in these conditions or survive worse than others will be selected against.

Acclimation is the short-term response of an individual to different or changing natural environments. For many species, this acclimation occurs each season. For example, a fish inhabiting a pond in which the water temperature changes from summer through to winter. As the winter cools in fall and winter, the tolerance for low temperatures increases, while their tolerance for high temperatures decreases. Conversely, as the water warms during the spring, the tolerance of the fish for warmer temperatures gradually increases. Although their tolerance changes with the seasons all of this shifting takes place within the adaptive limits of the fish.

Basic needs and adaptation

All wildlife need to solve a common set of problems. They must obtain oxygen, nourish themselves, excrete waste products, and move.

Abiotic factors, such as temperature, water, sunlight, wind, rocks and soil, and climate all impact an animal's ability to obtain the resources they need to live and ability to survive in the environment. The temperature of an area affects all biological processes. The availability of water within regions affects species distribution as all species need water to survive and many species live within this water. Sunlight provides the energy that plants use to grow. As the primary food source the abundance and distribution of plants in an environment will impact the abundance, density, and diversity of wildlife in a region. Additionally the physical structure of rocks and soil limit the distribution of plants and thus the animals that rely on them. Climate is one of the biggest abiotic driving factors that influence the distribution of wildlife on earth. Climate influences the temperature of a region, availability of water, sunlight, and wind, as well as the structure of rocks and soil. It also limits the biological process of all living organisms and thus plays a large role in dictating the diversity and abundance of wildlife.

Animals need to derive their energy from organic carbon compounds. All animals eat other organisms to stay alive. The ultimate source of these organic compounds is plants. More details about how animals obtain energy and the flow of energy through an ecosystem are discussed in Trophic Ecology.

Animals are required to obtain oxygen from their environment to stay alive. Groups of wildlife obtain this oxygen and distribute it through their bodies differently. Wildlife must take molecular oxygen (O_2) from their environment and release carbon dioxide (CO_2) back into the environment. The exchange of gases occurs on the respiratory surface. The oxygen must then be supplied to the entire body (through the circulatory system) and carbon dioxide removed. The structure of the respiratory surface depends on the size of the organism, its habitat, and its evolutionary past. Some animals, such as earthworms and some amphibians, use their entire outer skin as a respiratory organ. Gills, outfoldings of the body surface, are used by some aquatic invertebrates (e.g. sea stars, segmented worms, scallops, crayfish, etc.) as their respiratory surface. Tracheal systems are used in insects. The tracheal system is made up of air tubes that branch throughout the body. Lungs are a respiratory surface that is restricted to one location. They have a dense net of capillaries that form the main respiratory surface. They are present not only in mammals and birds, but other vertebrates, terrestrial snails, and spiders. The size and complexity of the lungs are correlated with the animal's metabolic rate. Further adaptation is seen within these basic respiration surfaces. For example, bird ventilation is much more complex than observed in mammals. The additional complexity increases the concentration of oxygen within the birds allowing them to fly at high altitudes.

An animal's size and shape are fundamental aspects of form and function that affect the way an animal interacts with its environment. Physical requirements constrain what natural selection can select for, including the size and shape of an animal. For example, physical requirements limit the size and shape of flying animals. An animal the size and shape of a mythical dragon could not generate enough lift with its wings to get off the ground. In contrast, a small hummingbird is light for its size and is well adapted to flight.

Habitat and specialized adaptation

Wildlife adapt themselves to the habitat in which they live. Specialized adaptation of each species to their habitat ensures their survival and continued ability to reproduce. This adaptation also allows species to survive predictable changes in their environment, such as the onset of winter or summer, or the wet or dry seasons.

Thermoregulation

Thermoregulation is the process by which animals maintain their internal temperature. Animals use different strategies to manage their "heat budgets". All of these strategies have both large benefits as well as costs associated with them.

Ectotherm – gain most of their heat from the environment

Many ectotherms regulate their body temperature through behavioural means, such as basking in the sun or seeking out shade. They include invertebrates, fishes, amphibians, lizards, snakes, and turtles.

Endotherm – use metabolic heat (from their body) to maintain or regulate their body temperature

Examples include mammals, birds, a few reptiles, some fish, and a few insect species.

The maintenance of a constant body temperature is another adaptation that is seen in some animal species.

Pokilotherm – an animal whose internal body temperature varies widely

Examples include fish and invertebrates.

Homeotherm – an animal whose internal body temperature remains relatively stable

Examples include mammals and birds.

Although we generally think of all ectotherms also being pokilotherms (or 'cold-blooded') and all endotherms being homeotherms (or 'warm-blooded') there are many species that have different adaptive strategies. Many species of marine invertebrates and fish are ecotherms but because of their environment their body temperature remains relatively constant, making them homeotherms. Further, some mammal species experience large variations in body temperature through the year (e.g. hibernation) despite them being endotherms.

Animals have many adaptations to assist them with thermoregulation. They include insulation (e.g. hair, feathers, blubber, etc.), circulatory adaptations (e.g. vasodilation, vasoconstriction, countercurrent heat exchanger, etc.), behavioural responses (e.g. hibernation, migration, etc.), and adjusting metabolic heat production (e.g. brown fat). More of these adaptations are highlighted in 'Wildlife and Winter'.

Camouflage

Camouflage is the set of methods of concealment that allows otherwise visible animals to remain unnoticed by blending in. In many animal species, young are born with dappled brown coats so that they can blend into the brush or forest. The arctic fox and snowshoe hare change into a white coat during the winter period to blend into their snowy environment. They shed this winter coat in the summer period. It is replaced by a mostly brown coat.

Mirnesis is a type of camouflage where an animal resembles something else in its environment. For example (as seen in the photo to the left), the stick insect mimics a stick, hiding itself from predators. Crypsis is a type of camouflage where the animal means to be hidden. Cuddlefish (as seen in the photo to the right) are very good at matching the colour and texture of their environment protecting them from predators. Many species of octopuses camouflage in the environment, allowing them to capture prey more easily.

Antlers, Horns, and Teeth

Antlers are an ornamentation that is shed yearly. Moose, caribou, deer, and elk grow antlers, which they use in mating displays, as protection against predators, and in foraging for food. Muskoxen, Dall sheep, and mountain goats grow horns, which they use in mating displays and defense from predators.

Animal teeth, particularly mammalian teeth, have also evolved according to diet. For example, grazers’ molars are large and flat, ideal for grinding up grass before swallowing. Baleen whales, such as humpbacks and bowhead whales, have long flexible strips of baleen instead of teeth. These are good for filtering tons of tiny plankton, krill, and small fish for food. Walrus tusks are used in defense against predators and as tools for digging molluscs on the bottom of the sea.

Behaviour

Each animal species has unique behaviours that allow it to survive in its habitat. Examples include different social organizations, such as flocks or herds (geese, cranes, caribou, sheep, goats, elk, muskoxen, fur seals, walrus), family groups (eagles, wolves, whales, river otters, foxes, beavers), solitary life (moose, lynx, wolverines, porcupines), and colonies (many rodents).

Other adaptive behaviours are defensive strategies. For instance, muskoxen form a tight circle around the herd's young when threatened by predators. The adults face the outside of the circle, showing only their horny brows and front hooves.

Still other adaptive behaviours include hunting methods, such as wolves' pack hunting, killer whales' and humpback whales'

Wolf pack

circles of bubbles that trap fish, and bears' use of their long claws to swipe salmon from streams.

Trophic ecology

Trophic ecology is the study of how energy moves through an ecosystem. All organisms must obtain energy for their growth, survival, and reproduction. The methods of obtaining these resources and the impacts of resulting interactions are all studied within trophic ecology.

Autotrophs – organisms that use inorganic sources of carbon and energy from solar radiation. Examples include plants, algae, and certain bacteria. They are also known as PRIMARY producers.

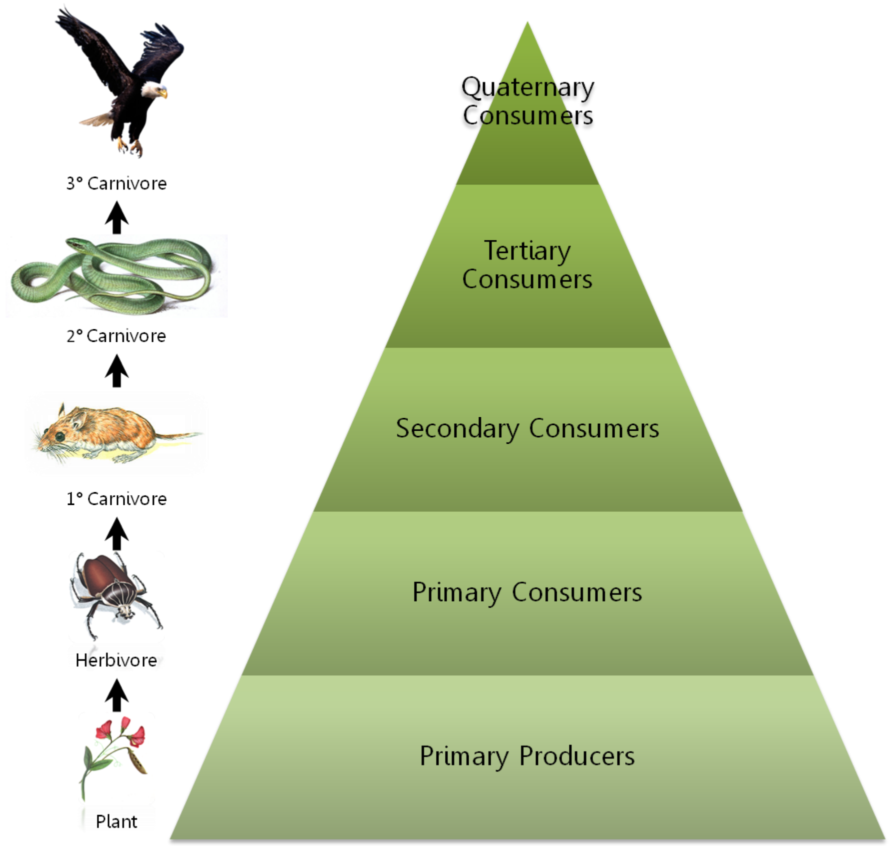
Heterotrophs – organisms that use organic sources of carbon by consuming other organisms or their by-products. Examples include animals, bacteria, and fungi. They are often referred to as SECONDARY producers.

> **Consumers** – these are heterotrophs that consume other organisms
> **Decomposers** – these are heterotrophs that consume dead organic matter or waste products

Herbivores – organisms that primarily consume plant materials. They include grazers (feed on leafy material like grasses), browsers (feed on woody material), granivores (feed on seeds), and frugivores (feed on fruit).

Carnivores – organisms that are 'flesh-eaters'. They consume herbivores or other carnivores. Individuals that feed directly on herbivores are considered first-level carnivores (second level consumers). Individuals that consume both herbivores and first-level carnivores can be considered second-level carnivores (third level consumers).

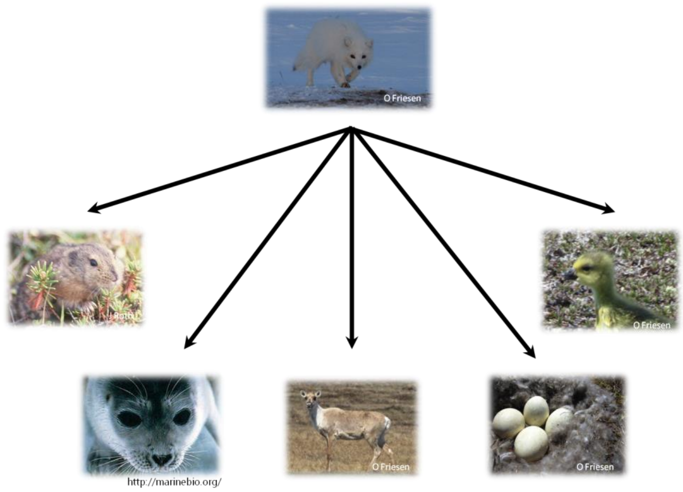
The trophic level is a stem in the transfer of energy, or food, within a food web or chain. There may be several trophic levels within a system, including primary producers, primary consumers, and secondary consumers. Further carnivores may form fourth and fifth levels. Primary producers are the most abundant food source and biomass (mass of organic material) available. Primary consumers, who consume primary producers, are the second most abundant group of organisms. Tertiary and quaternary consumers represent the smallest groups of organisms. The amount of energy in each a trophic level is reduced with every step up.



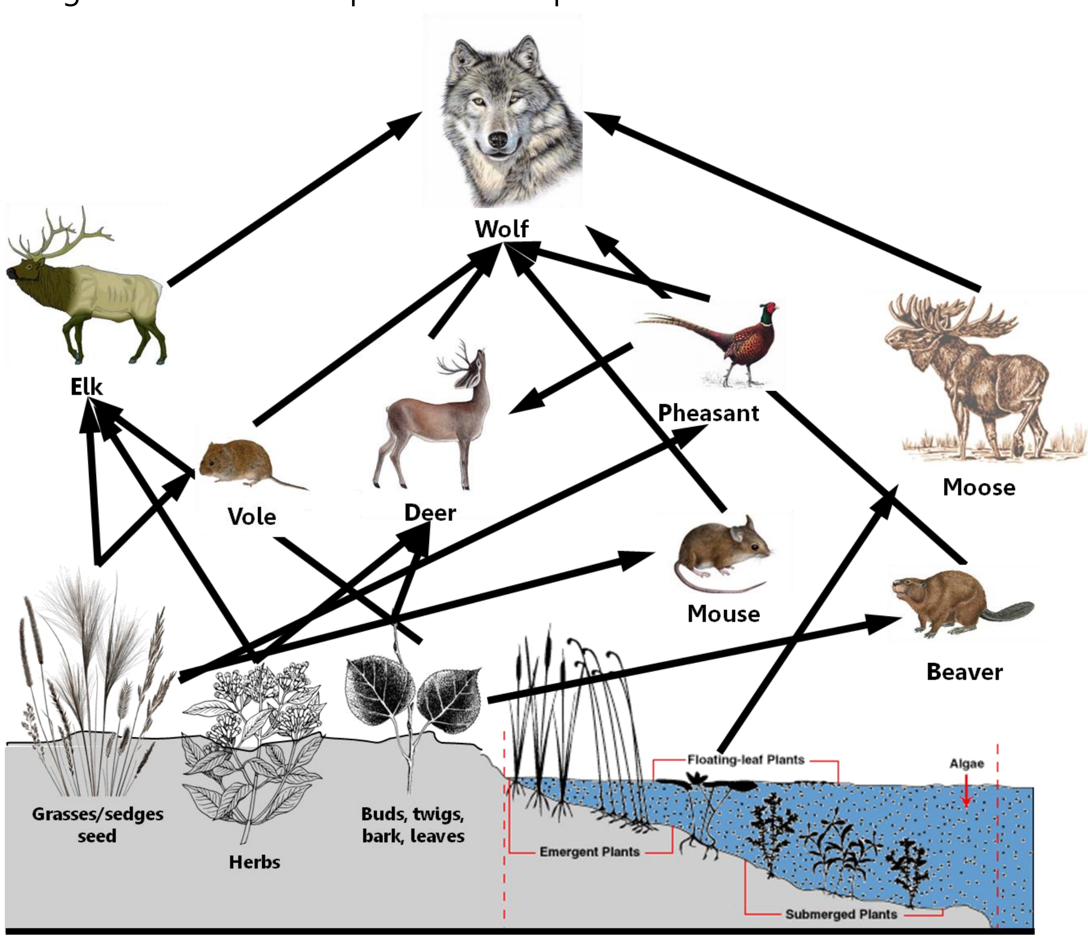
Many species can feed on different trophic levels. For example, the red squirrel often will consume acorns or fruits, primary producers, and so it acts as a primary consumer. However, red squirrels can also consume insects or nesting birds. When they consume these prey sources they are acting as secondary consumers.

Most food webs are interconnected. Animals typically consume a varied diet and, in turn, serve as food for a variety of other species that prey on them. These interconnections are very important for the structure and diversity of an ecosystem.

For example, below is a simple food web of the diet of an arctic fox. It can consume a variety of different items that all come from different trophic levels.



The arctic fox consumes lemmings (primary consumers), caribou (primary consumers), goslings (primary consumers), as well as seals (secondary or tertiary consumers). Food webs can get much more complex. For example is a boreal forest food web:



Note that even though this food web may seem complex it is missing many species that are important including, but not limited to, insects, arachnids (spiders, ticks, mites), many species of parasites (including cestode (tapeworm), nematodes, trematodes (flatworms)), fishers, weasels, foxes, and many species of birds (especially song birds and raptors).

Ecology and wildlife management

Wildlife conservation and management is the protection and use of wild-animal populations and of the land necessary to support them to ensure that productivity and ecological balance are maintained in perpetuity, while social benefits are realized. Human activity has become one of the most significant influences on the abundance and well-being of wildlife.

The over exploitation, or misuse of wildlife as a resource, has a long history in Canada. Wildlife, fish, and timber were previously free for the taking for personal use, or could be converted into a monetary return. In the early 19th century this attitude had removed elk from their eastern most limits near Ontario. The bison previously numbered in the millions across the North American plains. By 1885 they were almost gone. The extinction of the previously abundant passenger pigeon was the driving force behind the passage of wildlife conservation laws. The development of national parks, such as the Banff National Park (1885) created areas that protected wildlife and provided them with areas in which they could prosper. Various treaties have been signed (e.g. Migratory Birds Convention Treaty of 1916) in hopes of protecting the remaining wildlife.

While many forms of wildlife are more abundant now than they were in 1870, a number of species have continued to decline to threatened levels or are in danger of extinction. Wetland drainage permanently removes the habitat required by many species. Pollution of rivers and estuaries renders them unfit for wildlife survival. Acid rain from industrial effluent stacks, automobiles and urban areas continue to sterilize vast tracks of land and waterways in Canada. Marine birds and mammals increasingly face the threat of offshore oil spills and general pollution of the oceans. Recent and continued changes in the climate have already started to impact wildlife populations, particularly in the Arctic.

The uses and value of wildlife to society vary. Wildlife is one part of the equation which, together with vegetation and the abiotic environment, establishes the "balance of nature", the set of complex natural processes on which human survival depends. Wildlife is a direct source of food and other products for many Canadians. The value is most apparent in northern regions, but it is also important in southern Canada. Coastal and inland commercial fishing, based on naturally reproducing populations, is an important industry. The wild fur industry provides a direct source of income for thousands, representing the highest continuing economic return of any resource in mid-northern regions. These harvest uses not only give direct economic return but, provided their management is biologically sound, also keep populations in balance with their food supply. It helps prevent overpopulation and dramatic losses from starvation and disease.

Wildlife Management Techniques

Wildlife management is the practical application of ecological principles to ensure the survival of all animals. Present wildlife management efforts focus on the conservation and continued existence of ideal numbers of wildlife. Wildlife managers use several approaches to arrive at these goals including:

1. Research
   In order to exert careful control over the amount taken and methods used in the harvesting of wildlife, wildlife managers need a great deal of information about wildlife populations. Most importantly, they need an estimate of the number of animals in the hunted population, and the number taken each year.

2. Monitoring
   Estimating the number of animals present is called inventory. Biologists use aerial surveys to inventory most large wildlife species. When leaves have fallen from the trees and snow is on the ground, dark animals like moose are easy to see from the air. The animals may be counted and classified on sample plots or entire winter ranges. More examples of techniques used to monitor populations are discussed in the Wildlife Research Methods Section

3. Refuges
   Refuges provide safe areas for animals to live. For example, refuges provide safe areas during staging periods, restrict hunters access to staging waterfowl, eliminate the potential for hunting related accidents near urban centers and high non-consumptive resource user areas like Birds Hill Provincial Park and critical habitat areas.

4. Management Areas
   Wildlife Management Areas are designated lands created within an agency's jurisdiction and in some cases, these areas are managed separately. They may be based on habitat, species, remoteness, hunting pressure or any other factor

which managers feel requires a certain area to be managed separately. By breaking a larger area into smaller management areas, biologists can better gauge population levels, habitat conditions, hunting pressure, etc.

5. Seasons and bag limits (for hunting and harvesting)
   The ability to set seasons and bag limits is an important part of managing wildlife populations. A season, in this context, is the time period when a particular species may be hunted. Seasons and bag limits are set only after considering all factors affecting that population. If a wildlife manager feels a need to increase or decrease a particular population, seasons can be lengthened or shortened to help reach the desired number. Seasons also help protect animals during critical breeding stages.

6. Habitat management and conservation
   Habitat is the combination of soil, water and plants, commonly called 'cover' in which wildlife exists. The relationships between soil, water, plants and the species of wildlife dependent on them are many and varied. Humans and their activities can cause profound and often irreversible changes to habitat, usually to the detriment of wildlife. In order to maintain productive wildlife habitat, planning programs concerning man's use and the future of habitat components are necessary. Both short and long term planning for use of our land and water resources must include a recognition of the need to maintain suitable habitat if wildlife is to continue to flourish.

7. Hunting and trapping
   Regulated hunting and trapping also make it possible to harvest animals when populations are at, or close to, their highest numbers over the year. Hunting and trapping remove a portion of the annual surplus before it is lost to "natural" causes. This is called the "harvestable surplus". Regulated hunting has never led to the extinction of a wildlife species or caused any species to become rare or endangered.

8. Public Education
   Public understanding, acceptance and support are essential if wildlife management programs are to be successful. This will only happen if people are educated about wildlife and its needs.

9. Compliance (Laws)
   The creation and enforcement of wildlife laws is an important management tool. To be effective, these laws must be flexible to cope with changes in wildlife

populations, habitats and the needs of people; they must be based on biological fact and complement other management practices. For example, a hunting season is a law enforced by Conservation Officers. Wildlife managers set the season based on sound biological information and in the best interests of the wildlife species. In cases involving rare or endangered species or sensitive breeding sites, complete protection from harvesting may be required. Conservation Officers enforce laws related to sex-specific licence types, not simply to be difficult but rather to support the concept of selective harvest, a sound, beneficial wildlife management practice.

10. Cooperative, co-management or joint management agreements
    Formal Agreements and joint management agreements have been used by Manitoba and other governments like First Nations and conservation organizations to manage wildlife and wildlife habitat. Examples of this are: The Waterhen Wood Bison re-introduction agreement between the Waterhen First Nation and government of Manitoba has resulted in the successful reintroduction of wood bison into Manitoba.

11. Species re-introductions
    Reintroduction of wildlife species has been used where a species became extinct within Manitoba or parts of Manitoba. Successful reintroductions include the Waterhen wood bison initiative where sixteen wood bison were released to the area. There are now over 120 free roaming bison in Manitoba. Another excellent example of this management technique is the reintroduction of elk into the Interlake region.

Problem wildlife

Human-wildlife conflicts can occur when people and wildlife compete for resources, whenever you’re living, working or pursuing recreational activities. Wild animals in inappropriate locations can pose significant problems for or threats to humans, other animals, or the environment. They can cause serious damage to crops, livestock and property. They can create hazardous conditions for vehicular traffic. They can expose humans and pets to pathogens leading to disease and health issues. Below we will discuss some of the problem wildlife found in Manitoba and the conservation and management issues surrounding these populations.

©The Washington Post

White-tailed Deer – White-tailed deer are one of the most abundant and easily seen big game species in Manitoba. Cities and towns have many natural areas that help support these deer in an urban setting. The deer do well with abundant food, shelter, and protection from natural predators. Bylaws also prohibit the hunting of deer within city limits.

White-tailed deer can cause damage to gardens, shrubs, fruit trees, and other public and private property. They can become a treat to human health and safety when they move onto roadways and collide with vehicles. They also are suitable hosts for deer ticks, which can transmit Lyme disease to other animals, pets and humans.

Managers ask people not to feed deer. Feeding the deer helps maintain artificially high populations, making the deer more susceptible to starvation and disease. Deer also become accustomed to humans and lose their fear of being around human communities. A feeding area attacks larger groups of deer that may result in more damage as well as encouraging them to travel, increasing their chance of being hit by a vehicle. Using fencing and repellents may also help people reduce the presence of deer in undesired areas.

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Coyotes – Coyotes are a very common wildlife species seen throughout North America, including in Manitoba. They are well adapted to live in urban centers. They are also suitable hosts for canine distemper, rabies, canine hepatitis, the parvovirus, mange, tapeworms (*Echinococcus multilocularis*, and *Taenia* spp.), nematodes, and heartworm (*Dirofilaria immitis*). All of these pathogens can be transmitted to domestic dogs, other pets, sometimes humans and wildlife species. Coyotes can also cause damage to property, including hunting domestic livestock. They will also go through garbage and fight with pets. On rare occasions, they have been known to attack humans, especially after being fed by people in the past.

Managers try to make sure people do not feed coyotes, especially near human homes. They also try to keep garbage in proper containers. They suggest people closely supervise their children while outside and keep pets in at night. They also recommend avoiding contact with feces (of coyotes and any wild animal) and making sure your pet does as well. Coyotes are trapped using humane traps and trapping techniques annually in Manitoba.

Raccoons – Raccoons are one of the most commonly problematic wildlife species in urban areas in Manitoba. They are an extremely adaptable species that is able to live almost anywhere. To manage raccoons in the city, managers ask people to supervise their children and inspect outdoor play structures as well as covering sand play boxes as they may be used by raccoons as latrines. They ask people to not deliberately feed raccoons, or leave garbage or pet food outdoors. Protecting outdoor fishponds with metal screens or mesh is important. Block any access (no matter how small) to attics, sheds, chimneys, or other potential dens and replace old wooden roof materials. If you encounter a raccoon, make sure not to fed, disturb or handle it. Do not adopt young as pets. If you have to clean up raccoon feces, you should use shovels, disposable rubber gloves, strong disinfectants, and masks to collect the feces, which should then be buried or sent directly to a landfill. Raccoons serve as host to many pathogens, including rabies and canine distemper as well as many other dangerous parasites that may be transmitted to other wildlife, pets, or humans.

Pathogen and disease management
(See ‘Pathogens, Parasites, and Disease in Wildlife’ for more details)

Wildlife pathogens and disease represent significant management concerns in North America. Interactions between wildlife and livestock as well as wildlife and human populations (with their pets) represent an important management concern, particularly when examining the potential for pathogen transmission.

Pathogens are a natural part of any ecosystem. Species within the environment have evolved alongside parasites and pathogens. Parasites induce specific reactions and changes in the immunity, physiology, and host behaviour. The hosts, or wildlife, use these changes to counteract the parasite attack. The actions of parasites on populations help select for individuals with increased resistance to this parasites invasion. Parasites also keep evolving alongside their hosts.

The need to manage pathogens and disease in wild animals is a relatively recent phenomenon. Previously, management only occurred when major events happened, often involving the health of domestic animals or humans. Recent interest in managing pathogens and disease in wild animals has been caused by several factors. Wildlife can serve host to pathogens that are zoonotic, such as Lyme disease, haemorrhagic fevers, and the hantavirus. Wildlife can also serve as a reservoir for pathogens that cause disease in both wildlife and domestic animals. For example, bovine tuberculosis and brucellosis are two pathogens causing disease in wildlife that are transferred to domestic animals. As long as the wildlife remains a reservoir for these pathogens, we cannot eliminate them from domestic animals. Humans have increased their domestication of native species, such as elk and deer, for game farming. This increases the rate of pathogen transmission to and from free-ranging individuals. There also has been the increased awareness of the risks with the movement of wild species with their pathogens. The general concern about the well being of wild populations, particularly in light of habitat degradation, fragmentation and loss, as well as climate change has also raised the concern.

Three management strategies exist for managing wildlife pathogens and disease:

1) Prevention of introduction of pathogen – measures designed to exclude or prevent the introduction of a pathogen into unaffected individuals or populations
    - Includes habitat modification, changes in human activities, restricting translocation of wildlife
2) Control of existing pathogens and diseases – reduce frequency of occurrence or the effects of a pathogen within an individual animal or population to an acceptable or tolerable level, or to contain the spread of the pathogen
    - Includes immunization of hosts
3) Eradication – total elimination of an existing pathogen
    - Includes using disinfection or treatment of the hosts or habitat, selective culling of hosts (reducing density),

These management techniques may be directed at the pathogens, the host population, habitat, or human activities. Proper management requires knowledge of the ecology of the pathogen, its life history, the course of the disease it causes, and the population biology of the parasite-host interaction.

Endangered species

Various factors, including human activities and climatic changes, have led to the reduction and alteration in animal populations. In response, government wildlife agencies and public groups have formed the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) which encourages and commissions studies on rare and endangered animals or animals of unknown status. Other groups, such as the International Union for Conservation of Nature (IUCN) have taken this idea internationally, trying to monitor and report on wildlife populations worldwide. The IUCN Red List of Threatened Species is a world-renowned database of information collected over the last four decades. The IUCN Red List assesses both plants and animals and provides taxonomic, conservation status, and distribution information. The IUCN Red List sorts each species into one of the following categories:

Extinct – a species or taxon is extinct when there is no reasonable doubt that the last individual of this group has died. Exhaustive surveys of known and expected habitat during appropriate times will have failed to record the presence of this species.

Extinct in the Wild – a species is considered to be extinct in the wild when they are only known to survive in cultivation (e.g. farming), in captivity (e.g. zoo), or as a naturalized population well outside their past range. As with extinct animals, exhaustive surveys of known and expected historical habitat during appropriate times will have failed to record the presence of this species.

Critically Endangered – a species is considered to be critically endangered when all evidence indicates that its population has either: (a) been seen to be reduced by 90% or more in last 10 years or three generations, (b) its geographic range has been reduced to less than 100 km^2 and severely fragmented or less than 10 km^2, (c) population less than 250 mature individuals and continuing to decline, (d) population size of less than 50 individuals, or (e) quantitative modeling suggests the probability of extinction at least 50% in the next 10 years. It is considered to be facing an extremely high risk of extinction in the wild.

Endangered – a species is endangered when the evidence indicates that its population has either: (a) been seen to be reduced by 70% or more in last 10 years or three generations, (b) its geographic range has been reduced to less than 5000 km^2 and severely fragmented or less than 500 km^2, (c) population less than 2500 mature individuals and continuing to decline, (d) population size of less than 250 individuals, or (e) quantitative modeling suggests the probability of extinction at least 20% in the next 10 years. It is considered to be facing a very high risk of extinction in the wild.

Vulnerable – a species is considered vulnerable when its population meets any of the following criteria: (a) been seen to be reduced by 50% or more in last 10 years or three generations, (b) its geographic range has been reduced to less than 20 000 km^2 and severely fragmented or less than 2000 km^2, (c) population less than 10 000 mature individuals and continuing to decline, (d) population size of less than 1000 individuals, or (e) quantitative modeling suggests the probability of extinction at least 10% in the next 10 years. It is considered to be facing a high risk of extinction in the wild.

Near Threatened – a species that is near threatened is close to meeting the criteria for critically endangered, endangered or vulnerable in the near future.

Least Concern – a species is least concern when it does not meet any criteria to qualify for critically endangered, endangered, vulnerable, or near threatened. Species that are widespread or abundant are included in this category.

Invasive species

Invasive species are organisms, including plants, mammals, birds and crocodiles, amphibians, invertebrates, reptiles (lizards, snakes, turtles), and microorganisms that spread beyond their natural range into new locations. This expansion is often due to human activities. Invasive species are more commonplace than one might think. Kentucky bluegrass, periwinkle, lily of the valley, and dandelion are all common plant species found in our lawns and gardens but are invasive species to this region. The domestic cat is thought to have originated in Africa. The European starling came from Europe. Some species have moved within the country into areas they have been previously absent. For example, the moose is an introduced species on Newfoundland but is native to most of Canada. The house finch, native to several western provinces, is now found in a number of eastern provinces.

Alien or invasive species can be beneficial in a region but a good number are not. Sometimes the invasive species does not have the same limiting factors in their new habitat. This can lead to populations growing beyond control.

Invasive species come into Canada by any means of transport that moves them farther than they could move on their own. Sometimes they are brought in on purpose, but often they arrive unintentionally. Seafaring European explorers and settlers were the first to introduce new species to Canada. They brought cattle, goats, and other domestic animals, along with familiar crops like wheat, when they came by ship to explore and settle the New World. Without meaning to, they also introduced unwanted organisms—pests, like the Norway rat, and viruses, like deadly influenza and smallpox.

Many invasive species are transported to an area by accident. Accidental arrivals are rarely discovered until they have established themselves and have spread beyond their point of entry. For example, many unwanted invasive species arrive in ballast water, the seawater or freshwater used to stabilize large ships during travel; aquatic species are taken up along with ballast water at one port and released at the destination port. About half of the invasive shellfish species in Canada, including the highly invasive zebra mussel, as well as the invasive zooplankton, the spiny water flea, probably arrived in North America in this way.

Purple loosestrife, introduced from Europe in the early 1800s as a garden ornamental plant, has invaded wetlands throughout eastern North America, edging out many native species. Wetlands are the most biologically diverse part of our ecosystem. When the purple flower chokes out habitat, it affects hundreds of species of plants, birds, mammals, reptiles, insects, fish, and amphibians that rely on wetlands to survive. Only three provinces prohibit the sale of purple loosestrife; it can still be purchased in garden centres everywhere else in Canada.

When an invasive species enters an ecosystem, it can have an impact on the species that are present, on important habitats, or even on the ecosystem itself. Concern arises when an invasive species changes the system for the worse, by either reducing or eliminating populations of native species, or by otherwise changing the way the ecosystem works. These changes have made the invasion of alien species a major global problem. If organisms were not able to move beyond their normal ranges, each part of the world would have a unique array of plants, animals, and microorganisms. However, as species move from one area of the world to another, sometimes squeezing out the competition, different places in the world become more alike in their biology—a process called biological homogenization.

Biological homogenization is undesirable because as it takes place, ecosystems often become less stable, and valuable biodiversity, or variety of life, is lost. This variety is essential to the health of our planet; each species performs a function that contributes to global well being. The spread of invasive species, like habitat loss, is considered one of the major threats to biological diversity. Invasive species have obliterated over 110 vertebrate species around the world and have affected nearly every type of ecosystem. For example, in New Zealand, predatory European mammals such as rats, cats, and stoats have caused the extinction of nine native bird species, and they threaten many more. In Guam, the brown tree snake, an import that arrived hidden in ship cargo from New Guinea, has wiped out virtually all the island's native forest birds.

Invasive species are successful due to some advantage they have over native species. For example:

Competition: invasive species can often outcompete native species for space, water, food, and other essential resources

Predation: some invasive species cause native species to decline by being aggressive herbivores or predators.

Pathogens and Parasites: often invasive species bring with them novel parasites or pathogens to a region. Sometimes the invasive species is a parasite itself and can affect population dynamics

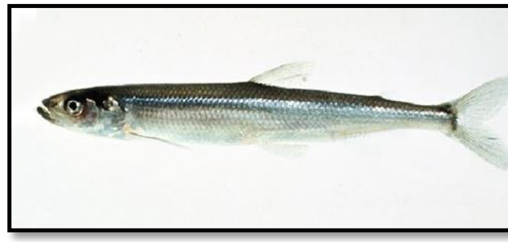
Hybridization: sometimes invasive species weaken the gene pool of the native species by interbreeding with them, a process called hybridization.

Habitat alteration: invasive species may change the structure or composition of a habitat; invasive species make it unsuitable for other native species.

There are quite a few examples of invasive species in Manitoba that are of great management concern. They include the leafy spurge, Eurasian watermilfoil, yellow flag iris, flowering rush, purple loosestrife, narrow-leaved and hybrid cattail, common carp, rainbow smelt, round goby, rusty crayfish, spiny water flea, zebra mussels, yellow starthistle, tall buttercup, lily leaf beetle, and dutch elm disease fungi.

The leafy spurge (*Euphorbia esula*) is native to Europe. It was first introduced to North America from ships or as a seed contaminant in the early 1800s. It is a perennial plant, which is deeply rooted and grows up to 90 cm tall. It is capable of dominating habitats displacing or choking out native vegetation. This reduces food sources for both wildlife and cattle. Chemical, biological control (using sheep, goats, or beetles), or physical control (using mowing, burning, or tiling) have all been used to control this invasive species.

Rainbow smelt (*Osmerus mordax*) are an elongate fish between 178-203 mm long. They are found in clear lakes, rivers, and coastal waters including Lake Winnipeg. Rainbow smelt compete with native fish species for food and other resources. They are also a source of food for other species of native fish. Affected native species include yellow perch, cisco, emerald shiner, walleye, lake erring, bloater, whitefish, lake trout, and slimy sculpin.



©. D. Watkinson, DFO

The rusty crayfish (*Orconectes rusticus*) is an aggressive species that originates in the Ohio River basin (USA), which began to spread into the northern Great Lakes regions, including Minnesota, Wisconsin, and Ontario in the 1960's. They are often spread when they are used as bait by anglers. Rusty crayfish reduce aquatic plant beds and the species that live in these environments. It has been suggested that the damage that the rusty crayfish does to the aquatic ecosystem is the equivalent to clear cutting forests. They feed heavily on aquatic plants, small fish, and water insects. Rusty crayfish are relatively new to Manitoba, being first spotted in 2007. Managers have been using information campaigns with recreational anglers to try to reduce the spread of this invasive species.

Dutch elm disease fungi (*Ophiostoma* spp.) are fungi that damage elm trees, including all elms native to North America and Europe. It is spread by the elm bark beetles. It was first found in North America in Ohio prior to 1930. It is thought to have been introduced from diseased elm logs from Europe. The fungus was first found in Manitoba in 1975. The fungus spreads rapidly after it establishes itself in a tree, eventually killing the tree. Managers have been killing and removing any tree with evidence of the presence of these fungi. Measures including regular pruning of dead branches, basal spraying of an insecticide, and public education can all be used to further reduce the spread of this deadly fungus.

Various management techniques can be used to both slow and prevent the spread of invasive species. Cooperation between different countries and their experts is key to developing programs like the Global Invasive Species Program. Canada has instituted many laws, regulations, and policies, aiming to prevent the spread of invasive species. Further education initiatives, such as with zebra mussels and spiny water flea campaigns with anglers, will further assist in preventing these invasive species to spread further. Targeted control, including physical control (i.e. physically removing the species from its environment), chemical control (i.e. pesticides, herbicides, fungicides, and other chemicals to kill invasive species), biological control (i.e. using living organisms, particularly predators, parasites, and disease are used to control the growth of invasive species populations), and integrated control (i.e. combination of all listed above).

Climate change

Climate change, or the alteration and lasting change of the distribution of weather patterns over period of time, is something that the earth is now facing. Of all the ways in which human activity affects the distribution and abundance of wildlife on our planet, none is as pervasive and powerful as climate change. All species have a capability to adapt – at least to some degree – to natural stresses. Changes to climate and habitat have been occurring for eons, and with them have come changes to the diversity of species on earth. What makes current climate change unique is that, with the exception of cataclysmic events such as meteor strikes, the rate at which it is taking place is leaving species and ecosystems no time to adapt.

The direct impacts of human caused climate change have now been documented on every continent, in every ocean, and in most major taxonomic groups. One of the most studied and observed climate change responses of organisms has involved alterations of the species' phenologies (the study of periodic plant and animal life cycle events). For example, humans have been recording the flowering of cherry trees in Japan since the 1400's. Although the timing of the flowering is highly variable among years, no clear trends have been observed between 1400-1900. Since the early 1900s to 1952 the date of flowering has steadily moved earlier into the year. In the past few years, the flowering time has moved even earlier. Another study examined the calling of six frog species in Ithaca, New York. These frogs use calling as part of their mating ritual. The study found 10-13 day advancement in this calling. Further, amphibian breeding has also started 1-3 years earlier per decade of change.

The problem with these shifts in life history comes when they start to become mismatched with other events in the environment. For example, many species of songbirds rely on huge increases in insect populations (seen after the insect's successful breeding) to feed their young. Activity and reproductive cues for many species of insects are related to the ambient temperature. If the temperature continues to increase, insects may start to become active sooner and breed earlier. If the breeding time of songbirds does not change in sync with the insects (due to other drivers in their life cycle such as daylight hours) they will miss this large population boom of insects, not be able to feed their young, and their populations will suffer.

The increase in storms and unpredictable weather patterns is also expected with climate change. These extreme weather events can devastate wildlife populations as well as their habitat. This puts already vulnerable species further at risk of extinction.

Another direct impact of climate change is the loss of habitat. The decline in sea-ice extent has led to large changes and in turn trophic cascades in both the Antarctic and the Arctic ecosystems. In the Antarctic, declines in sea ice have reduced the abundance of ice algae (due to loss of habitat), leading to declines in krill (38-75% per decade since 1976). Krill is the primary food source for many species of fish, seabirds, and marine mammals. Emperor penguins have declined from 300 to 9 breeding pairs in certain portions of their range and other areas have shown a reduction by 50% of their population since 1970. Adelies penguins have seen similar declines. In contrast, open-ocean feeding penguins, such as the chinstrap and Gentoo, have increased their range. In the Arctic, invertebrate communities in Arctic lakes have shown hug species turnover (change in the community of organisms). Polar bears have suffered significant population declines. Climate change has caused a lengthening of the ice-free period, periods during which the polar bears live only on their fat reserves, as an ice shelf is essential for feeding. Further, climatic warming trends have led to a reduction in their main food source, the ringed seal.

The movement of parasites and pest species is another component of climate change. A nematode parasite has seen an increased abundance due to a shortening of its life cycle in response to warming trends. The increased abundance has had associated negative to its wild musk oxen host, decreasing their survival and ability to breed.

Increasing temperatures can also lead to both local and worldwide extinction of wildlife species. Global sea surface temperatures have risen an average of 0.1-0.2°C since 1976. El Nino events (climate pattern that increases the temperature) alongside global climate warming has led to 16% of all corals rendered extinct globally.

Wildlife research methods

Field Notes

A wildlife biologist or naturalist should always keep field notes and a journal as an essential record of activities and observations. Keeping accurate field notes and a good journal enables one or others to return to the same areas in the future and look for important ecological changes. A journal also provides a good record of one's investigations, observations, thoughts, speculations, and random musings of the field. Although certain details may not seem useful or applicable at the time, great discoveries and revelations have been made by referencing back to ones field notes. Good field notes include quite a few things:

1) Name of observer(s)

2) Date, time, and locality of the day's observations

3) Numbered pages

4) Weather should be noted at the beginning of the day and whenever significant changes occur

5) Recent events (fires, storms, or droughts, for example)

6) Brief description of the habitat including the topography (flood plain, forest, sedge meadow, fen, etc.) and vegetation (oak-pine forest, wetland, etc.)

7) GPS location of site, and any photo or sample taken or significant observation

8) Route traveled

9) Quantitative (numerical) data (for example estimates of the numbers or sizes of individual plants and animals seen, frequency of events, etc.) and other observations (e.g. other animals or plants, and any invasive or non-native spp.)

10) Records & Photos of collected items (e.g. samples)

11) Photos taken and their location

12) Thoughts, questions, speculations, etc.

13) Field Notes/Journals must be legible and should not include abbreviations or terms that might not be easy to understand. If you reference your notes in a few months or years, you may not remember what you were intending to say if the abbreviations and terms are vague. You also never know who else may need to reference your field notes/journal so they should be written in terms others will understand.

An example of a page out of a field journal:

Page 1

Name: J. Doe
Date: 22 04 2013
Time: 19:30

Location: Den E25, Wapusk National Park (near Nestor One)
Habitat: Tundra, beach ridge, fox den
Temperature: -21°C **Humidity:** 60%
GPS Coordinates: 15 473110 6473943 UTM

Data and Observations:

- Fox burrow present with fresh digging, two entrances
- Fox feces present
- Urine present
- White hair (Arctic fox) present in fox burrow
- No fox tracks present
- Ptarmigan present at den with lots of ptarmigan feces
- Large tracks (likely polar bear) present at outer edge of den
- Deep snow but some vegetation still obvious

Photos:
IMG_0986 – burrow opening
IMG_0987 – researching examining burrow opening
IMG_0988 – Ptarmigan

Collected Items:

- Fox feces collected and labeled
- White hair from burrow opening

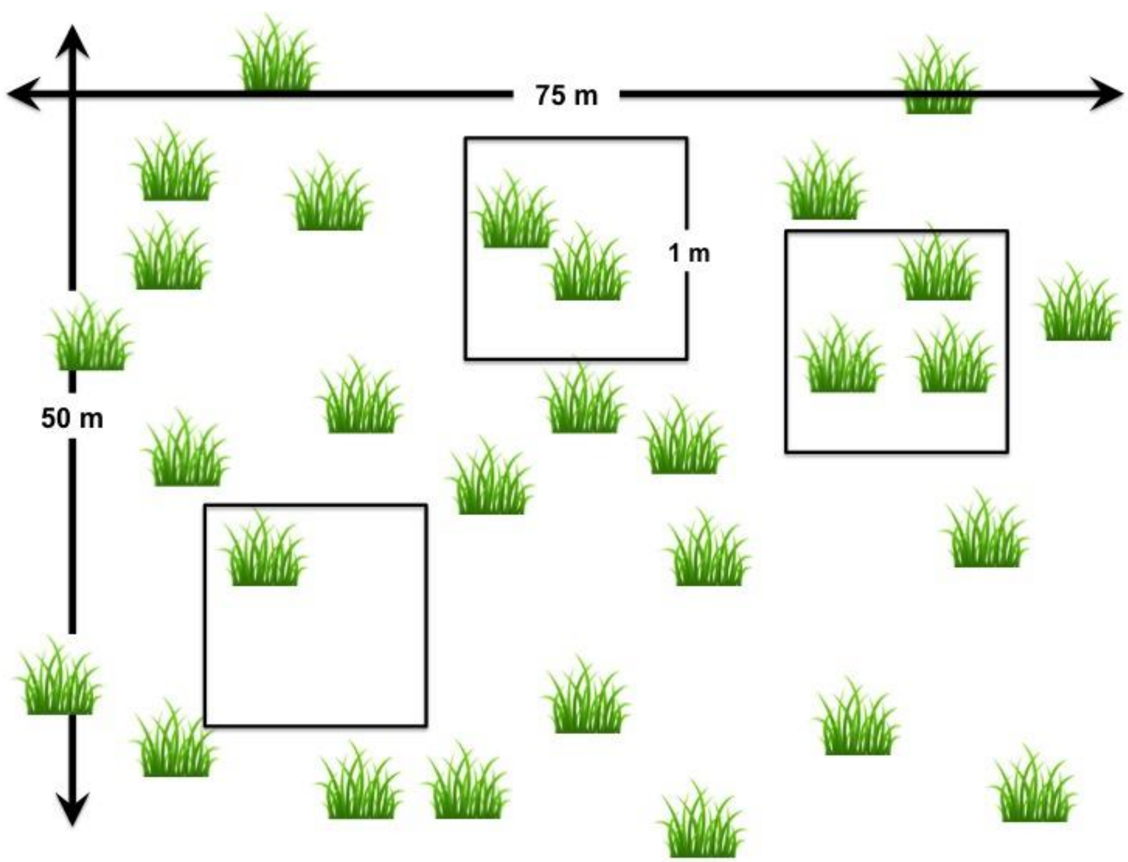
Field journals can be more detailed depending on the project. In many behavioural observation studies or mark-recapture studies, the researcher often records the mass of the animal, sex, tag number, pit tag, spine length, etc. The more detailed the field notes the easier it is to come back to them as a reference.

Population monitoring

Ecology is defined as the study of the factors that affect the distribution and **abundance** of organisms. Therefore as ecologists, wildlife biologists, and managers, determining the abundance of a specific group of organisms are important. To estimate the population size a researcher can use various methods.

Complete census: this method will count all the organisms. Often this method is difficult to do, difficult to tell if you have found all of the individuals in an area, takes a large amount of time. Further, how important is it to count every individual? For this reason we use samples from a population to estimate abundance under the assumption that it is representative of the entire population.

Quadrat Sampling: in this method you define a quadrant (small area of known size) that is chosen at random and count the number of organisms in that region. The mean (average) number of organisms in each quadrant is used to estimate the entire population. This method is used when the organisms are sedentary, e.g. plants or trees.



Mean plant density (number/m^2) x total area = population size
2 plants/m^2 x (50m x 75m) = 7500 plants

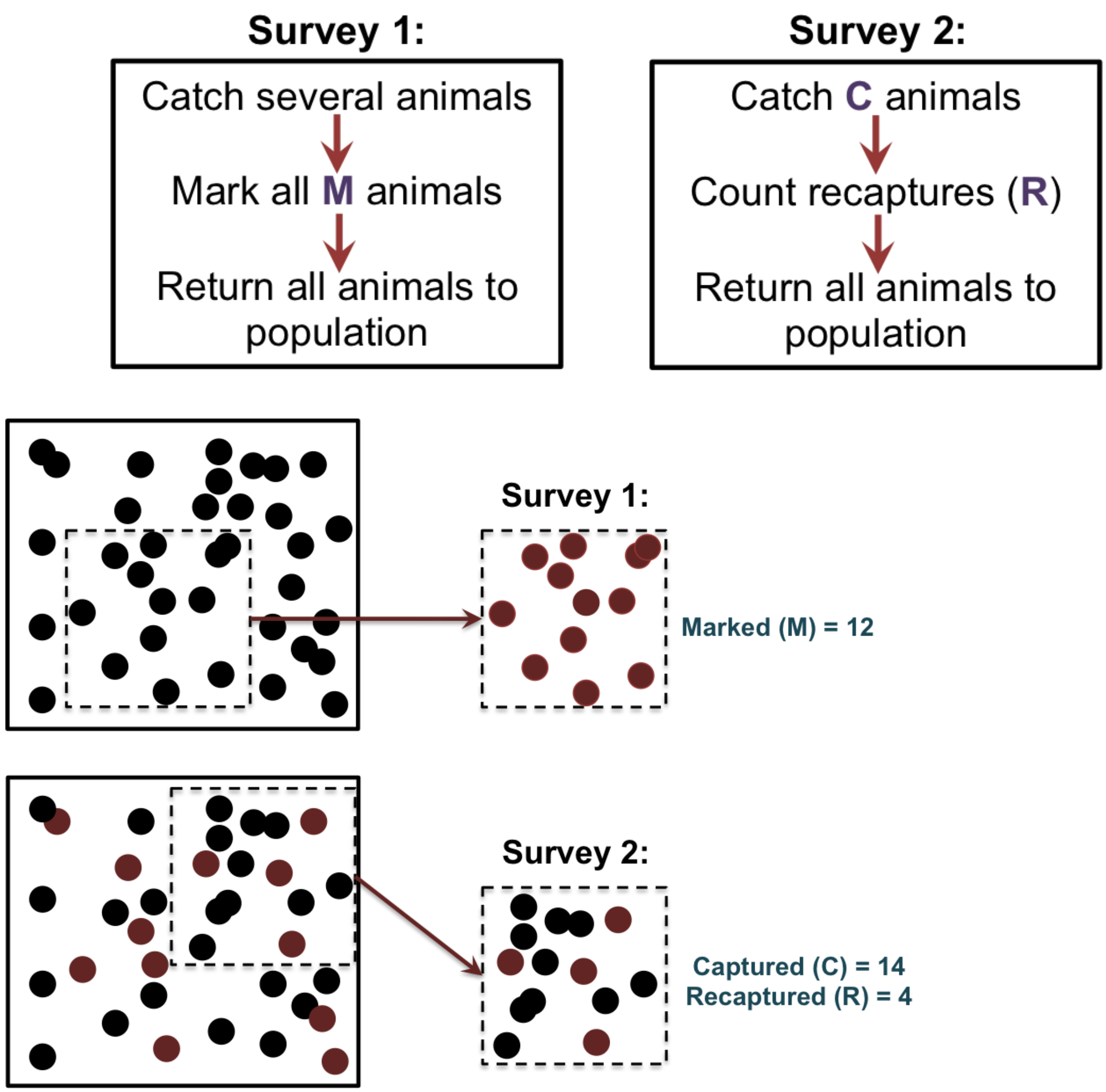
Many plants or animals do not distribute themselves evenly across the landscape. Due to this habitat heterogeneity (patchiness) we need to choose a sampling strategy that best captures the population and minimizes our variability of measurement. The edge effect is also something to consider when designing a sampling method. Individuals on the edge may or may not be counted, but this needs to be consistent to reduce counting errors. The plot size is also a factor to consider. The larger the quadrant area the less variability present. However, larger quadrants take more time to evaluate.

Transects: transects can be used in various forms to evaluate populations. A transect is a path along which one counts and records the occurrence of an individual or an object that is being counted as a representation of the occurrence of an individual or species. For example, many species of lemmings (brown and collared) as well as voles make winter nests in their tundra habitats. These winter nests are made from vegetation (mainly grasses and sedges) underneath the snow (subnivean layer) and are used to keep the small mammals warm during the winter. They appear like a ball of cut grass and are abandoned in the spring. They are counted and picked up as a representation of the winter small mammal population. To evaluate the small mammal population, researchers walk transects of a known distance and count each winter nest they encounter. If the winter nest is not on the straight line transect, the researcher leaves the transect at a 90° angle and measures the distance between the transect and the winter nest. Transects have also been used to evaluate snowshoe hare populations by looking at pellets at specific locations down the transect.

Transect in Churchill, Manitoba © O. Friesen

Mark-recapture: mark-recapture methods are one of the most common and best methods to get information not only on abundance, but birth, death, and movements. It can require substantial time and effort to collect this data. They are commonly used to monitor small mammal populations, but are not limited to this function. They have also been used (for example) to look at the growth and condition of American alligators, dynamics of increasing lake trout populations, and different responses of Agriotes click beetle species to pheromone traps. The methods for mark-recapture vary between populations that are closed (stable, no birth, deaths, or movements) or open (major changes in size and/or composition during the study). There are four methods for closed populations, Petersen method, Schnabel method, and Schumacher-Eschmeyer, and one common method for open populations, Jolly Seber. We will focus on the Petersen method, one of the most simple methods for a closed population.

Petersen Method (Closed population)



Total (estimated) population size (N) calculation:

$$\frac{Number\ marked\ individuals\ (M)}{Estimated\ population\ size\ (N)} = \frac{Number\ recaptured\ individuals\ (R)}{Number\ of\ individuals\ captured\ in\ resampling\ (C)}$$

$$N = \frac{MC}{R} = \frac{12\ x\ 14}{4} = 42$$

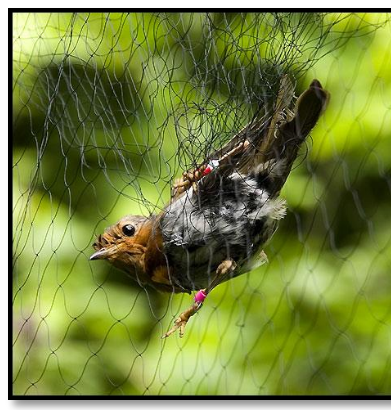
If you have a small number of individuals caught in the surveys, you can make a correction to account of these small sample sizes. For our example above…

Total (estimated) population size (N_c) corrected:

$$N_c = \frac{(M+1)\ x\ (C+1)}{R+1} - 1$$

$$N_c = \frac{(12+1)\ x\ (14+1)}{(4+1)} - 1 = \frac{13\ x\ 15}{5} - 1$$

$$N_c = 38$$


© J. Surgey

Mist Net: Mist nets are an important tool for monitoring the population of both birds and bats. It also helps assess the species composition of a region, the relative abundance of different species, the overall population size, and the survival of individuals. Mist nets are large nylon nets that are suspended between two poles that appear almost invisible when used properly. The grid size of the mesh on these nets will vary according to the size of the species researchers desire to catch. Nets are often set up at dawn and dusk as many species of birds are the most active during these times. Nets are then monitored until birds are caught. Once a bird is entangled in the mist net it must be extracted (as seen in the photo to the right). This removal takes experience and proper training to do without injuring the bird. Once the bird is removed, a researcher may band the bird (for identification of the bird later on and mark-recapture studies) as well as record the species, sex, age, size (length and mass), and body and reproductive condition.

Bal-chatri: Bal-chatri traps are used to catch raptors. It consists of a cage with a visible rodent and a series of monofilament nooses attached to the surface that functions to snag the legs of free-flying raptor when they attempt to catch the prey. Researchers will travel in an area in which they are interested in monitoring raptors. Once a raptor is observed, the trap is thrown out of a vehicle on the opposite side from the raptor's location (to ensure the raptor does not observe the deployment of the trap). The raptor will attempt to

© T.J. Poczciwinski

capture the small rodent and in doing so will be caught in the monofilament nooses. The rodents very rarely harmed. Once caught, researchers will come remove the bird, often tag the bird and make record of its species, sex, age, size (length and mass), and body and reproductive condition.

Breeding Bird Atlas: The Manitoba Breeding Bird Atlas is a five-year project examining the distribution and abundance of all the breeding birds in Manitoba. The province has been split up into 14 administrative regions in which they ask volunteers to go and observe birds and bird nests. The research is carried out during the main bird breeding season between late May to mid-August. A volunteer will venture into a specific area that is 10km^2 in size. They will visit this area more than once in the breeding season. Each time the volunteer will take record of any birds the observe and if there may be breeding in the region (suitable habitat, singing associated with breeding been observed in adults, pairs of birds, courtship displays, bird visiting a regular location, brood patch on a caught bird, agitated behaviour of a bird, nest building, distraction displays (such as the broken wing display), fledged young, nests with eggs or young). They are also asked to take point counts (abundance estimates of birds in one place – both by visual and audible evidence). Example forms for both types of counts are attached in the appendix.

Diet reconstruction

Knowledge about the diet of wildlife not only helps us have a better understanding of the ecology of a region, but also the relationships between species, the role of a species in the ecosystem, potential for competition with other species, their impacts on prey populations, and factors that limit their abundance and impact dynamics in the ecosystem.

Many methods are used to estimate diet of animals:

Observational: by observing feeding behaviour (e.g. following a wolf pack to their kill, watching a fox or owl hunt, etc.) we get some insight into both the food items included in an animal's diet but also their hunting or scavenging behaviours.

Stomach and fecal analysis: Stomachs and/or feces are collected to look at the diet of each individual. It gives insight into the animal's last meal. Remains from the food items, such as bone, hair, eggshells, feathers, seeds, and exoskeletons (e.g. insects and zooplankton) survive the digestive process and can be used to identify the prey. They can also be quantified to provide estimates and importance of each item. Owl pellets can also be used in a similar manner to reconstruct their diet. Although this method can be good in giving a broad idea of the foods included in a population's diet, most soft-bodied prey are difficult to identify since they digest rapidly.

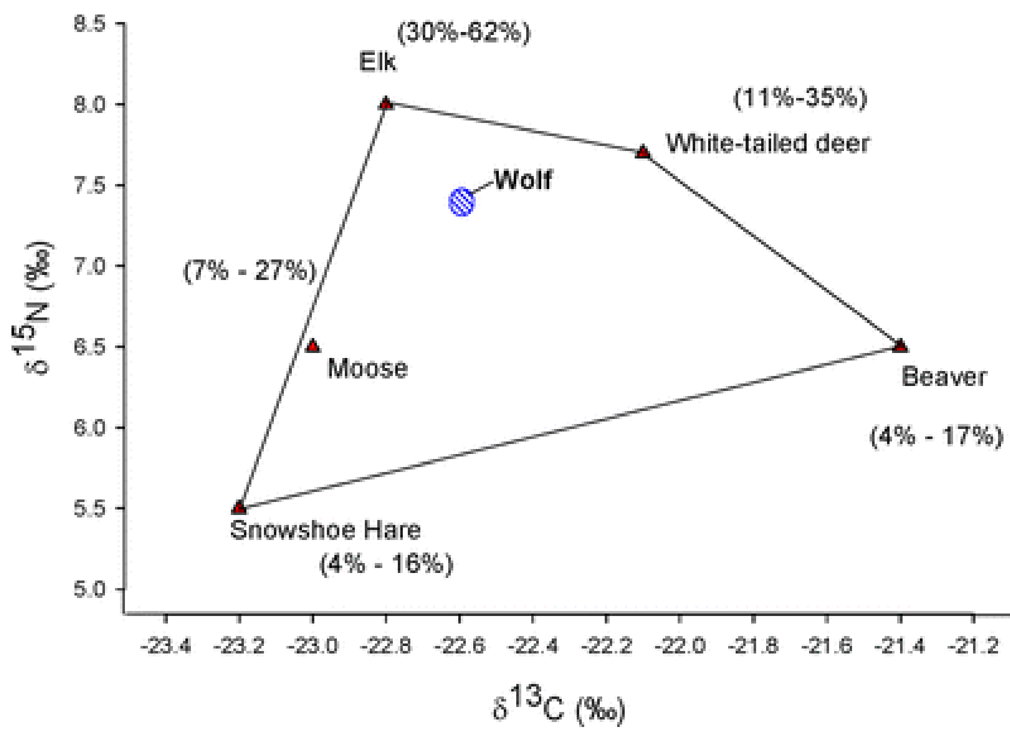
Fatty acid signature analysis: Fatty acids can be used as a natural biomarker to assist in the reconstruction of a predator's diet, particularly when the diet is of marine origins. Fatty acids are the main part of most lipids (or fats) and unlike many other nutrients (e.g. proteins and carbohydrates) are not readily broken down during digestion. Animals can also only make a limited number of fatty acids; we are able to distinguish between fatty acids created by the body versus those taken in from the diet. The fatty acids are passed on from prey to predator throughout the food web. Fatty acids can also represent the diet of the predator over a longer period, representing the average diet of an individual over a set time (e.g. a month, year, etc.).

Stable isotope analysis: stable isotopes are a natural biomarker (like fatty acids) that can be used to reconstruct diet of an animal. Researchers measure the ratio of heavy to light isotopes of different elements (e.g. carbon, nitrogen, sulphur, oxygen, hydrogen, etc.) which have been transferred from the food item (plant or animal) to the consumer. Stable isotopes can indicate the trophic level the animal is eating at, the length of the food web, and source of primary production in this food web. They also can be used to study animal movement, looking at where an animal may spend its winter or migrate.

Carbon and nitrogen are the two most commonly used stable isotopes ratios in reconstructing the diet as carbon is influenced by the type of plant eaten by the primary consumer and nitrogen increases with every increase in trophic level. Marine and terrestrial stable isotopes also vary greatly in carbon stable isotope ratios. Due to these differences, researchers are able to start to reconstruct the diet of an individual consumer. Further, using the stable isotope ratios of the consumer you can look at the overlap of the diet of two competing species.

A researcher can also use different tissues from the consumer that represent the diet of the individual from different periods. For example, the blood of an animal is rapidly turned over and so its stable isotope ratios will represent the diet of the animal over the past few days. On the other hand, muscle represents the diet of the individual over the past few months.

To reconstruct the diet of an individual, or a population, a researcher (with modelling software) will examine the stable isotope values of the consumer (e.g. wolves in the example below) and compare its 'location' (represented by its carbon and nitrogen stable isotope values) to those of possible prey (e.g. white-tailed deer, elk, beaver, snowshoe hares, and moose in the example below). Based on its distance from these possible prey, the proportion of each type of prey in the diet of the consumer (e.g. wolf) can be estimated.



Urton and Hobson 2005

Basic and applied ethology

Ethology is the systematic study of the behaviour of animals in the wild. Animal behaviour is the expression of an effort to adapt or adjust to different internal and external conditions, simply, an animal's response to a stimulus. The study of behaviour includes not only what an animal does but when, how, why, and where the behaviour has occurred. The study of animal behaviour concentrates on four main questions:

1) *Causation* (mechanism): How is the behaviour accomplished?
   e.g. cockroaches running away from toads use wind-sensitive hairs on their bodies to predict the point at which the toad has committed itself to strike in a certain direction. The cockroach will then turn and run away once the strike has started.

2) *Function*: How does the behaviour contribute to the animal's survival and reproductive success?
   e.g. cockroaches running only when they are certain of an actual threat so that they do not waste resources on unnecessary effort

3) *Development*: How does the behaviour develop during the animal's lifetime?
   e.g. does the animal have to learn the behaviour or does it behave this way without prior experience?

4) *Evolution*: How did the behaviour evolve is asking how did certain behaviour develop?
   e.g. beak-wiping in the zebra finch which is also exists in the embryonic form of a closely related finch species.

Animal behaviour is often observed and recorded as part of an experiment. To do this, a research needs to choose the relevant observations for their project, define the behaviour to be observed (described on an empirical basis (not an interpretation of behaviour – e.g. yawning but not bored, happy, restless, etc.) or an ethogram (a catalogue of the behaviours of a species), have an observation schedule, and consider other variables (e.g. spacing arrangements between animals, orientation, posture, various behavioural rhythms (over times and seasons), and age and sex of animal). A researcher writes observations down in a notebook, uses videotape recordings, or uses single-event recorders (e.g. critter-cams). Once the behaviour is observed and recorded, it can be quantified so that these behaviours can be analyzed. The frequency or magnitude of the behaviours can be recorded (e.g. how often does the arctic fox stretch?). The duration of behaviour can be recorded (e.g. how long does a coyote drink?). If social interactions are being examined, recording which individuals participated in the behaviour, which individual started the behaviour, and which individual ended the behaviour are all important (e.g. social grooming in some species of primates).

Research in animal behaviour is wide ranging and can involve many different approaches.

Observational (field): animal behaviour is observed in a natural environment without interference and trends are observed. For example, polar bears in the Hudson Bay region are recorded (by both photos and video-taped) and analysed interactions between individuals, movements, play behaviour as well as identifying each individual (for more information visit http://www.polarbearlibrary.org/).

Manipulative (field): animal behaviour can be observed in a natural environment with some manipulation by the researcher. For example, mobbing behaviour (or predator harassment) has been studied in different species by exposing the animal of interest (e.g. ground squirrel) to the scent, model, or caged predator or threat (e.g. snake). Ground squirrels often will mob a predator to identify this individual in the environment and reduce their chances of being killed by this predator (e.g. snakes, lizards, etc.) as well as the chances of this predator eating other members of their group (possibly including their young). To study this behaviour, a researcher may introduce a predator (such as a snake) into an area with a group of ground squirrels and observe the resulting behaviour. They may take into account which members of the group participated in this predator harassment, including if they were male or female, juveniles or adults, and if they had young. The researcher also may place the scent in the group to try to figure out if it is the sight or scent or a combination of these both that cause the squirrels to mob.

Another example may include understanding the communication between members of a social group. For example, the Richardson's ground squirrels have alarm calls to warn other members of the group of any incoming threat, such as a predator. Researchers have been interested in the information conveyed between individuals with these alarm calls. Researchers have recorded the alarm calls of Richardson's ground squirrels by using an avian predator model. They then played these calls back to individuals in the field to detect if individual squirrels paid more attention to calls made from neighbours than from non-neighbours.

Manipulative (lab): Wild animals are often studied at zoos. As a concentration of wildlife kept in human made conditions, they provide the opportunity to study species that are difficult to access or study in the wild. Studies may include group interactions, as well as reactions to stressful events (e.g. proximity to predators), as well as communication between individuals.

Glossary

-A-

Abdomen – in vertebrates this is the region of the body that contains the internal organs, other than the heart and lungs. In most arthropods it is the hind region of the body

Abiotic – nonliving component of the environment (e.g. soil, water, air, etc.)

Acclimation – changes or differences in the physiology state after exposure to a different environment

Adaptation – genetically determined characteristic (e.g. behavioural, morphological, etc.) that will improve a species ability to survive and reproduce in certain conditions

Aerobic – presence of free oxygen in the atmosphere or dissolved in water

Age structure – the proportion or number of individuals in each age class within a population

Aggregation – group of animals that forms when individuals are attracted to the same environmental resource (does not imply social organization)

Aggression – animal behaviour that tries to intimidate or injure another individual

Allogrooming – grooming performed by one individual to another of the same species

Alloparental care – parental behaviour by an individual to young to which they are not a parent (though often related)

Altricial – condition of young birds or mammals being born blind and unable to support their own weight needing more parental care

Amphibia (Amphibian) – a class made by three groups, caecilians, salamanders, and frogs and toads. They are poikilothermic vertebrates, with a larval stage that develops in water, and soft non-scaly skin that is important in cutaneous respiration.

Anaerobic – absence of free oxygen in the atmosphere or dissolved in water

Animal – a multicelular, heterotrophic organism. Most commonly motile at least at some point in their life cycle and have sensory apparatus that detect changes in the environment.

Annelid – a phylum off worms that have a definitive head and good metameric segmentation. They have well developed vascular, respiratory, and nervous systems. They include earthworms, sandworms, and leeches.

Antlers – appendages on the heads of adults which is made from bone and shed annually

Aquatic – living in or near fresh water or taking place in fresh water

Arboreal – living in trees (mainly animals)

Arthropoda – a large diverse phylum of joint-limbed animals, including crustaceans (e.g. lobsters and crabs), arachnids (e.g. spiders), and insects. They have metameric

segmentation (at least as an embryo), dorsal hear, dorsal anterior brain, and ventral nerve cord. They have a chitinous exoskeleton.
Artiodactyla – an mammalian order of even-toed ungulates, including camels, pigs, and ruminents
Asexual reproduction – any form of reproduction which does not involve the fusion of gametes
Assemblage – a collection of animals and plants characteristically associated with a specific environment (can be used as an indicator of that environment)
Autotomy – voluntary severance by an animal of a part of its body usually to escape a predator
Autotroph – a species that uses carbon dioxide as the main source of carbon
Aves – the class that includes all birds

-B-

Bacteria – prokaryotes, most of whom are single celled and having a rigid cell wall
Behavioural ecology – the study of the behavioural mechanisms
Benthic – lower most regions or bottom of aquatic ecosystem
Benthos – animals and plants living in the benthic (bottom) of the sea or lake
Biodiversity – all aspects of biological diversity, including species richness, ecosystem complexity, and genetic variation
Biological species concept – species comprise populations that are reproductively isolated from each other
Biome – major regional ecological community of animals and plants
Biotic – living components
Biotic community – assemblage of populations living in an area or physical habitat
Bone – the skeletal tissue of vertebrates, composed mostly of inorganic calcium salts
Bovidae – family of artiodactyls including bison. Most males have horns.
Browse – portions of twig or leaf growth of trees, shrubs, and woody vines that are available to animals

-C-

Canidae – mammalian family that have long legs, with blunt, straight, non-retractable claws, long face, diet which is largely carnivorous but includes some plants
Canine – mammalian tooth that is conical and pointed located between the incisors and premolars. In some mammals they are enlarged to form tusks or reduced, or absent.
Cannibalism – the killing and consumption of one’s own species

Carnassial tooth – the last upper premolar and first lower molar teeth of a carnivore which has sharp edges for cutting flesh
Carnivora – mammalian order characterized by carnassial teeth, strong incisors, canines for piercing, reduced molars
Carnivore – organism that feeds on animal tissue. Often members of the order Carnivora
Cervidae – a mammalian family of browsing or grazing animals. Antlers are present in most species
Cetacea – mammalian order of whales. They have modified limbs, vestigial pelvis, tail is used for propulsion, and modified skull.
Character – any detectable attribute or property of the phenotype of a species
Chiroptera – a mammalian order of true flying bats
Classification – arrangement of different organisms into separate groups based on characteristics
Climax – stable end of community succession
Cnidaria – a phylum that includes sea anenomes, sea jellies, and corals. They are radially symmetrical, have tentacles, and a gastrovascular cavity.
Coevolution – joint evolution of two or more nonbreeding species that have a close relationship and through reciprocal selective pressure, the evolution of one species depends on the evolution of the other
Community – group of interacting animals and plants in a specific area
Competition – interaction that is detrimental to both participants
Conspecific – individuals of the same species
Courtship – behaviour that precedes the sexual act and can involve displays and posturing
Crepuscular – animals that are active during dawn and dusk (twilight)

-D-

Death rate – number of individuals in a population dying in a specific time interval by the number alive at the same time interval
Decomposer – organism that obtains energy from the breakdown of dead organic material
Demography – study of the size and structure of populations
Density dependence – mechanism or interaction that is dependent on or influenced by the number of organisms per unit area
Detritivore – organism that feeds on dead organic material
Diastema – a naturally occurring gap in the tooth row
Diet – food consumed by an organism
Dispersal –the movement of an organism away from its birth site or breeding site

Diurnal – active during the daylight hours
Diversity – being comprised of many different things, e.g. different species in an ecosystem
DNA (deoxyribonucleic acid) – a nucleic acid that is the genetic material of an organism
Dominance – the possession of high social status within a group that has social organization
Dorsal – area nearest to the back, in vertebrates this is towards the spinal column

-E-

Ecdysis – the periodic shedding of the exoskeleton by some invertebrates or of the outer skin by some amphibia and reptilia
Ecological indicator – any organism or group of organisms indicative of a particular environment or set of environmental conditions
Ecology – the study of the interrelationships among organisms and between organisms, and all aspects, abiotic and biotic of their environment
Ecosystem – natural unit that consists of living and non-living parts
Enamel – crystals of a calcium phosphate-carbonate salt, containing 2-4% of organic matter, which are formed from the epithelium of the mouth and which provide a hard outer coating to denticles and to the exposed part of teeth
Environment – the external environment surroundings within which an organism lives
Epidermis – the outermost layer or layers of cells in an animal. It is one cell thick in many invertebrates, but many cells thick in vertebrates. In terrestrial vertebrates its surface layer is formed from dead keratinized cells
Eukaryote – an organism comprising cells that have a distinct nucleus enveloped by a double membrane and other features including double-membraned mitochondria and 80S ribosomes in the fluid of the cytoplasm
Evolution – change, with continuity in successive generations of organisms (e.g. descent with modification)
Exoskeleton – the horny skeleton that encloses the body of all arthropoda. It is secreted by their hypodermis. Much of the structure is made from chitin.
Extinction – any taxon where no member is living at this present time
Eye – any organ, sensitive to light, that is developed in many animals

-F-

Family – taxonomic rank (e.g. wolves are in the family Canidae)
Fatty acid – a long chained carboxylic acid that may be saturated or unsaturated

Feather – a keratinous outgrowth of the skin of birds that is highly modified for the purposes of flight, insulation, and display. Feathers can be divided into distinct types: contour feathers, down feathers, intermediate feathers, filoplumes, powder down, and bristles
Fertilization – the union of two gametes to produce a zygote, which occurs during sexual reproduction
Food web – a diagram that represents the feeding relationships of organisms within an ecosystem. It consists of a series of interconnecting food chains
Fossorial – species adapted for digging
Fungi – a large group of eukaryotic organisms that includes microorganisms such as yeasts and molds, as well as the more familiar mushrooms

-G-

Gait – manner of walking
Generalist – a species that eats a wide variety of food items, based on their abundance in the environment
Genes – the fundamental physical unity of heredity. It occupies a fixed chromosomal locus and when transcribed has a specific effect upon the phenotype
Genetics – the scientific study of genes and heredity
Genotype – the genetic constitution of an organism, as opposed to its physical appearance (phenotype)
Gestation period – length of time from conception to birth in a viviparous animal
Gill – the respiratory organ of an aquatic animal, often complex in form, consisting of an outgrowth from the body surface or an internal layer of a modified gut, past which water flows

-H-

Habitat – the living place of an organism or community, characterized by abiotic or biotic factors
Harem – a group of female mammals with which a single male has exclusive mating rights
Herbivore – a heterotrophy that obtains energy by feeding on primary producers
Heterodont – possessing teeth that are differentiated into several forms
Homeostatic – the tendency of a biological system to resist change and to maintain itself in a state of stable equilibrium
Homodont – possessing teeth all of which are of the same form

Horn – appendage on the skeleton, with a covering of keratin and other proteins surrounding a core of live bone
Hybrid – an individual animal that results from a cross between parents of differing genotypes (species)

-I-

Immunity – the resistance of an organism to a pathogenic microorganism or its products. Immunity may be active or passive.
Incisor – in mammals, one of the chisel-shaped teeth at the front of the mouth
Individual – a single entity (e.g. a single organism)
Insect – class of arthropods hat have three pairs of legs, and usually two pairs of wings borne on the thorax. Typically they have a single pair of antennae and one pair of compound eyes
Instinct – a genetically acquired force that impels animals to behave in certain fixed ways in response to particular stimuli
Invertebrate – an animal that lacks a spinal column. Includes multiple phyla

-K-

Keystone species – a species that has a disproportionately strong influence within a particular ecosystem, so that its removal results in severe destabilization of the ecosystem and can lead to further species loses
Kingdom – one of the major groups into which organism are placed

-L-

Learning – the acquisition of information or patterns of behaviour other than by genetic inheritance, or the modification of genetically acquired information or behaviour as a result of experience
Life cycle – the series of developmental changes undergone by the individuals comprising a population, including fertilization, reproduction, and the death of those individuals and their replacement by a new generation
Limiting factor – any environmental condition or set of conditions that approaches most nearly the limits of tolerance for a given organism

-M-

Marine – anything relating to the sea or ocean
Mastication – the process by which food is crushed and ground by teeth

Mesopredator – a predator of intermediate size
Migration – the movement of animals from one area to another, specifically a periodic two-way movement to and from a given area, usually along well-defined routes
Molar – in mammals, one of the posterior teeth, commonly used for crushing, that are not preceded by milk teeth
Moulting – the periodic, often seasonal, shedding of hair or feathers by animals
Mutation – a process by which a gene or chromosome set undergoes a structural change or a change in the amount of DNA it contains
Mysticeti – a mammalian suborder of whales, characterized by the present of baleen plates that are used in feeding

-N-

Natural selection – a complex process in which the total environment determines which members of a species survive to reproduce and so pass on their genes to the next generation
Niche – the functional position of an organism in its environment comprising the habitat in which the organism lives, the periods of time during which it occurs and is active there, and the resources it obtains there
Nocturnal – active during the night
Nutrient – A substance that provides nourishment essential for growth and the maintenance of life

-O-

Omnivore – a heterotroph that feeds on both plants and animals
Organ – a group of tissues that performs a specific function or group of functions
Organ system – a group of organs that work together to perform a certain task

-P-

Parasite – a parasite obtains food, shelter, or other requirements from its host
Parasitism – an interaction of species populations in which one (typically smaller) organism (known as the parasite) lives in or on another (known as the host)
Parasitoid – an organism that spends part of its life as a parasite and part as a predator (e.g. many wasps that are parasites during their larval stages and predators when mature)
Pathogen – any parasite (e.g. virus, bacteria, nematode, platyhelminth, etc.) or prion that causes disease

Pest – an animal that competes with humans by consuming or damaging food, fibre, or other materials intended for human consumption or use
Phenotype – the observable manifestation of a specific genotype
Phylum – one of the major groupings in animal taxonomy
Physiology – the way in which a living organism or bodily part functions
Piscivorous – fish eating
Poikilotherm – an organism whose body temperature varies according to the temperature of its surroundings
Population – a group of organisms all of the same species that occupies a particular area
Population dynamics – the study of factors that influence the size, form, and fluctuations of individual species or genus populations
Precocial – applied to young mammals or birds which are born with their eyes and ears open and are able to stand and walk, regulate body temperature
Predatory – an organism that obtains energy by consuming, usually killing, another species
Prey – an organism that is killed to provide energy for another species
Protozoa – a phylum of eukaryotic, single-celled microorganisms which show a wide variety of forms
Proximal – applied to that part of an organ or structure which is closest to its point of attachment to the body or to the centre of the body

-Q-

Quadrant – small region of known size
Quadrupedal – applied to animals that walk on four feet

-R-

Raptor – a bird of prey of the order Falconidae
Refuge – a site, defined in space and time, within which particular organisms are sheltered from the competitive effect of other species
Reptiles – a large and diverse class of pokilothermic vertebrates

-S-

Specialist – an organism that selects specific types of food, despite the abundance of food sources in the environment

Species – a group of organisms that resemble one another closely, usually that can breed with each other facilitating gene flow
Stress – a physiological condition, usually affecting behaviour, produced by excessive environmental or psychological pressures
Sympatry – the occurrence of species or other taxa together in the same area
Subnivean – zone underneath the snow, often used by small mammals to live during the winter

-T-

Taxonomy – the scientific classification of organisms
Terrestrial – referring to land, such as a terrestrial animal would live on land
Territoriality – the establishment, demarcation, and the defence of an area by animals, normally during the mating ritual
Tissue – a group of cells of similar type that work in a co-ordinate manner towards a common function. They are normally bound together by an intercellular substance
Torpor – a state of adaptive hypothermia used by endotherms in order to save energy
Tracks – imprints left in a substrate when an animal walks through it
Trait – any detectable phenotypic property of an organism
Transect – a line marked within an area that is undergoing an ecological survey to provide a means of measuring and representing graphically the distribution of organisms. It can also be used to set up traps for other types of research.

-V-

Ventral – the surface of an organism or structure that is usually nearest to the substrate

-W-

Weather – the state of the atmosphere (e.g. temperature, pressure, and humidity) and associated phenomena (e.g. precipitation and wind) occurring at a specified time and place

-Z-

Zoonotic (zoonoses) – A pathogen that can be transmitted from animals to humans and vice versa
Zygote – the fertilized ovum of an animal, formed from the fusion of male and female gametes

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Appendix: Breeding Bird Atlas Breeding Evidence Form and Point Count Form

Atlas des oiseaux nicheurs du MANITOBA Breeding Bird Atlas

Breeding Evidence Form - Northern Manitoba

Survey square number	Region	Year
		2 0 1

Atlasser's name	Atlasser's number

Additional observers	Atlasser number (if known)

Visit	Month	Day	Start time	End time	Team time
1			:	:	:
2			:	:	:
3			:	:	:
4			:	:	:
5			:	:	:
6			:	:	:
7			:	:	:
8			:	:	:
9			:	:	:
10			:	:	:

Additional team time not tallied in the table above :

Paid team time :

Additional information:

Please consult the Guide for Atlassers to ensure that this form has been filled out correctly.
Remember to complete a Rare/Colonial Species Form if you observe a species marked with a symbol (†, ¤, ‡ or §) or a species that is not listed on this form.

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Species	1st visit	Ob.	Po.	Pr.	Conf.	No.
Snow Goose §						
Ross's Goose †						
Cackling Goose †						
Canada Goose						
Tundra Swan ¤						
Gadwall						
American Wigeon						
American Black Duck ¤						
Mallard						
Northern Shoveler						
Northern Pintail						
Green-winged Teal						
Greater Scaup						
Lesser Scaup						
Common Eider §						
Surf Scoter ¤						
White-winged Scoter †						
Long-tailed Duck						
Bufflehead						
Common Goldeneye						
Hooded Merganser						
Common Merganser						
Red-breasted Merganser						
Spruce Grouse						
Willow Ptarmigan						
Red-throated Loon ¤						
Pacific Loon						
Common Loon						
Horned Grebe ¤						
American Bittern						
Osprey						
Bald Eagle						
Northern Harrier						
Northern Goshawk						
Red-tailed Hawk						
Rough-legged Hawk						
American Kestrel						
Merlin						

Species	1st visit	Ob.	Po.	Pr.	Conf.	No.
Yellow Rail ¤						
Sora						
Sandhill Crane						
American Golden-Plover						
Semipalmated Plover						
Killdeer						
Spotted Sandpiper						
Solitary Sandpiper						
Greater Yellowlegs ¤						
Lesser Yellowlegs ¤						
Whimbrel ¤						
Hudsonian Godwit						
Semipalmated Sandpiper †						
Least Sandpiper						
Dunlin						
Stilt Sandpiper						
Short-billed Dowitcher						
Wilson's Snipe						
Red-necked Phalarope						
Bonaparte's Gull						
Little Gull †						
Ross's Gull †						
Ring-billed Gull §						
Herring Gull §						
Arctic Tern §						
Parasitic Jaeger ¤						
Great Horned Owl						
Northern Hawk Owl ¤						
Great Gray Owl ¤						
Long-eared Owl ¤						
Short-eared Owl ¤						
Boreal Owl ¤						
Belted Kingfisher						
Hairy Woodpecker						
Am. Three-toed Woodpecker						
Black-backed Woodpecker						
Northern Flicker						
Yellow-bellied Flycatcher						

Species	1st visit	Ob.	Po.	Pr.	Conf.	No.
Alder Flycatcher						
Northern Shrike ¤						
Gray Jay						
American Crow						
Common Raven						
Horned Lark						
Tree Swallow						
Bank Swallow §						
Cliff Swallow §						
Barn Swallow						
Boreal Chickadee						
Red-breasted Nuthatch						
Brown Creeper						
Ruby-crowned Kinglet						
Gray-cheeked Thrush ¤						
Swainson's Thrush						
Hermit Thrush						
American Robin						
European Starling						
American Pipit						
Bohemian Waxwing						
Tennessee Warbler						
Orange-crowned Warbler						
Yellow Warbler						
Yellow-rumped Warbler						
Palm Warbler						
Blackpoll Warbler						
Northern Waterthrush						
Wilson's Warbler						
American Tree Sparrow						
Chipping Sparrow						
Savannah Sparrow						
Nelson's Sparrow						
Fox Sparrow						
Song Sparrow						
Lincoln's Sparrow						
Swamp Sparrow						
White-throated Sparrow						

Atlas des oiseaux nicheurs du MANITOBA Breeding Bird Atlas

Breeding Evidence Form - Northern Manitoba

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		2 0 1

Atlasser's name	Atlasser's number

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6			:	:	:
7			:	:	:
8			:	:	:
9			:	:	:
1 0			:	:	:

Additional team time not tallied in the table above :

Paid team time :

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Greater Scaup						
Lesser Scaup						
Common Eider §						
Surf Scoter ¤						
White-winged Scoter †						
Long-tailed Duck						
Bufflehead						
Common Goldeneye						
Hooded Merganser						
Common Merganser						
Red-breasted Merganser						
Spruce Grouse						
Willow Ptarmigan						
Red-throated Loon ¤						
Pacific Loon						
Common Loon						
Horned Grebe ¤						
American Bittern						
Osprey						
Bald Eagle						
Northern Harrier						
Northern Goshawk						
Red-tailed Hawk						
Rough-legged Hawk						
American Kestrel						
Merlin						

Species	1st visit	Ob.	Po.	Pr.	Conf.	No.
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Sora						
Sandhill Crane						
American Golden-Plover						
Semipalmated Plover						
Killdeer						
Spotted Sandpiper						
Solitary Sandpiper						
Greater Yellowlegs ¤						
Lesser Yellowlegs ¤						
Whimbrel ¤						
Hudsonian Godwit						
Semipalmated Sandpiper †						
Least Sandpiper						
Dunlin						
Stilt Sandpiper						
Short-billed Dowitcher						
Wilson's Snipe						
Red-necked Phalarope						
Bonaparte's Gull						
Little Gull †						
Ross's Gull †						
Ring-billed Gull §						
Herring Gull §						
Arctic Tern §						
Parasitic Jaeger ¤						
Great Horned Owl						
Northern Hawk Owl ¤						
Great Gray Owl ¤						
Long-eared Owl ¤						
Short-eared Owl ¤						
Boreal Owl ¤						
Belted Kingfisher						
Hairy Woodpecker						
Am. Three-toed Woodpecker						
Black-backed Woodpecker						
Northern Flicker						
Yellow-bellied Flycatcher						

Species	1st visit	Ob.	Po.	Pr.	Conf.	No.
Alder Flycatcher						
Northern Shrike ¤						
Gray Jay						
American Crow						
Common Raven						
Horned Lark						
Tree Swallow						
Bank Swallow §						
Cliff Swallow §						
Barn Swallow						
Boreal Chickadee						
Red-breasted Nuthatch						
Brown Creeper						
Ruby-crowned Kinglet						
Gray-cheeked Thrush ¤						
Swainson's Thrush						
Hermit Thrush						
American Robin						
European Starling						
American Pipit						
Bohemian Waxwing						
Tennessee Warbler						
Orange-crowned Warbler						
Yellow Warbler						
Yellow-rumped Warbler						
Palm Warbler						
Blackpoll Warbler						
Northern Waterthrush						
Wilson's Warbler						
American Tree Sparrow						
Chipping Sparrow						
Savannah Sparrow						
Nelson's Sparrow						
Fox Sparrow						
Song Sparrow						
Lincoln's Sparrow						
Swamp Sparrow						
White-throated Sparrow						

Point Count Form - Northern Manitoba

Atlas des oiseaux nicheurs du MANITOBA Breeding Bird Atlas

Survey square number | Atlasser's name | Atlasser's number | Year 2 0 1

Point A	Point B	Point C
Designated number*	Designated number*	Designated number*
Coordinates (see guide)** UTM Easting (NAD83)	Coordinates (see guide)** UTM Easting (NAD83)	Coordinates (see guide)** UTM Easting (NAD83)
Month / Day	Month / Day	Month / Day
UTM Northing (NAD83)	UTM Northing (NAD83)	UTM Northing (NAD83)
Start time (24 h) :	Start time (24 h) :	Start time (24 h) :
○ GPS ○ Survey square map ○ Web conversion tool	○ GPS ○ Survey square map ○ Web conversion tool	○ GPS ○ Survey square map ○ Web conversion tool
Habitat: Class SC, Structure (Optional), Modification (Optional)	Habitat: Class SC, Structure (Optional), Modification (Optional)	Habitat: Class SC, Structure (Optional), Modification (Optional)
1st	1st	1st
2nd	2nd	2nd

Species	Point A No.	Point A Br. evid.	Point B No.	Point B Br. evid.	Point C No.	Point C Br. evid.
Canada Goose						
American Wigeon						
Northern Shoveler						
Green-winged Teal						
Greater Scaup						
Common Eider §						
Long-tailed Duck						
Common Goldeneye						
Willow Ptarmigan						
Pacific Loon						
Sandhill Crane						
Killdeer						
Whimbrel ¤						
Hudsonian Godwit						
Dunlin						
Short-billed Dowitcher						
Wilson's Snipe						
Red-necked Phalarope						
Bonaparte's Gull						
Northern Flicker						
Yellow-bellied Flycatcher						
Gray Jay						
Common Raven						
Horned Lark						
Tree Swallow						
Boreal Chickadee						
Ruby-crowned Kinglet						
Gray-cheeked Thrush ¤						
Swainson's Thrush						
Hermit Thrush						
American Robin						
Orange-crowned Warbler						
Yellow Warbler						
Yellow-rumped Warbler						
Palm Warbler						
Blackpoll Warbler						
Northern Waterthrush						
Wilson's Warbler						
American Tree Sparrow						
Savannah Sparrow						
Fox Sparrow						
Lincoln's Sparrow						
Swamp Sparrow						
White-throated Sparrow						
Harris's Sparrow						
White-crowned Sparrow						
Dark-eyed Junco						
Rusty Blackbird ¤						
White-winged Crossbill ¤						
Common Redpoll						

Additional species or species with > 99 individuals

Species	4-letter code	Point A No.	Point A Br. evid.	Point B No.	Point B Br. evid.	Point C No.	Point C Br. evid.

* Only for predetermined point count locations
** Only for point counts that are not at predetermined locations (e.g., off-road). Please provide UTM coordinates and the method used to determine them.
Please consult the Guide for Atlassers to ensure that this form has been filled out correctly

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Point Count Form - Northern Manitoba

Atlas des oiseaux nicheurs du MANITOBA Breeding Bird Atlas

Survey square number	Atlasser's name	Atlasser's number	Year
			2 0 1

Point A	Point B	Point C
Designated number*	Designated number*	Designated number*
Coordinates (see guide)** UTM Easting (NAD83)	Coordinates (see guide)** UTM Easting (NAD83)	Coordinates (see guide)** UTM Easting (NAD83)
Month / Day	Month / Day	Month / Day
UTM Northing (NAD83)	UTM Northing (NAD83)	UTM Northing (NAD83)
Start time (24 h) :	Start time (24 h) :	Start time (24 h) :
◯ GPS ◯ Survey square map ◯ Web conversion tool	◯ GPS ◯ Survey square map ◯ Web conversion tool	◯ GPS ◯ Survey square map ◯ Web conversion tool
Habitat: Class SC; Structure (Optional); Modification (Optional)	Habitat: Class SC; Structure (Optional); Modification (Optional)	Habitat: Class SC; Structure (Optional); Modification (Optional)
1st	1st	1st
2nd	2nd	2nd

Species	Point A No.	Point A Br. evid.	Point B No.	Point B Br. evid.	Point C No.	Point C Br. evid.
Canada Goose						
American Wigeon						
Northern Shoveler						
Green-winged Teal						
Greater Scaup						
Common Eider §						
Long-tailed Duck						
Common Goldeneye						
Willow Ptarmigan						
Pacific Loon						
Sandhill Crane						
Killdeer						
Whimbrel ¤						
Hudsonian Godwit						
Dunlin						
Short-billed Dowitcher						
Wilson's Snipe						
Red-necked Phalarope						
Bonaparte's Gull						
Northern Flicker						
Yellow-bellied Flycatcher						
Gray Jay						
Common Raven						
Horned Lark						
Tree Swallow						
Boreal Chickadee						
Ruby-crowned Kinglet						
Gray-cheeked Thrush ¤						
Swainson's Thrush						
Hermit Thrush						
American Robin						
Orange-crowned Warbler						

Species	Point A No.	Point A Br. evid.	Point B No.	Point B Br. evid.	Point C No.	Point C Br. evid.
Yellow Warbler						
Yellow-rumped Warbler						
Palm Warbler						
Blackpoll Warbler						
Northern Waterthrush						
Wilson's Warbler						
American Tree Sparrow						
Savannah Sparrow						
Fox Sparrow						
Lincoln's Sparrow						
Swamp Sparrow						
White-throated Sparrow						
Harris's Sparrow						
White-crowned Sparrow						
Dark-eyed Junco						
Rusty Blackbird ¤						
White-winged Crossbill ¤						
Common Redpoll						

Additional species or species with > 99 individuals

Species	4-letter code	Point A No.	Point A Br. evid.	Point B No.	Point B Br. evid.	Point C No.	Point C Br. evid.

* Only for predetermined point count locations
** Only for point counts that are not at predetermined locations (e.g., off-road). Please provide UTM coordinates and the method used to determine them.

Please consult the Guide for Atlassers to ensure that this form has been filled out correctly

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