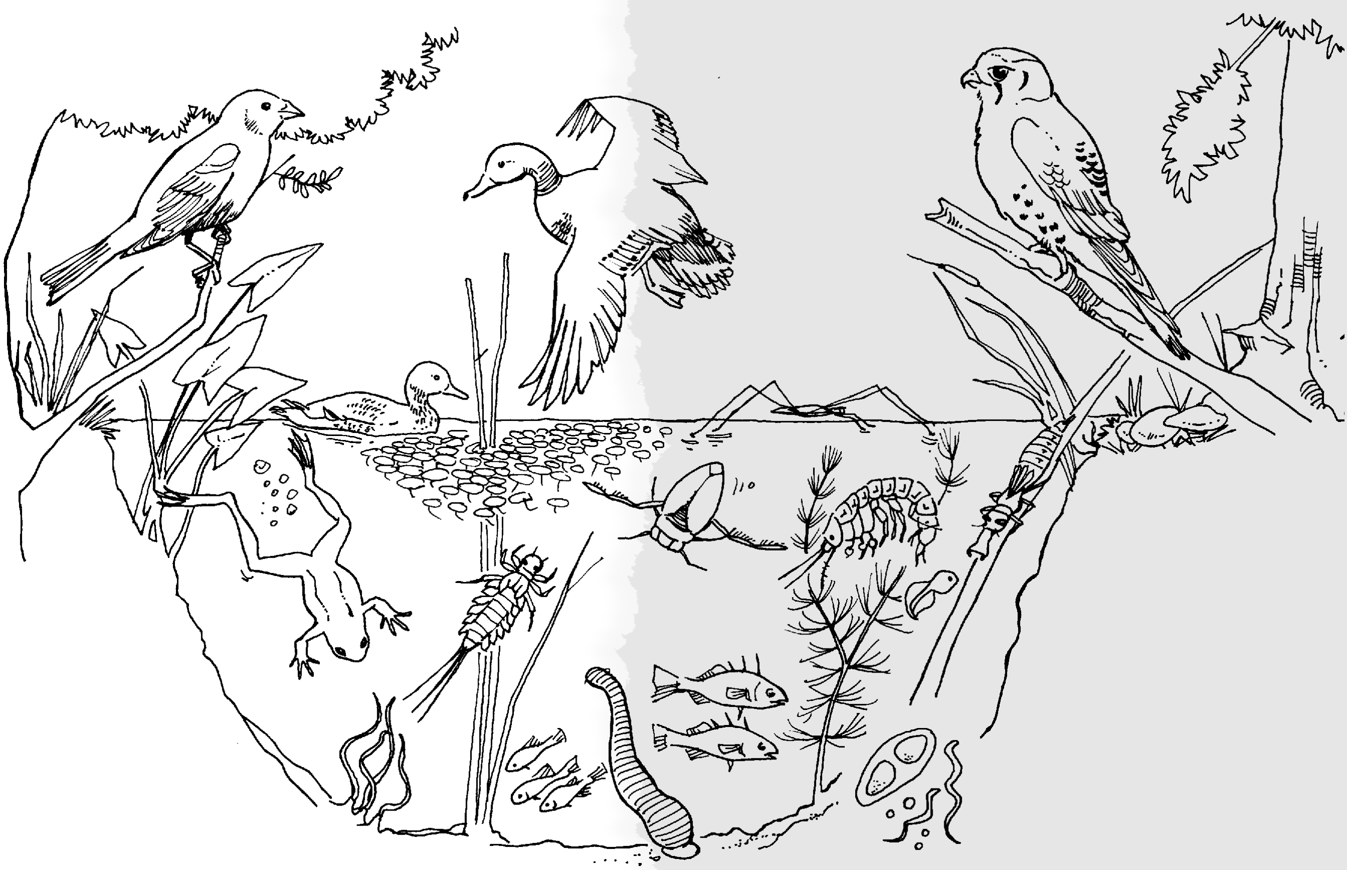
WETLAND ECOSYSTEMS III

EVOLUTION, DIVERSITY AND THE SUSTAINABILITY OF ECOSYSTEMS

STUDENT

JOURNAL

HIGH SCHOOL SCIENCE GRADES 9 to 12



PRESENTED BY Ducks Unlimited Canada

Table of Contents

info ZONE

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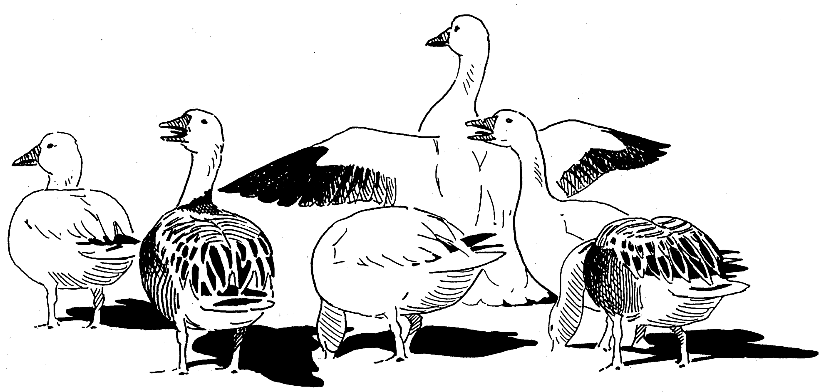
Lesson one

A species and ecosystem in peril



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The Snow Goose Life Cycle

The lesser snow goose *(Chen c. caerulescens)* nests colonially in coastal marsh ecosystems in the high arctic, and around Hudson and James Bay. On northward migration the birds feed heavily and add large fat reserves needed to nest successfully. On average, four eggs are laid in a down-lined tundra nest bowl and incubated for 23 days by the female, while the male guards against predators. When the young hatch the parents lead their brood to rich feeding areas where they grow quickly during the long summer days. The parents too must grow a new set of feathers at this time and are flightless for several weeks. The strong serrated bill of the snow goose is adapted to graze on grasses and sedges, as well as burrow in the thin soil for nutritious roots and rhizomes. Muscles, bones and feathers must mature before early fall storms force the families to migrate. Carried south on favorable weather fronts, the large noisy flocks descend periodically at traditional staging sites where they drink, feed and refuel the energy reserves needed to continue their journey. After many days of travel, they reach their historical wintering areas in marshes along the Gulf of Mexico. Here they feed and rest to prepare for their next annual cycle. Adult birds pair for life but juveniles usually don't nest until at least two years old. Mortality is high each year with the major causes being disease, starvation, predation (including human), weather and accidents.

1. Read the **Info/Zone** about the lesser snow goose. Complete the exercise below:

   i) Name the major geographically separate ecosystems used by the snow goose over its *annual biological cycle*.

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   ii) In the space below centred around the title, label the main components of the annual biological cycle of the lesser snow goose.

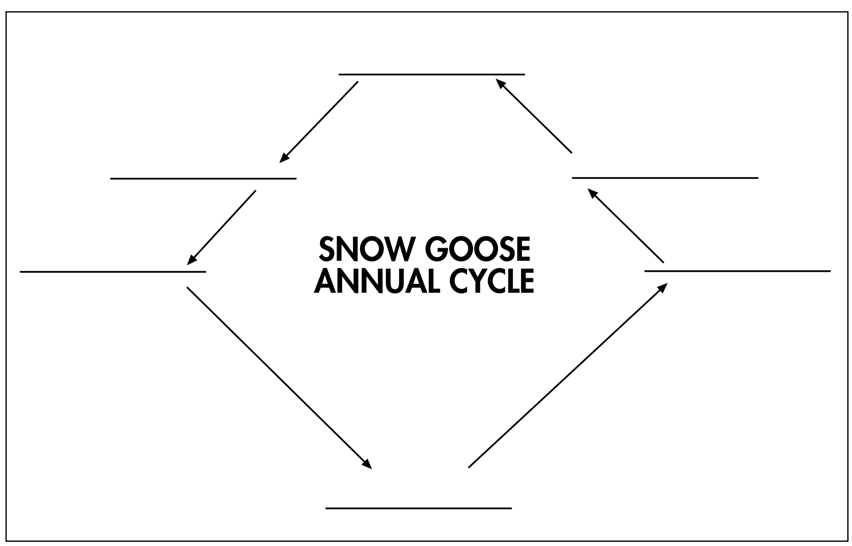


DIAGRAM 1.1

Lesson one continued

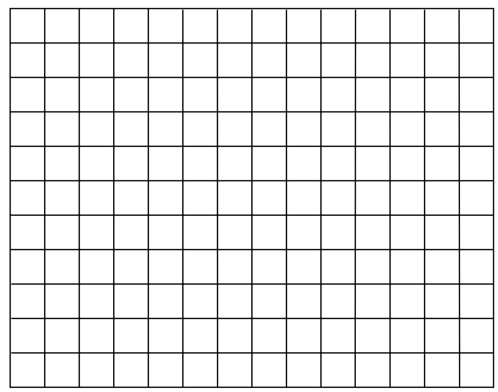
Surveys by the Canadian Wildlife Service and the U.S. Fish and Wildlife Service show that mid-continent lesser snow goose populations were near the *carrying capacity* of less than one million birds for many years, held in check by the availability of food on the wintering grounds. Then things changed and populations began to grow exponentially. See some of the reasons in the **InfoZone.**

2. Graph the data below for the numbers of lesser snow geese estimated on midwinter surveys and draw a line of best fit.

Number of lesser snow geese surveyed in midwinter

Year	Birds (thousands)
1951	700
1958	750
1960	800
1962	600
1965	800
1969	800
1975	1600
1981	1750
1984	1900
1993	2200
1996	2700
2000	3200

Birds



Year

i) Using the method of *interpolation*, indicate the year in which a major change in population occurred. ______________________________

ii) Compare the rate of increase (per cent) in population over the first 18 years of survey data compared to the last 31 years. ______________

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iii) Using the method of *extrapolation* (extend the line), estimate what the population will be in the next 30 years assuming that controlling factors do not take effect.

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iv) Do you think the growth in population estimated through the year 2030 is sustainable? Discuss your hypothesis. _________________________

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(Note: there has been a similar increase in greater snow geese and Ross' geese while the number of giant Canada geese living in urban areas has also increased greatly.)

info ZONE

Changes and adaptations

Over several decades changes have occurred which have affected snow goose survival in a dramatic way.

- Since 1961 there has been a warming trend in the western arctic which has resulted in an earlier snow melt and a reduction in late spring snowstorms. This has allowed birds to feed and nest more successfully.
- The spread of modern farming practices, such as *combining* replacing *stooking*, has resulted in more grain being available for wildlife in fields during and after harvest. Snow geese have taken advantage of this on staging grounds. In the south the acreage of rice production has more than doubled since the 1940s. Birds have expanded their winter range from 200,000 hectares of Gulf Coast marshes to include another 900,000 hectares of rice wetlands throughout Texas, Louisiana and Arkansas. Birds are now able to overwinter and migrate in much better condition and, as a result, nest more successfully.
- Between the 1930s and 1970s, a network of wildlife preserves were established where food crops are managed for wildlife. Geese have learned to leapfrog at a leisurely pace between these refuges during migration and take advantage of the food and protection.
- The number of waterfowl hunters has declined significantly across North America over the past 25 years. With the tremendous increase in goose numbers, the *harvest rate* (fall harvest as a proportion of the midwinter population) has declined from about 40 per cent to eight per cent. This may have resulted in an increase in wariness of the large flocks of snow geese which now have a higher number of older and more experienced birds in them. Annual survival of adult nesting snow geese from the Hudson Bay area has increased from 78 per cent to over 88 per cent.

Lesson one continued

infoZONE

Impacts on the ecosystem

The increase in snow goose numbers at a rate of five to eight per cent annually is impacting the environment. For example, the colony at Cape Henrietta Maria in northern Ontario has increased from 2,000 pairs in 1960 to 225,000 pairs in 1999. The most noticeable effect has been the degradation of the fragile salt marshes used by the geese for feeding. Their grazing and grubbing for the shoots and below-ground parts of grass and sedge has resulted in the destruction of large regions of the coastal lowlands which have been transformed into a moonscape of barren mud flats. Geese have been feeding this way for thousands of generations but are now consuming vegetation faster than it can recover in the harsh arctic environment. This impact has been measured using satellite imagery as well as small wire pens (exclosures) that have been in place for many years to exclude the geese from feeding on representative test sites.

With the removal of ground cover of plants, surface evaporation has increased on the mud flats and the soil salinity has risen. Hypersaline conditions have restricted regrowth of vegetation except by a small number of inedible, salt tolerant species like *Salicornia* (glasswort). At other overgrazed sites with lower salinity, moss has now become dominant and restricted the reestablishment of more nutritious plants. Studies have shown that natural recovery of the tundra marshes may take many decades and that new technology needs to be developed to restore ground cover economically. The extent of desertification (desert formation) and destruction has been staggering. On a 1900-km length of coastline scientists have estimated that 35 per cent of the original habitat has been destroyed, another 30 per cent has been severely damaged and the remainder has been overgrazed. Thus, out of a total of 55,000 hectares of intertidal salt marsh, over 35,000 hectares are no longer productive and the remainder is being heavily used.

(continued on next page)

3. Read the **InfoZone** piece about the factors that changed in the environment used by snow geese and how the geese responded. Answer the questions below.

   i) List the responses (*adaptations*) made by snow geese in relation to the changes that occurred in their environment, which have led to the population explosion in geese.

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   ii) Which of the changing factors are *abiotic* (A) VS *biotic* (B)?

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   iii) Which of the factors are direct (D) vs indirect (I)?

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   iv) Which of the factors are *natural* (N) vs induced by humans (H)?

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4. Read the **InfoZone** on this page and the next page about the impacts that have resulted from the population explosion of lesser snow geese. Do the following exercises in groups of four:

   i) On a separate piece of paper, using arrows and words, make a flow chart to show the complexity of interrelated factors, relationships, processes, results and impacts that have occurred in the lesser snow goose's ecosystem during the latter half of the 20th century. Transfer the results to a poster board for discussion in class.

Lesson one continued

info ZONE

(continued from previous page)

Impacts on snow geese are evident as broods are now forced to walk many kilometers from their nesting colonies to find food. Thousands are suffering and eventually dying from starvation or exposure. Young birds able to fledge are lighter and in weaker condition. It is only a matter of time before a major population *crash* occurs unless solutions are found. In the interim, goose numbers continue their meteoric climb. Farmers along the migration route are demanding compensation for the crops that the geese are eating.

Back on the tundra many other species which depend on coastal wetlands for their survival are also in jeopardy. These include some populations of Canada geese, dabbling ducks like wigeon and shoveler, and water birds like the yellow rail, stilt sandpiper, short-billed dowitcher and Hudsonian godwit. These species may be significantly and permanently affected. On the other hand predators and scavengers like gulls, jaegers, eagles, ravens and foxes are likely benefiting from the increased food supply of eggs, goslings and adults.

ii) See the simple *biomass pyramid*, below, representing the relative sizes of trophic levels in the snow goose's arctic ecosystem during the 1950s. Develop a pyramid to show what you think the system currently looks like. Is the shape representing the two systems the same? Discuss briefly.

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iii) Under present conditions do you believe the *species diversity* of the system is sufficient to sustain it in its present state for much longer? Discuss briefly.

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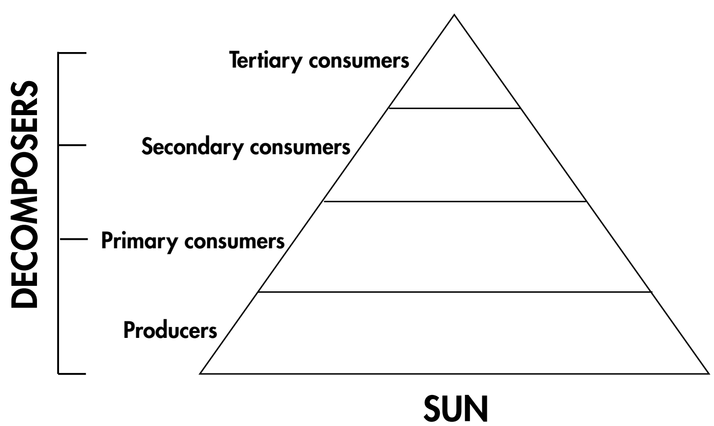
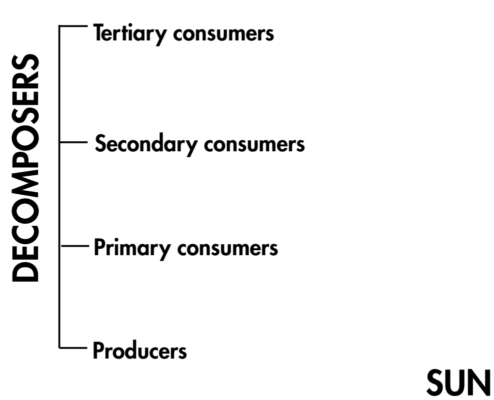
Energy/biomass pyramid – snow goose ecosystem in the 1950s



Energy/biomass pyramid – snow goose ecosystem today



Lesson one continued

info ZONE

Solutions?

Much of the snow goose problem has been caused directly or indirectly by people (*anthropogenic*) and therefore some believe a human solution is required. Others believe that nature should take its course. It has been estimated by ecologists that the lesser snow goose population will need to be reduced by 50 per cent within six years if the coastal marine ecosystem in the arctic is to be preserved. They believe this can be accomplished most effectively by reducing the survival of adult geese. Snow geese are very wary and quickly learn to avoid people. Some believe that snow geese are not as good tasting as other geese, while some consider them gourmet food.

Possible solutions are outlined on pages five to seven. Note that some of these may not be technologically or economically feasible given the time frames outlined above. Other possible solutions might work in the short term but not solve the longer-term problem. Some potential solutions may cause equally problematic outcomes from an environmental or economic standpoint. Consider each idea carefully in terms of providing a workable and sustainable solution. Can you suggest other solutions or combinations of solutions that might work?

5. Read the **InfoZone** and the sections below about some of the possible solutions to address the snow goose dilemma. In groups of four discuss these and other solutions. Your teacher will assign your group a title (e.g. tax payers group, non special interest group, hunting guide business, environmental research foundation, farmers coop, bird watching society, habitat conservation group, animal rights association, hunter's association, environmental activist group, aboriginal peoples' council, tour operator group, small business association, etc.)

   Consistent with the group you belong to, select one or more of the solutions that your group will support. Based on the principles you believe are appropriate for your group, prepare a paper for **public hearings** that have been struck to decide on the correct course of action to address this environmental issue. Each member of your group will present part of your paper to the rest of the class and share in answering questions from other students in defense of your stance.

   After all presentations are made a **referendum** will be organized by your teacher to determine which solutions should be implemented and scientifically tested to see that they will solve this real life problem. Students should vote based on their own personal conclusions and not necessarily in accordance with the special interest position they were assigned. Select no more than five solutions that you support and mark these on your ballot, in order of priority, with numbers one to five. The class will review and discuss the final results in an open forum. In particular discuss some of the studies and hypotheses that will need to be developed by researchers to ensure that the solutions you have decided on are actually solving the problem. As well, discuss some of the socio-political considerations that arose at the public hearings that could have affected consideration of some of the solutions. How important is public education as a precursor to holding a referendum?

Possible solutions

i) **Genetic Engineering:** Have the government pay for genetically engineering new salt tolerant plant species that can be reintroduced onto overgrazed areas and that will withstand the grazing pressure by the growing number of geese. Develop seeding techniques and machinery that can be used over large remote areas to establish the plants.

ii) **Birth Control:** Have the government develop safe and long lasting birth control drugs and an economical system of applying them to at least 500,000 geese.

iii) **Trap and Release:** Implement a large trapping program and negotiate agreements with other governments to release one million geese into appropriate ecosystems (assuming these can be found) in other parts of the world.

Lesson one continued

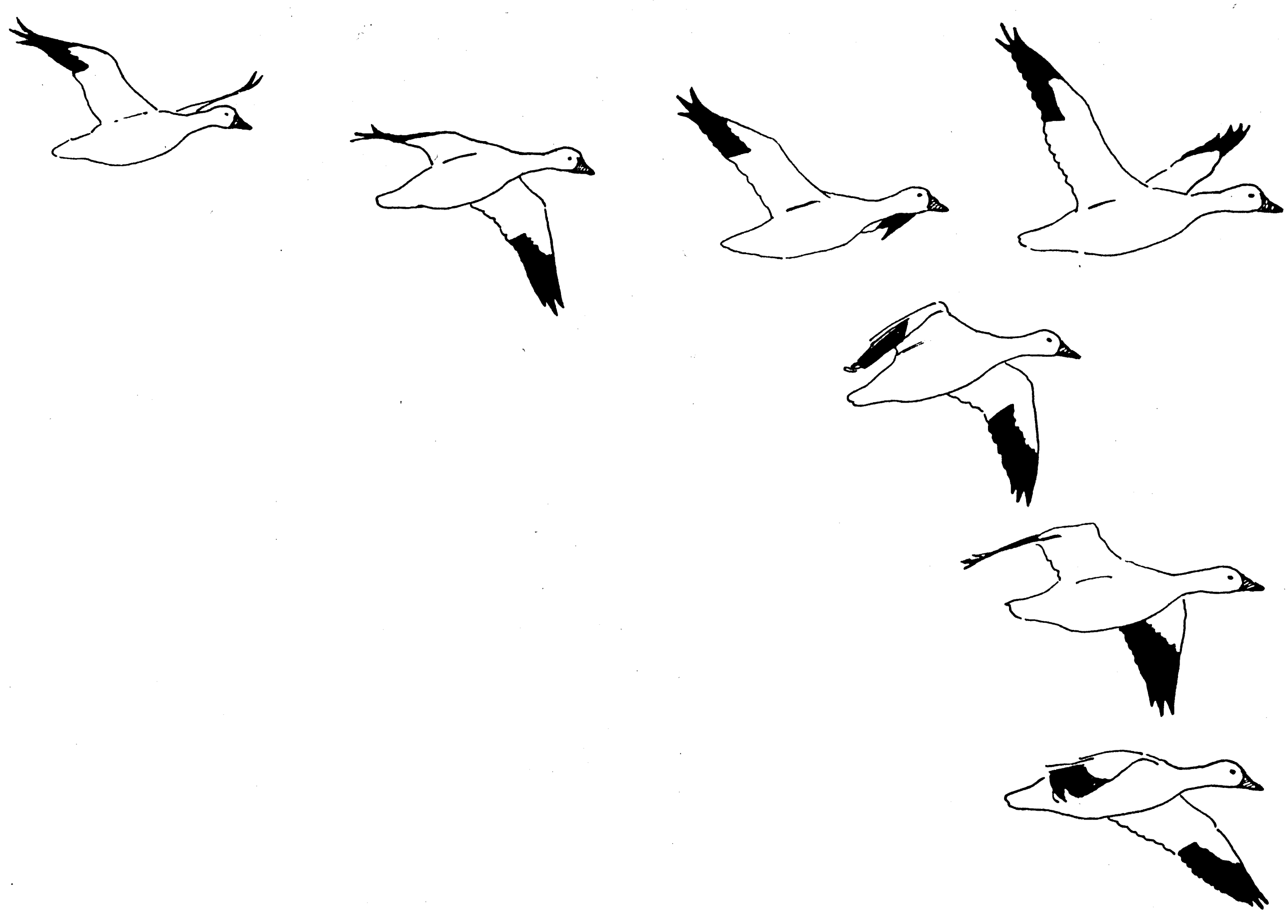
iv) **Subsistence Harvest:** Work with aboriginal councils to encourage them to increase their subsistence harvest of eggs and adult geese.

v) **Commercial Harvest:** License small businesses to capture and humanely prepare geese for export as a gourmet food to urban markets in North America and Europe.

vi) **Soup Kitchens:** Have government wildlife agencies capture geese and humanely prepare them for needy people and soup kitchens both in North America and abroad.

vii) **Do Nothing:** Do nothing and let nature take its course with the snow goose and the other species that depend on the arctic salt-marsh ecosystem for their existence.

viii) **Drastic Measures:** Introduce drastic measures (poisons, explosives, disease vectors, etc.) to quickly cull a predetermined number of geese where they congregate on wintering and nesting areas. Dispose of the carcasses in landfill sites or by incineration.



Lesson one continued

ix) **Agricultural Practices:** Pass legislation to have farmers revert to past farming practices so as to reduce the food available for geese (i.e. revert to stooking vs combining). Any reduction in farm income and food production would be borne by taxpayers.

x) **Increase Hunting:**
- increase daily limit from 5 to 40 birds per hunter
- allow hunting in spring
- put a leg band on a goose offering a $1 million reward
- allow electronic calls and baiting to increase hunter success
- educate hunters on how to properly cook and prepare snow geese
- allow managed hunting in some refuges

xi) **Tillage:** Require farmers to harvest their crops and till waste grain into the soil before geese arrive on migration. Alternatively they would be made responsible for keeping geese from feeding in their fields. A new surveillance and enforcement department would implement this program. Have taxpayers responsible for any extra costs involved.

xii) **New Predators:** Introduce new or more predators to areas near snow goose colonies so as to reduce the population and/or increase nest destruction.

xiii) **Sterilization:** Introduce radiation or chemically induced sterility to the snow goose population to reduce birth rate.

Lesson two

Wetlands and environmental quality

info ZONE

Until recently in humanity's history, pollution has been primarily a local problem. The industrialization of society, the introduction of motorized vehicles and the explosion of human population, however, have caused an exponential growth in the production of goods and services. Along with this growth has been a tremendous increase in waste by-products. The indiscriminate discharge of untreated industrial and domestic wastes into the environment has a number of serious effects on the quality of our air, water and soil.

As an environmental biologist there are many factors you must look at to determine the degree to which we are impacting our environment. We tend to consider the air, water and soil as separate issues, but this is not the case. Any pollutants in the soil or atmosphere will be washed out by precipitation into our surface or ground water.

This exercise will focus on water quality because water is an excellent indicator of the overall health of our environment. You can do without food for weeks, but you can't go without water for even a day.

Water quality

Most measurements of water quality look at the relative levels of dissolved oxygen and carbon dioxide as an indicator of the degree of pollution. This is because these gases play essential roles in the metabolism of almost all living things. Before you begin to look at water quality, it is necessary that you gain an understanding of how oxygen and carbon dioxide affect living organisms.

Oxygen and carbon dioxide are both clear, colourless, odourless gases found in the atmosphere. The amount of each gas present is regulated by living organisms. At the boundary between the atmosphere and a body of water, both oxygen and carbon dioxide gases will dissolve to some extent into the water. The concentration of dissolved oxygen depends on the concentration of dissolved carbon dioxide.

The following table indicates the amount of oxygen and carbon dioxide gases which dissolve into water under normal atmospheric pressure.

Table 1: Solubility of oxygen and carbon dioxide in water

TEMPERATURE (˚C)	OXYGEN GAS Solubility (ppm)	CARBON DIOXIDE GAS Solubility (ppm)
0	14.6	1.00
5	12.8	0.83
10	11.3	0.70
15	10.2	0.59
20	9.2	0.51
25	8.4	0.43
30	7.6	0.38

Lesson two continued

1. Graph the solubility of oxygen gas VS temperature. On a separate graph, show the solubility of carbon dioxide gas VS temperature. The higher the line, the greater the solubility. Label your graphs as well as each dependent and independent axis.

Lesson two continued

2. Compare the two graphs you have produced. Which gas has a greater dependence on temperature for solubility?

3. What is the significance of this difference in temperature dependency?

Almost all of the aquatic organisms that you will be dealing with depend on dissolved oxygen for survival. In general, how active an organism is will determine the amount of dissolved oxygen that it requires. However, different types of organisms have different tolerances to low oxygen levels. For example, goldfish in your home aquarium can survive on as little as one part per million (1 ppm) of dissolved oxygen, but trout have specialized requirements and usually need at least nine parts per million (9 ppm) of dissolved oxygen, and water no warmer than 20 degrees Celsius.

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The amount of dissolved oxygen in water has a significant effect on fish health and growth rate. Table two shows how trout growth can be slowed by a reduction in the amount of dissolved oxygen in water. Shallow wetlands like marshes and swamps do not support trout. Only species that can withstand lower oxygen levels and higher water temperatures, such as pike and sticklebacks, are found there. When wetlands are too shallow they may freeze to the bottom in winter and oxygen levels drop to very low levels. Fish die-offs will occur under such anoxic conditions.

Table 2: Per cent reduction in growth rate at various dissolved oxygen concentrations

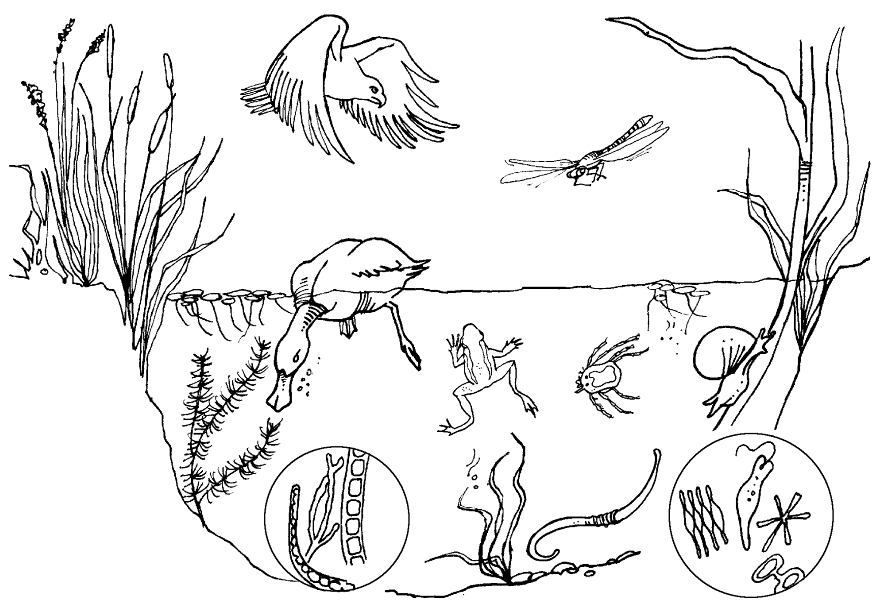
DISSOLVED OXYGEN	PER CENT REDUCTION IN GROWTH RATE		
(ppm)	Rainbow trout	Brown trout	Lake trout
9	0	0	0
8	1	0	0
7	5	1	2
6	9	6	7
5	17	13	16
4	25	23	29
3	37	36	47

4. Which of the trout species in Table two is affected the most by a decrease in dissolved oxygen levels?

Lesson two continued

5. Lake trout prefer deep areas of lakes where the temperature is less than 10 degrees C. Brown trout and rainbow trout tolerate and prefer higher temperatures and thus can survive in shallower wetlands. Explain how the information in table two could support these observations.

In bodies of standing water, oxygen is present due to photosynthesizing organisms and diffusion from the atmosphere. When oxygen is consumed by the respiration of plants, animals and microorganisms faster than it is replaced, many of those organisms are no longer able to survive. At the bottom of deep and/or murky bodies of water there is not enough light for photosynthesis to replace the amount of oxygen consumed and decomposers (bacteria) use up the available oxygen quickly. Aerobic bacteria use oxygen to convert dead organic matter into energy, water and carbon dioxide, and if the oxygen levels drop to zero, anaerobic bacteria take over and convert the organic matter into energy, methane and hydrogen sulfide. The "rotten-egg" smell you experience at some wetlands is due to anaerobic respiration.



Lesson two continued

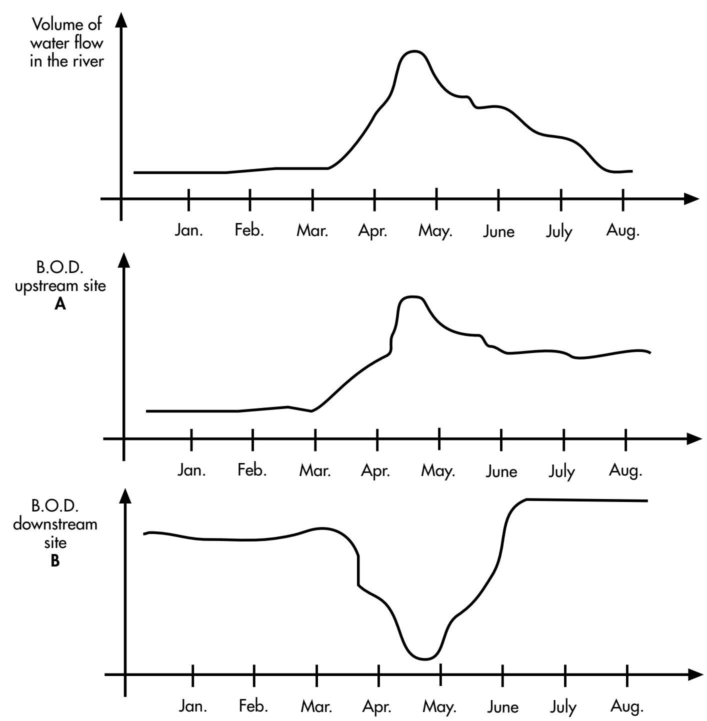
You should note that water which contains over 25 ppm of dissolved carbon dioxide gas is generally lethal to most aquatic organisms.

A standard measure of the water quality is *biochemical oxygen demand* (B.O.D.), which measures the amount of oxygen consumed over a five day period by aerobic bacteria at 20 degrees C. To test B.O.D. a water sample is divided in half. One half is immediately tested for the amount of dissolved oxygen present. The other half is placed in the dark at 20 degrees C for five days and then tested for the concentration of dissolved oxygen. The difference between the two measurements is the biochemical oxygen demand.

Now that you have some idea how the concentrations of dissolved oxygen and carbon dioxide influence living organisms, consider the effects of releasing water-borne pollutants into the environment.

info ZONE

See the map on page 13 showing the river and various sampling locations. The following set of graphs represent plots of the volume flow and biochemical oxygen demand for a river into which a town has been dumping lightly treated sewage residue. Measurements for B.O.D. were taken at two locations – one upstream from the town (A) and the other downstream (B). Note: in the top graph the flow volume quickly peaks in spring after snow melt and then declines through the summer as runoff from melting snow decreases.



6. Explain why the B.O.D. of the water in the river is higher at a site downstream from the town during the months of January to March than it is at a site upstream for the same months.

Lesson two continued

info ZONE

A biologist has been hired to survey the river just upstream and for 20 kilometres downstream of the town. She notes in her report that the species of bottom dwelling insects show marked changes relative to the site at which the outflow of the town's sewage treatment plant enters. The map she has prepared of the area shows the location of her survey sites, the species present and the number of times each species is seen in a standard-sized bottom sample. The report uses the term *indicator species* when she refers to sludge worms and midge larvae. Relate this to the information on B.O.D. you have reviewed on page 12.

7. In April and May why does the B.O.D. of the river water increase with volume flow at upstream sites and decrease with volume flow at downstream sites?

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8. Why would the B.O.D. of the water in the river be lower at sites, both upstream and downstream, for January to March compared with June to August?

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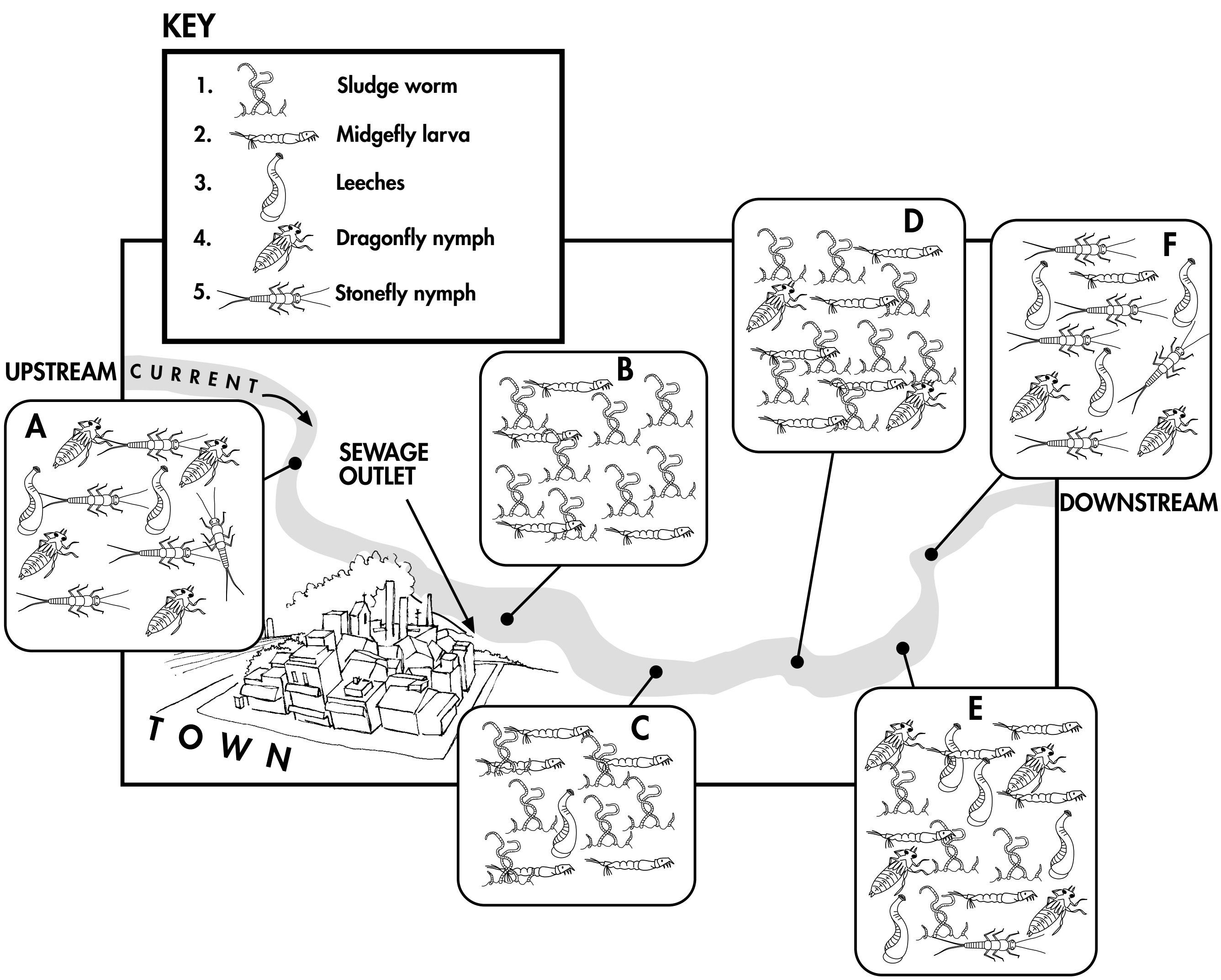

Lesson two continued

For each sampling location, count the number of each type of organism per m^2 and fill in the following table. Graph your results with a separate line for each species.

Site	Sludge worms	Midge larva	Leeches	Dragonfly nymph	Stonefly nymph
A Upstream					
B Downstream					
C Downstream					
D Downstream					
E Downstream					
F Downstream					

9. Based on the biologist’s map on page 13 and your graphs above, what can you conclude about the five types of organisms? ____________________

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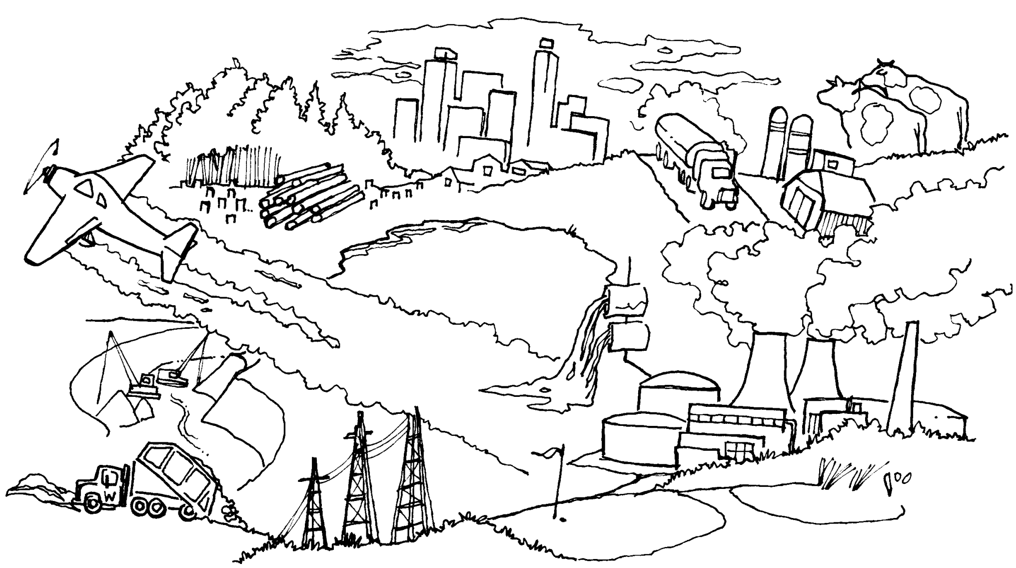
Lesson two continued

10. In the report, the biologist refers to some organisms as *indicator species*. Explain the term *indicator species* (see **InfoZone** on page 13).

11. Walking along the banks of the river you notice an increase in the amount of algae in the water. As you move downstream, you discover there is a decreased amount of oxygen and increased amounts of carbon dioxide in the water where the amount of algae is the greatest. Can you think of a reason why? Algae is a photosynthetic organism so shouldn't the amount of oxygen increase when the algae increases?

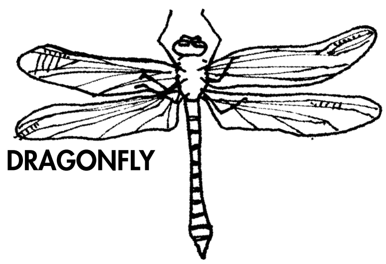
12. A small marshy pond is found to contain many small fish of a species known to tolerate low oxygen conditions. Is the pond necessarily polluted? Explain your answer.

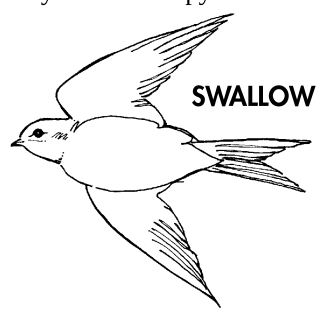


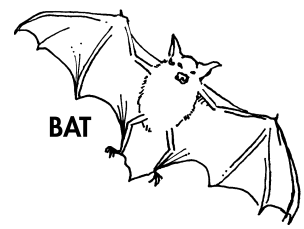
Lesson three

Specialization and natural selection

The ecological niche of an organism is its position or status within its community resulting from its structural, physiological and behavioural adaptations to the biotic and abiotic environment in which it lives. Swallows and dragonflies share a similar ecological niche in that they both occupy habitats over and around wetland environments, feeding on insects they catch during the day in flight. Bats also feed on flying insects but inhabit forests and fields and feed at night. Thus, they do not occupy the same niche as swallows or dragonflies.







1. Functionally, all of the above organisms are similar. They all fly and eat insects. In the chart below, list the ways in which these organisms are structurally similar and different.

DRAGONFLY		SWALLOW		BAT	
Same	Different	Same	Different	Same	Different

2. All three of these organisms are animals but bats and swallows are described by biologists as being more closely related to each other. By comparing the pictures above and using the library and Internet to gather additional information, describe which characteristics could be used to place dragonflies into a different grouping of animals than swallows and bats.

Lesson three continued

info ZONE

In order to separate organisms into groups, biologists first note the structural similarities between organisms. Without the aid of technologies like the microscope, the original groupings were between plants and animals – organisms that make their food and organisms that eat others. The difficulty with this is that the invention of the microscope allowed us to view other organisms that seemed to combine both of these traits. We now recognize five separate groupings, or **kingdoms**, of organisms based on the organization of their cells. These are the **Kingdoms Animalia, Plantae, Protista, Monera** and **Fungi**.

Within each kingdom there are further groupings since not all organisms look the same. Modern biologists explain those differences by referring to the genetic make-up of the cells within each organism. With each smaller grouping the genetic make-up becomes similar. When two individuals are so alike that they can mate and produce viable offspring which are also able to mate and reproduce, we say they belong to the same **species**.

The current naming system used by biologists uses seven different categories, called **taxa**. Listed in order from most general to most specific they are: **Kingdom, Phylum, Class, Order, Family, Genus** and **species**. By convention the species name is never capitalized and most biologists refer to organisms by their Genus and species names only. For example, modern humans are referred to as *Homo sapiens*. The genus name begins with a capital letter and both names are either underlined or written in italics.

3. Using your textbook or other reference sources (e.g. encyclopedia, biology textbook, Internet), find and describe the structural differences between the cells of each of the five kingdoms. ______________________________
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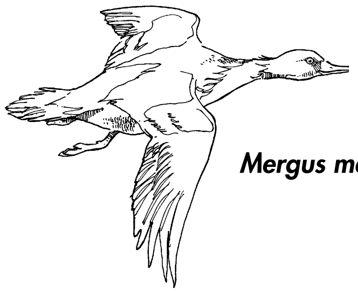
b) Given the common names of the organisms in random order – bank swallow, coyote, dragonfly, mosquito, house cat – place each in the appropriate space in the table below. Use reference material if needed.

KINGDOM	Animalia	Animalia	Animalia	Animalia	Animalia
PHYLUM	Arhropoda	Chordata	Arhropoda	Chordata	Chordata
CLASS	Insecta	Aves	Insecta	Mammalia	Mammalia
ORDER	Odonata	Passeriformes	Diptera	Carnivora	Carnivora
FAMILY	Corduliidae	Hirundinidae	Culicidae	Felidae	Canidae
GENUS	*Cordulia*	*Riparia*	*Aedes*	*Felis*	*Canis*
SPECIES	*shurtleffi*	*riparia*	*vexans*	*domesticus*	*latrans*
COMMON NAME					

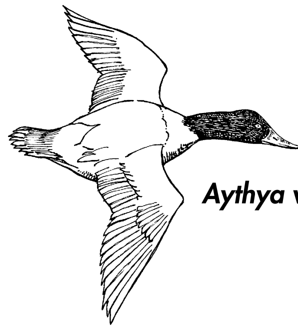
c) Which two organisms in 3b are most closely related? How did you determine this? ______________________________
____
____
____
____
____

Lesson three continued

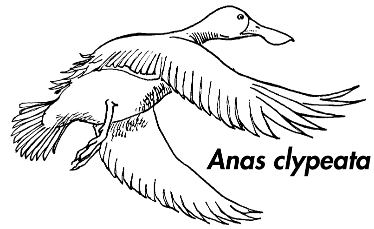
Carefully study the following set of pictures.



Mergus merganser



Aythya valisinera



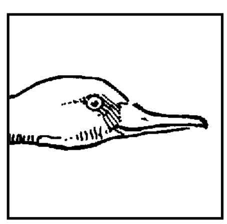
Anas clypeata

info ZONE

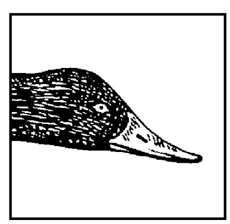
Within a particular grouping you would expect to find certain similarities. As you proceed towards a species group, the number of similarities increases. Differences are regarded as adaptations to a particular ecological niche. Such differences allow different species to take advantage of specialized niches, reduce competition with closely related individuals and increase success (survival and production of offspring).

5. The 148 species of ducks, geese and swans all belong to the same family – the Anatidae. The three ducks shown in the diagrams above belong to different genera but all can be found on wetlands. List the structural similarities between these ducks. Do you notice any structural adaptations to a lifestyle that is at least semi-aquatic? Can you think of any reasons why a flying animal like a duck might take on an aquatic lifestyle? Use reference material (books, Internet, etc.) to learn more about this. See the following Internet pages:
   http://home.att.net/~DanCowell/page2.html
   http://www.npwrc.usgs.gov/resource/tools/duckdist/duckdist.htm
   http://www.cws-scf.ec.gc.ca/hww-fap/eng_ind.html

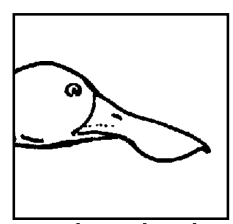
6. Look carefully at the illustration of the beaks of these ducks. The common merganser is a diving duck that catches and eats fish. The northern shoveler is a dabbling duck that strains aquatic animals out of the water and eats vegetation near the surface. The canvasback dives and digs up the tubers of aquatic plants on the bottom. Describe how the beak of each of these ducks is adapted to its lifestyle (use reference material).



Common Merganser



Canvasback



Northern Shoveler

Lesson three continued

Design an alien

Your goal is to design an *alien* life form which is adapted to life on a distant planet called *Marshlandia*. This planet is somewhat different than earth in that it has a smaller radius and a rocky core, giving it a surface gravity of only 0.8 that of Earth's. In addition, the planet is mostly water covered with warm shallow oceans and small clusters of low rocky islands, none rising more than 150 metres above sea level. Along the shorelines and surrounding islands are highly productive salt marsh ecosystems. At low tide these marshes form broad expanses of mud flats interspersed with tidal pools and grassy vegetation. The planet's two small moons produce two tides a day. Occasionally the moons will be aligned such that a much larger tide than normal results, creating large tidal bores in the wetlands and channels. The planet orbits a G2 type star which has slightly more ultraviolet light in its spectrum than does Earth.

To complete this exercise, produce a report which includes the following items:

a) a written description of your alien which describes its physical and behavioural characteristics, habitat, and ecological niche in relation to other species.

b) a written description of how each physical and behavioural characteristic of your alien suits it to life on Marshlandia.

c) a series of diagrams illustrating the appearance of your alien from a side, front and top perspective.

d) a physical model of your alien completed to an appropriate scale.

e) a common and scientific name for your species with a rationale for this name.

Note: You may use any materials you wish to construct your model but no preconstructed kits are allowed. You may work in teams of two or three.

Marks for this project will be assigned in three categories – creativity, craftsmanship and quality of your written report.

Lesson four

Who am I?

The following is a list of a few animals found on Earth. Using the dichotomous key on the next page, identify the animals using correct species and genus names. Note that in this key genus and species names are in italics. The genus name is capitalized and the species name is not. When you have identified the scientific name of each animal, use an underline to indicate italics (i.e. *Anas americana* may be written Anas americana). Check off those which are wetland dependent.

info ZONE

Keys have been developed by biologists to help others identify unknown organisms. As new species are discovered, their taxonomy must be developed using existing keys modified to include them. A *dichotomous key* is a simple chart which enables you to identify and isolate the name of a specific item from a larger group of items, based on a series of either/or choices. There are many different types of dichotomous keys. The *flow chart* approach you will use in lesson four to divide organisms into groups is really only useful for very short keys and often uses illustrations rather than written descriptions. One of the more common methods for keying involves using of pairs of statements which offer a choice between two characteristics. A good dichotomous key will select characteristics which are easily observed, valid regardless of sex and/or age whenever possible, and not subject to value judgements. Unfortunately at certain times of year the characteristics needed to differentiate certain species may not be available (e.g. leaves, flowers or fruit). In an ideal key the first statement of a pair is completely contradicted by the second statement:

e.g. 1a) Has long furry ears...
1b) Has short hairless ears...

	COMMON NAME	SCIENTIFIC NAME
1	Beaver	
2	American Robin	
3	Leopard Frog	
4	Great Horned Owl	
5	Moose	
6	Raccoon	
7	Mallard Duck	
8	Bison	
9	Lynx	
10	Jack Rabbit	
11	Grizzly Bear	
12	Ruby-throated Hummingbird	
13	Domestic Sheep	
14	Red-sided Garter Snake	
15	Little Brown Bat	
16	Polar Bear	
17	Harbour Seal	
18	Giraffe	
19	Plains Zebra	
20	Koala	
21	Red Kangaroo	

Lesson four continued

KEY

1. a. Flying (go to 2)
   b. Not flying (go to 6)

2. a. Feathered (go to 3)
   b. Not Feathered. .... *Myotis lucifugus*

3. a. Web footed, water living .... *Anas platyrhynchos*
   b. Not web footed, nor water living (go to 4)

4. a. Hovering flight, very small .... *Archilochus colubris*
   b. Not hovering flight (go to 5)

5. a. Mouse eater, nocturnal .... *Bubo virginianus*
   b. Insect eater, diurnal .... *Turdus migratorius*

6. a. Hairy or furred (mammalian) (go to 8)
   b. Not furred (not mammalian) (go to 7)

7. a. Legs present .... *Rana pipiens*
   b. Legs absent .... *Thamnophis sirtalis parietalis*

8. a. Aquatic mammal .... *Phoca vitulina*
   b. Terrestrial mammal (go to 9)

9. a. Hopping or jumping locomotion (go to 10)
   b. Not hopping or jumping locomotion (go to 11)

10. a. Large with large tail used for balance .... *Marcopus rufus*
    b. Small with small bobbed tail .... *Lepus townsendii*

11. a. Large, flat, leathery tail .... *Castor canadensis*
    b. Tail not leathery and flat (go to 12)

12. a. Hoofed, vegetation eating (go to 13)
    b. Not hoofed, carnivores or omnivores (go to 17)

13. a. Spotted or striped coat (go to 14)
    b. No spots or stripes on coat (go to 15)

14. a. Spotted coat, long neck .... *Giraffa camelopardalis*
    b. Striped black and white, horse-like .... *Equus burchelli*

Lesson four continued

15. a. Can be domesticated .... *Ovis aries*
    b. Not usually domesticated (go to 16)

16. a. Lives primarily in marshes and forested areas .... *Alces alces*
    b. Once numerous on the prairies .... *Bison bison*

17. a. Long ringed tail .... *Procyon lotor*
    b. Shorter, bobbed tail (go to 18)

18. a. Cat-like .... *Lynx lynx*
    b. Not cat-like (go to 19)

19. a. Eats eucalyptus leaves, often found in trees .... *Phasolarctos cinerous*
    b. Not eucalyptus leaf eating (go to 20)

20. a. White coat, northern dwelling .... *Ursus maritimus*
    b. Brown coat, can be found in southern areas .... *Ursus arctos*

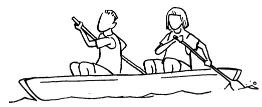
Note that some animals like the garter snake have been subdivided even further as subspecies and therefore, are also given a subspecies name which must be italicized or underlined.

Name another species that has been designated with subspecies:

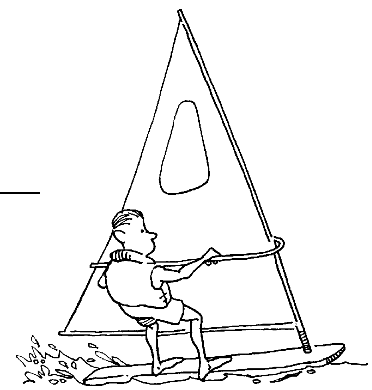
____

Lesson four continued

A good dichotomous key allows you to identify a particular individual from a group in the least number of steps. For a group of eight individuals a properly constructed key would require only seven steps. Constructing such a key requires careful observations and the ability to devise discriminating criteria. The challenge in this exercise is to produce a key which allows the user to determine the name of any member of the group below. Provide a scientific name of your choice for each of the “species” on this page. On the next page develop a dichotomous key that others could use to identify these “species” in seven or eight steps.



a. ______________________________



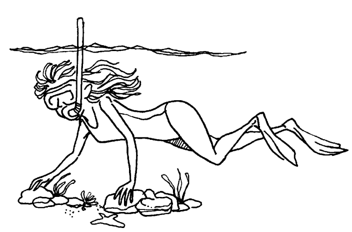
b. ______________________________

c. ______________________________

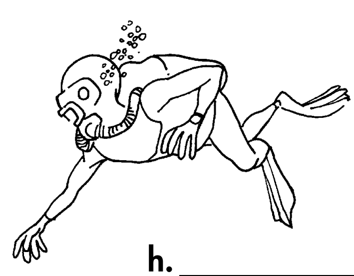
d. ______________________________

e. ______________________________

f. ______________________________



g. ______________________________



h. ______________________________

Lesson four continued

1. a. ______________________________
   b. ______________________________

2. a. ______________________________
   b. ______________________________

3. a ______________________________
   b ______________________________

4. a ______________________________
   b ______________________________

5. a ______________________________
   b ______________________________

6. a ______________________________
   b ______________________________

7. a ______________________________
   b ______________________________

8. a ______________________________
   b ______________________________

Lesson five

Diversity and adaptations

Every organism that exists (or has ever existed) must interact with other living organisms. This is an important criteria to be considered since that organism must be capable of four things:

1. Competing for limited resources (food, shelter, water) with members of its own species and other species.

2. Avoiding being eaten by something bigger, tougher, nastier, etc.

3. Adapting to short or long term changes in living conditions – some as a result of changes made to the environment by that species and some because of other species.

4. Finding mates and producing viable offspring.

The diversity of living organisms we see in the world around us is the result of an evolutionary selection for specific adaptations that give some advantage to individuals in their quest for survival in specific parts of the ecosystem or niches. Although there are a large number of adaptations, we can divide them into five general categories – *getting food, locomotion, respiration, protection* and *reproduction*.

At the completion of this assignment, submit a written report about a wetland organism from the list on this page. Prepare a five minute class presentation in which you outline the basics of your research. Include the following:

a) common and scientific names and full taxonomy to kingdom level.

b) a description of the organism – anatomy, size, colouration, differences between sex, other interesting physical traits. A full page drawing is needed.

c) habitat requirements – where does it live, what does it eat, what eats it? What is its world range?

d) specific adaptations this organism has to its environment under the following subheadings: how it gets its food, moves around, breathes, protects itself and reproduces.

e) Any other interesting and relevant information.

f) a bibliography of the resources used including Internet URL's. Use at least six references documented correctly as in the examples below.

Hochbaum, H.A. 1973. *To Ride the Wind.* R. Bonneycastle Books, Toronto. 120 pp.
Hutchison, G.E. 1959. *Homage to Santa Rosalia Or Why Are There So Many Kinds of Animals?* American Naturalist. 93:145-159.
King, J.R. 1998. *Reproduction in Birds.* pp 78-107 in: *Breeding Biology in Birds.* D.S. Farmer (editor). National Academy of Science. Washington, D.C.
Ducks Unlimited Web site: www.ducks.ca

Topic Suggestions

dragonfly
a mosquito species
water strider
tiger salamander
wood frog
American wigeon
softstem bulrush
daphnia
common cattail
predaceous diving beetle
a duck weed species
water boatman
freshwater shrimp
Wilson's phalarope
canvasback
American bittern
muskrat
northern harrier
fingernail clam
a leech species

Lesson six

Wetland field trip

Describe and record the general appearance and abiotic (nonliving) factors present at this site using the data sheet below:

LOCATION: **DATE:** **TIME:**

WEATHER (cloud cover, cloud type, humidity, wind speed and direction, temperature)

WATER QUALITY (colour, transparency, odour)

MAP OF WETLAND AND ITS SURROUNDING AREA
(reeds and rushes, inlets, outlets, roads, trails, buildings, land use, compass direction and scale)

BOTTOM CHARACTERISTICS (Check one or two)

SILT AND MUD	SAND	CLAY	GRAVEL/ROCKS

	SHORELINE	CENTER
WATER TEMPERATURE (in ˚C)		
AIR TEMPERATURE (in ˚C)		
OXYGEN LEVEL		
pH		
WATER DEPTH		

SHORELINE CHARACTERISTICS (Check all appropriate)

Cultivated	Uncultivated	Wooded	Open	Wooded
Swampy	Boggy	Sandy	Rocky	Flat

% OF WATER SURFACE COVERED BY VEGETATION

OBSERVATIONS OF HUMAN IMPACTS ON THE WETLAND:

Lesson six continued

If the wetland has an inlet and/or an outlet stream, calculate the velocity of the water. Float an object down a 10 metre section of the stream (be sure to measure the distance) and measure the time it takes to complete that distance. Do this three times and average your results. Calculate the velocity by adding your values to the formula shown.

$$\textbf{velocity} \quad \frac{\text{distance in meters}}{\text{time in seconds}} = \frac{\square}{\square}\ \frac{\mathbf{m}}{\mathbf{s}} = \square\ \frac{\mathbf{m}}{\mathbf{s}}$$

Sketch a cross section of the stream and measure the average depth and breadth of stream to calculate its cross-section in square metres. Determine how many cubic meters are flowing per second by calculating the number of litres of flow per second (1 m^3=1000 litres) in and/or out of the wetland. Many wetlands receive inflow from overland runoff.

CROSS SECTION SKETCH OF STREAM

Flow: _______ l/sec

Randomly lay out a one square meter plot at five sites around the water’s edge. Include in your plot a section of land and shallow water with good plant growth present. Record the general appearance of each plot. Search the area carefully, both land and water, catching all animal life within the area. To avoid getting the water too cloudy, search the surface first then in between the plants. Lastly, scoop out and filter some of the bottom material into a container.

Lesson six continued

Identify and record the major plant species growing in the wetland and along the shoreline. Look for algae, moss, rooted and floating plants. Use the table below to help organize your results.

Map of pond showing location of sampling sites	Site #	Names of major plant species found	Relative abundance*
N SCALE: km= ______	A		
	B		
	C		
	D		
	E		

*e.g. very common, regular, uncommon, rare

Lesson six continued

Sketch the plant that you have found to be the most abundant. Include major structural features, an indication of size, and the common and scientific names.

Using the table below, identify the animals (primarily invertebrates) you have found within your sampling sites. Make sure you indicate whether the animal is in its adult or juvenile form.

SITE #	WATER SURFACE ANIMALS	SHALLOW WATER ANIMALS	BOTTOM ANIMALS	LAND ANIMALS
A				
B				
C				
D				
E				

Lesson six continued

In the following tables identify and describe the two most abundant animals that you found (one aquatic and one upland).

AQUATIC SPECIES

Name of Organism and sketch		
	Size (measure if possible)	
	Activity when caught (sitting, swimming, diving)	
	Method of locomotion (swimming, jumping, flying, walking)	
	Method of breathing underwater	
	Description of mouth parts	
	Area where catch was made (check one)	Land / On Water / Under Water

UPLAND SPECIES

Name of Organism and sketch		
	Size (measure if possible)	
	Activity when caught (sitting, swimming, diving)	
	Method of locomotion (swimming, jumping, flying, walking)	
	Method of breathing underwater	
	Description of mouth parts	
	Area where catch was made (check one)	Land / On Water / Under Water

Lesson six continued

1. Compare, in appearance and lifestyle, the two most abundant animals that you found.

2. Based on the organization of their mouth parts and reference materials, how do you think each organism feeds? Is it a predator or herbivore?

4. Compare the characteristics of one of the animal organisms that you have described and the characteristics of the plant that you found to be most abundant. How similar are those two organisms? Compare the ways in which the two organisms – plant and animal – obtain their nutrients, get rid of their waste products, obtain oxygen and protect themselves against the environment and other organisms.

4. Discuss human impacts on the wetland and possible solutions.