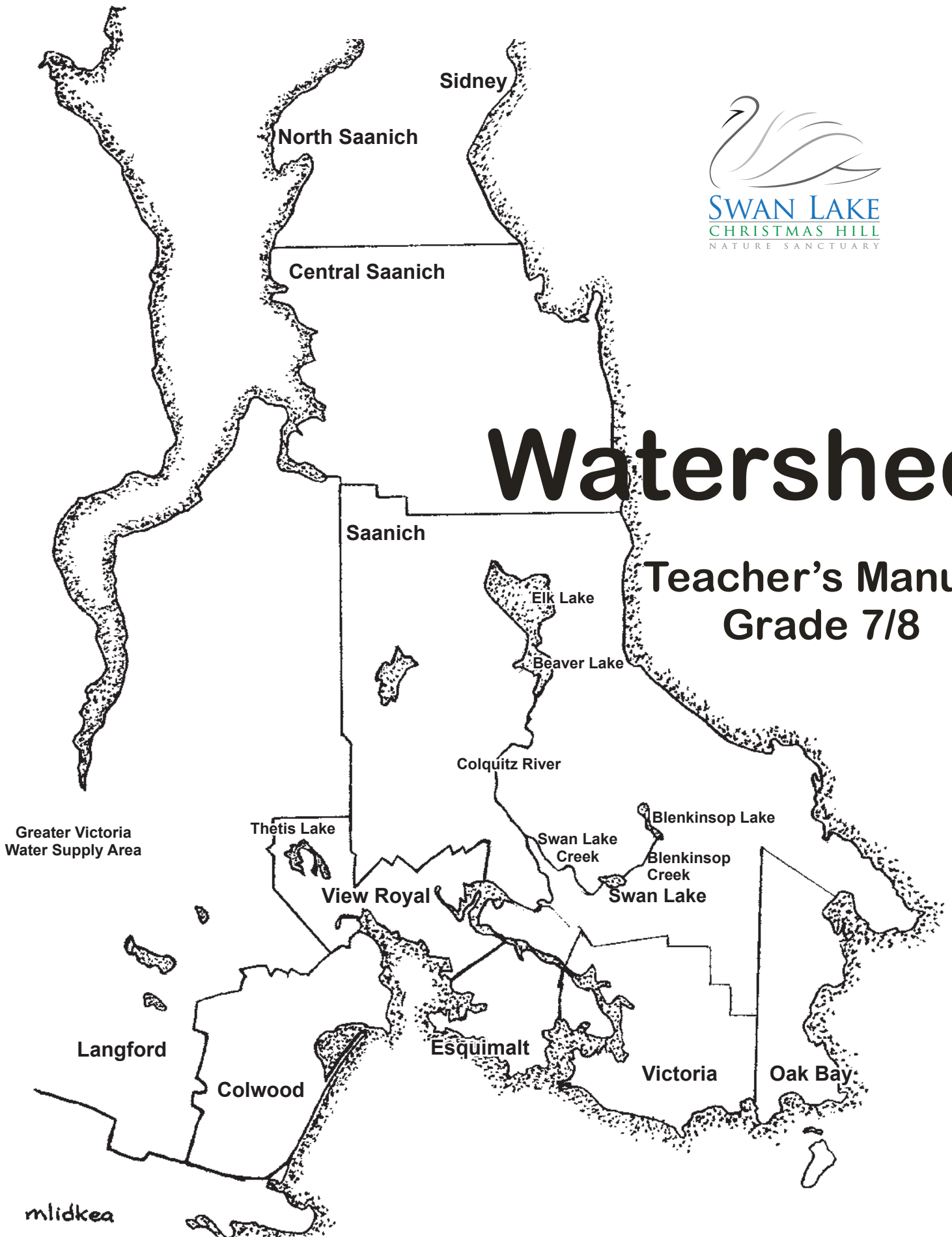




Watershed

Teacher's Manual Grade 7/8



SWAN LAKE CHRISTMAS HILL NATURE SANCTUARY

GRADE 7,8 PROGRAM: WATERSHED

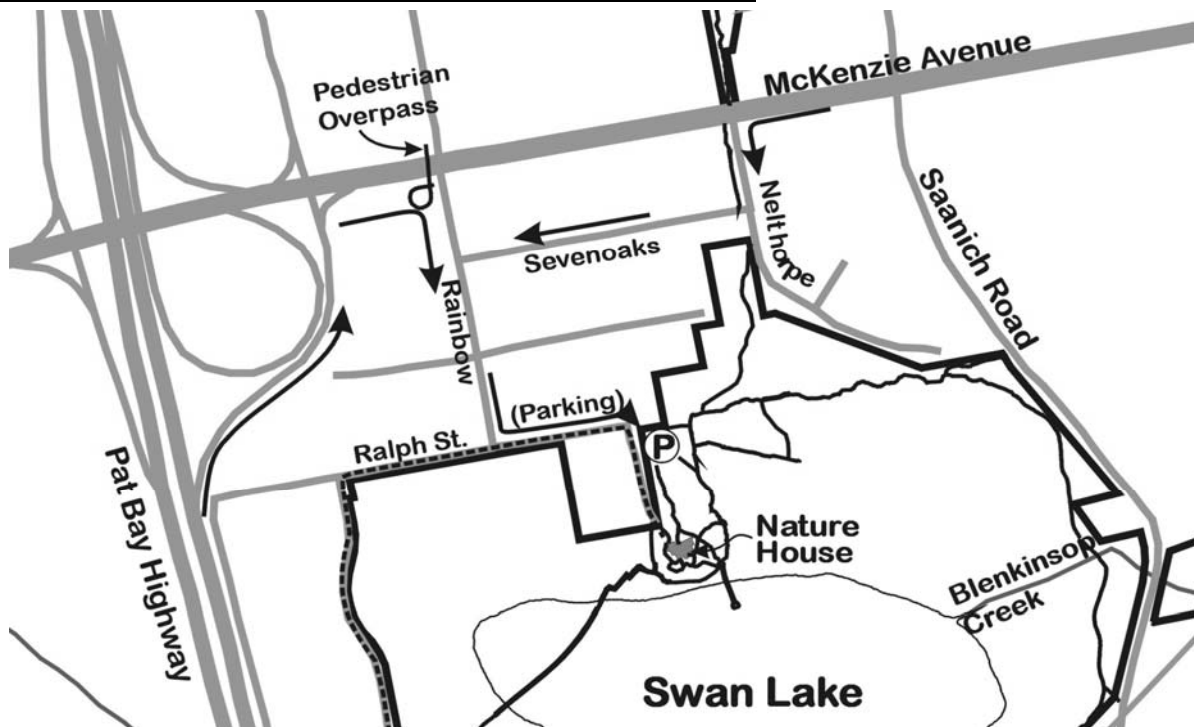
Welcome to Swan Lake! We hope this booklet will give you some background information to help you prepare your class for their visit and answer some of their questions.

BEFORE YOU ARRIVE:

1. Divide your class into **TWO groups** before the program. It is very helpful if you have an adult to go along with each group, so that they can manage any problems that may arise. i.e. taking a student to the washroom.
2. Provide each student with an easily read, waterproof **name tag** for both indoor and outdoor activities.
3. Have each student bring a **pencil**.
4. Please encourage appropriate **clothing** and **sun protection** for the weather. Remember that part of your program is outside.

Thank you for your cooperation.

WE'LL MEET YOU IN FRONT OF THE NATURE HOUSE.



SWAN LAKE - CHRISTMAS HILL NATURE SANCTUARY

WATERSHED - GRADE 7,8 PROGRAM

PROGRAM OUTLINE

- 30 minutes: History Discussion
- 30 minutes: Collecting at the lake
- 50 minutes: Microscope observations
- 10 minutes: Lab clean-up

PLEASE ALLOW EXTRA TIME BEFORE OR AFTER THE PROGRAM, IF YOU WANT YOUR CLASS TO HAVE FREE TIME IN THE NATURE HOUSE.

GOALS FOR THIS PROGRAM are for the students to be able to:

- a) learn about the **historical influence** of people and industry on the **aging of the lake**
- b) **collect** specimens with **dip nets** and a **plankton tow**
- c) observe the **diversity of lake life**
- d) gain experience in using two types of **microscopes**
- e) **draw** organisms seen under the microscope.

We hope that the students' experiences will help "develop personal responsibility for the care and protection of the natural environment". This is part of the Mission of the Swan Lake-Christmas Hill Nature Sanctuary Society.



GRADE 7,8 PROGRAM - SCIENCE INTEGRATED RESOURCE PACKAGE

Grade 7 Life Science: Ecology

- "Each living thing has some effect on all other living things in a community. Knowledge of ecosystems and food webs is important in developing a greater understanding of our environment. Through observation and investigation of local ecosystems, students explore interactions between species. They infer the importance of food webs to all organisms and their own place in them. Students analyze human impacts on local ecosystems and propose and compare options in the recovery of damaged ecosystems.
- Students can demonstrate their knowledge of ecology in their oral and written work and representations.
- Students demonstrate their scientific skills and processes when they engage in simulation activities or apply their knowledge to analyze current issues."

Our Program will contribute to the Grade 7 I.R.P. Learning Outcomes:

- Analyse the roles of organisms as part of interconnected food webs, populations, communities, and ecosystems
- Assess survival needs and interactions between organisms and the environment
- Assess the requirements for sustaining healthy local ecosystems
- Evaluate human impacts on local ecosystems

Our Program will also reinforce some Grade 6 Learning Outcomes:

- Demonstrate the appropriate use of tools to examine living things that cannot be seen with the naked eye
- Analyse how different organisms adapt to their environments
- Distinguish between life forms as single or multi-celled organisms and belonging to one of five kingdoms: Plantae, Animalia, Monera, Protista, Fungi

HISTORY TALK

The following information will be discussed **during the program at Swan Lake**, using visual aids.

Swan Lake has a watershed area of 1,018 hectares. The watershed:lake surface area ratio is over 100:1. The corresponding ration of Elk and Beaver Lake is 2.5:1 to 3:1 which shows how much larger our drainage area is. The use of this drainage area has dramatically affected the quality and quantity of the water in the lake.

Before the European settlers came, the area around Swan Lake was used by the First Nations people for hunting and fishing. Animals caught included trout, deer, muskrat and probably ducks collected in large nets as they flew up from the lake. The land around the lake was forested with Grand Fir, Douglas fir and Garry Oak trees. The lake, although shallow, was fairly clear and well oxygenated.

In the 1800's, settlers moved out from Fort Victoria, and started farms. Trees were cut down, and the resulting disturbance to the soil caused **run-off** of topsoil to the lake. This run-off added dirt to the lake, very gradually making it more **shallow**. It also added more minerals and nutrients to the water, which then resulted in more plants, like **algae**, growing in it. Each fall, the plants died down and were **decomposed** by bacteria. This decomposition requires oxygen and therefore **decreases the amount of oxygen in the lake water**.

The **Swan Lake Hotel** was a popular resort on the south east side of the lake. People came to swim, fish for trout, boat, and even ice skate in the winter. As more people moved to the Lakehill area, more trees were removed, more roads built, and more run-off added to Swan Lake. Run-off would also have come from the outhouses and the septic fields. The soil around the lake is largely clay, deposited after the last Ice Age. (Clay does not allow for easy percolation of water; instead water pools and runs off the surface.)

Farms, like the McKenzie's and the Pendray's, had sheep and cattle. The large numbers of animals produced large amounts of **waste**...partially decomposed plants. This added to the run-off into the lake, providing even more nitrogen-rich nutrients for the algae.

Wineries were opened to make wine from the berries grown by Saanich farmers. The sludge of used berries and fermenting chemicals was dumped in the nearby Blenkinsop Creek. This fed directly into Swan Lake, sometimes turning the water pink, and providing yet more nutrients for algae to grow.

A **Sewage Station** was eventually built at the site of the Saanich Municipal Yard, to collect waste from the houses nearby. It then dumped the sewage directly into Blenkinsop Creek which flows into Swan Lake. Household sewage is mainly "grey water" with partially decomposed organic matter. This also provided nutrients for algae growth.

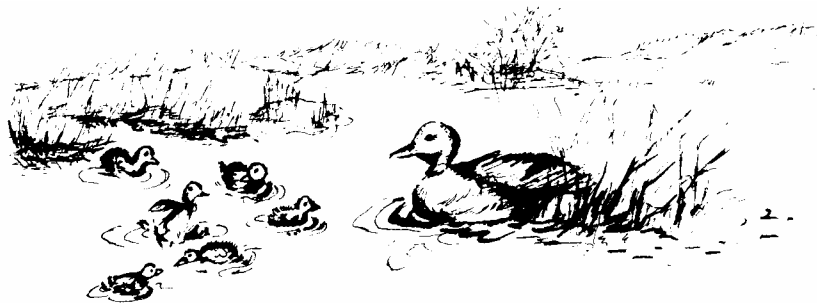
During the 1950's, **chemical fertilizers** became widely used by farmers, and extensive use on the farms around Blenkinsop Lake and Creek, would have also added nutrients to the water of Swan Lake. **Pesticides**, like D.D.T., were also used and would have deleteriously affected the organisms living in the water. Residents in the drainage basin area also added their share of fertilizers and pesticides.

By this time, Swan Lake was no longer a clear, trout-filled swimming lake. It had become a lake so rich in algae growth, the entire surface was covered in algae in the summer. But decomposition of the algae had reduced the amount of oxygen so that animals that needed cool, oxygen-rich water, like trout, could no longer survive in Swan Lake. The non-native Pumpkinseed Sunfish, introduced by a local resident, flourished. **The ecology of the lake had changed.**

Since then, the Wineries and the Sewage Station have closed. Pesticides and fertilizers used on the farms and yards are hopefully not as extensively used nor as dangerous as D.D.T. The land around Swan Lake was purchased by the **Municipality of Saanich**, and the Nature Sanctuary established in 1975 under **The Swan Lake Christmas Hill Nature Sanctuary Society**.

Although the water quality of the lake has improved under the stewardship of the Society, the lake will continue to have the vast algae and duckweed mats each summer. Each fall they will decompose into a thick, muddy compost pile at the bottom of the lake. Each spring the compost nutrients will provide food for more growing duckweed and algae. **It is a continuing cycle.**

Eutrophication, the gradual filling in and ageing of a lake, is a natural process. Usually it happens over many thousands of years. Because of the historical influence of people living and working in the watershed on the water quality of the lake, Swan Lake has aged dramatically in just 150 years. This has been called "**rampaging cultural eutrophication**".



COLLECTING AT THE LAKE

Half of the students will collect at the **North (Lollipop) Wharf** while the other students will collect at the **Floating Boardwalk**.

Plankton includes many species of microscopic free-floating aquatic organisms. The correct use of a **plankton tow** will be explained and students will be involved in a discussion of plant plankton (**phytoplankton**) and animal plankton (**zooplankton**). Phytoplankton are generally found near the surface where there is sufficient light for photosynthesis, and the water is generally warmer. The most common types in Swan Lake are *Volvox* or “tennis-ball” algae, *Aphanizomenon* which looks like grass clippings and *Anabaena* which forms dense filamentous mats on the water in summer.

Zooplankton often eat the phytoplankton and are generally found near the surface of the water where their food is. Zooplankton are capable of locomotion. The most common in our lake include *Daphnia* species (water fleas), various copepods, rotifers and ostracods (seed shrimp). Two students will be designated to collect for the group. Other students can have a turn, time permitting.

Students will also collect using **dip-nets** to gather submerged plant material including coontail, grasses and cattails and then shake these plants in tubs of water to release any creatures hiding in the plants. Animals that may be collected are shown on the following page. Often students will collect some specimens not on our charts.

GRADE 8 EXTENSION

Students will be introduced to some **physical parameters** that may be measured by biologists in the field to indicate **limiting factors** for the growth of plants and animals:

Dissolved oxygen: results are usually given to the class as we do not have equipment to do this during the program

Temperature: the group at the Lollipop Wharf will take the temperature of the air and of the water about 0.3 m below the surface

Turbidity: the group on the Floating Boardwalk will use a **Secchi Disk** to measure “Secchi Depth”. Turbidity or lack of clarity can be increased by plankton blooms, silt, and chemical pollution. Because the Secchi Disk has a large flat bottom, it can also be used to measure the depth of the lake.

MICROSCOPE OBSERVATIONS

Each group will use a different type of microscope for half the time and then switch. Students will be instructed briefly how to use the microscopes.

Dissecting Microscopes are also called **Binocular** microscopes and are used to observe the larger specimens. Light is shone down onto the creatures put in drops of water in the Petri dishes. Magnification of the lenses is demonstrated and students can use either **20x** or **40x magnification**.

Students work with a partner and make scientific drawings, i.e. "draw what they see", taking turns doing the drawings on the recording sheet. They can determine the names of their creatures by referring to the charts available in the classroom. Sometimes there are animals not on the charts and we need to refer to our books in the classroom.

Compound or Monocular Microscopes are used to examine **plankton on slides**. Light is reflected by a mirror up through the stage and through the slide so material observed needs to be small and fairly transparent/translucent. Magnification can be **40x** or **100x**. Students are shown how to make slides correctly and safely. They are encouraged to make good scientific drawings and to determine the name of the phytoplankton or zooplankton. The lab can get quite exciting when students realize that they are seeing eggs inside *Daphnia* or a heart beating... The sense of wonder is awesome!

LAB CLEAN-UP

Students will clean the lab by putting away all equipment and stacking the dishes etc. for washing after the program and handing their drawing sheets to the teacher. Samples collected may be used in our displays or returned to the lake.

GRADE 8 EXTENSION

Charts on the walls of the classroom will indicate what each animal eats and what is **Food Chain Role** is:

Producer (plants that produce their own food)

Herbivore (eats plants)

Carnivore (eats animals)

Omnivore (eats plants and animals)

Decomposer (scavenges or eats detritis)

Students will record this information on their drawing sheets.

On the back of this sheet, students can form their own Food Chain of Swan Lake.

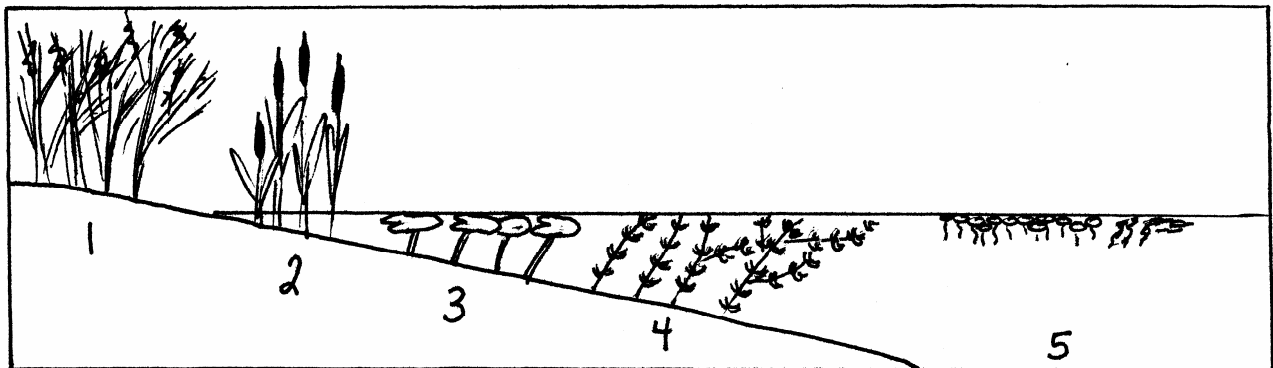
A Food Chain Example:

Volvox ----- *Daphnia* ----- Damselfly nymph
Producer Herbivore Carnivore

LAKE ECOLOGY NOTES

For teacher information

Lake habitats are determined by the kinds of plants that grow there. Large aquatic plants modify the habitat by their presence providing a variety of **microhabitats** for aquatic animals. The large plants are restricted by **competition** with other plants and by their own physical limits. If we follow a **profile** of the lake from the shore to the water, we find a very definite group of plants.



1. The first group from the shore includes **willows** and **Red Osier Dogwood**. These shrubs are moisture tolerant (they don't mind getting their "feet" wet). Bittersweet Nightshade often twines among the branches of willows and is easily recognized by its small purple flowers and later on bright red berries.
2. The next plants encountered are **Cat-tails**. These are familiar to most of us, but are often mistakenly called bulrushes. Cat-tail is the first emergent plant we find and its roots are always under water. The tuberous roots are edible and the native Indians had many uses for these plants. Muskrats eat them. **Rushes** and **Reed canary grass** may also be found here.
3. **Yellow Water Lilies** constitute our third group. Their large flat leaves provide a resting place for snails, insects and even blackbirds and ducklings. Roots must be in the lake bottom mud. The bright yellow flowers usually bloom from May until September.
4. **Coontail** is totally submerged, but rooted. Its whorls of finely divided leaves provides habitat for many lake creatures. Sticklebacks use a thicket of coontail in which to lay eggs and raise young. Snail eggs are attached to coontail.
5. **Duckweed** and **filamentous algae** are the two representative non-rooted, floating plants at Swan Lake. Duckweed makes extensive green mats on the surface providing food for dabbling ducks. The long green threads of filamentous algae often grow around coontail, forming a thick green floating sludge.

Creatures of the lake live in particular habitats because they provide the necessary kinds of **food, shelter, oxygen** and **space**.

Creatures possess many **adaptations** to cope with the varying conditions. It is remarkable to observe the many ways different organisms cope with breathing underwater, moving, catching food and tolerating seasonal temperature fluctuations.

Various anatomical features have evolved to allow aquatic animals to **obtain oxygen**. Slower moving or small organisms can often get enough oxygen directly through their skin. Bigger organisms and faster ones need extra breathing adaptations. Damselfly nymphs have **external gills** that look like tails; side-swimmer shrimps have gills on their legs while dragonfly nymphs have gills inside their anal cavity. Backswimmers and water boatmen carry **bubbles of air** with them like scuba divers. Short hairs on their bodies trap the air bubble which gives the insect a silvery appearance. Water sticks, mosquito larvae and rat-tail maggots have **snorkel tubes** for breathing.

To **move quickly** in the water, many organisms are **stream-lined**. Backswimmers and water boatmen have **modified oar-like legs**. The **expulsion of** water and carbon dioxide from the anal cavity of the dragonfly nymph propels them forward and helps them get more oxygen at the same time!

Hide and Seek is the Game of Life. Hunters hide in the vegetation and sneak up on their **prey**, while prey hide from the **predators**. Hunters have adaptations that help them like being **camouflaged**, fast, or having special ways to trap prey. The dragonfly and damselfly nymphs can extend their lower jaws to grab the food. The hunted greatly outnumber the predators.

Prey includes the **zooplankton** that feed on the **phytoplankton**. A rapid increase in the number of plankton is called a **plankton bloom**. This can be brought on by a change in environmental conditions like an increase in temperature, sunlight or nutrients. One of the most important zooplankton in the **Food Chain** of Swan Lake is the herbivore, *Daphnia*.

PLANKTON

PHYTOPLANKTON

Phytoplankton are the **plant forms** of plankton. They are **Producers** of food and oxygen. They are found in the upper zone of the lake where there is sufficient light for photosynthesis and where the water is generally warmer.

Phytoplankton include:

Blue-Green Algae (Cyanobacteria): *Aphanizomenon flos-aquae*, *Anabaena sp.*
Anacystis thermalis
Gomphosphaeria wichurea

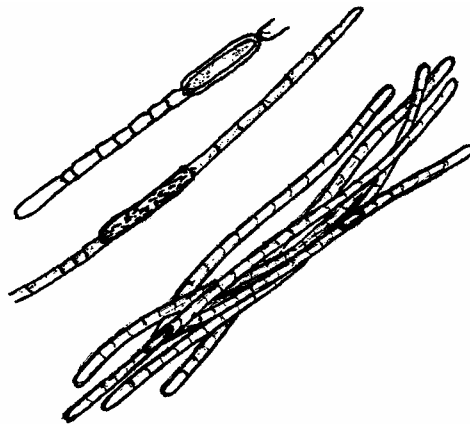
Green Algae: *Volvox sp.* *Spirogyra sp.*
Ulothrix sp. *Eudorina sp.*

Diatoms: (with “sculptured glass houses”)
Asterionella formosa *Melosira sp.*
Navicula sp. *Tabellaria sp.*

BLUE-GREEN ALGAE are the simplest form of phytoplankton with no organized nucleus and no chloroplasts (pigment bodies containing chlorophyll) and therefore are classified as Cyanobacteria. Pigments are dispersed throughout the cell and the plankton may be bluish, green, black or reddish purple in colour because of these different pigments. These plankton are most abundant in water that is high in nutrients. Blooms often occur in polluted water or in eutrophic lakes. Some of the most common forms found in Swan Lake include the following:

Aphanizomenon flos-aquae

Pockets of gas within the cells of this plankton cause it to float high in the water. Large colonies are formed that resemble clumps of “**grass clippings**”. When examined with a microscope, bundles of parallel fibres can be seen. After the algae has bloomed, large turquoise clumps of decomposing algae form.



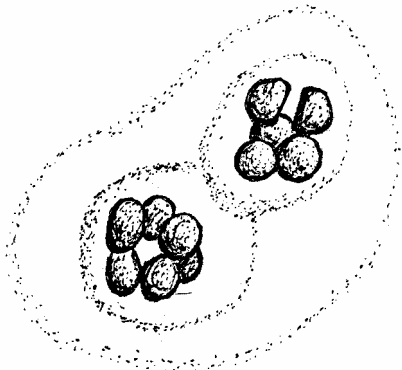
Anabaena sp.

When abundant, *Anabaena* gives water an **unpleasant odor** and can cause the death of cattle and other animals that drink the water.

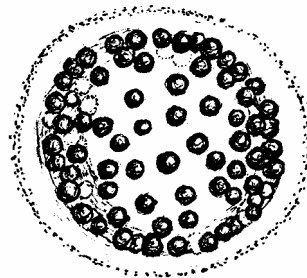
The empty cells in the filament are weak points at which the algae breaks apart during asexual reproduction.



Anacystis thermalis



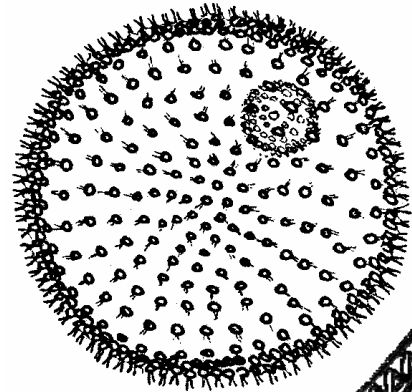
Gomphosphaeria wichurae



GREEN ALGAE are more advanced than the blue-green algae. They have organized **nuclei** and the chlorophyll is bundled into specialized packages called **chloroplasts**. Some forms have whip-like appendages called **flagella** which allow them a certain degree of mobility. For this reason, some experts feel that these forms should be classified as animal life despite the presence of chlorophyll in their cells. Common forms of green algae in Swan Lake are:

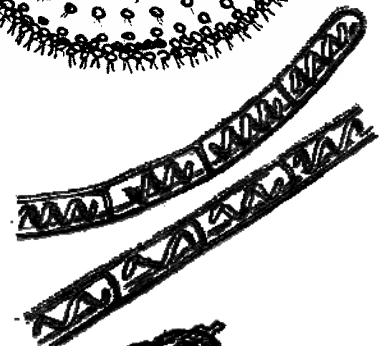
Volvox sp.

This globular **colony** is a common algae in ponds or shallow lakes like Swan Lake. Each cell in the colony has two **flagella**. As the flagella beat back and forth, the colony rotates and rolls through the water. *Volvox* colonies often have **daughter colonies** inside which are released when the mother colony breaks apart.



Spirogyra sp.

In the reproductive state, this **filamentous** algae forms green cotton-like mats (“pond silk”) on the surface of the water. These mats turn brown later in the season as the algae lose their green colour. Each cell in the filament has a **spiral-shaped chloroplast**.

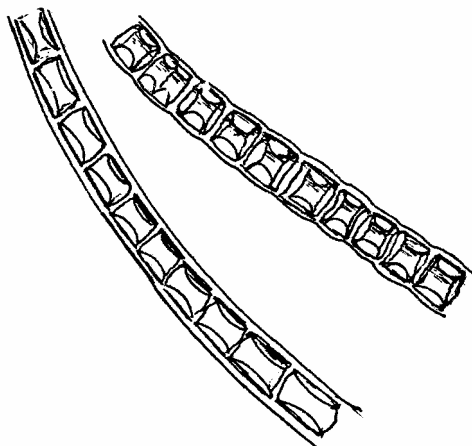


Botryococcus braunii

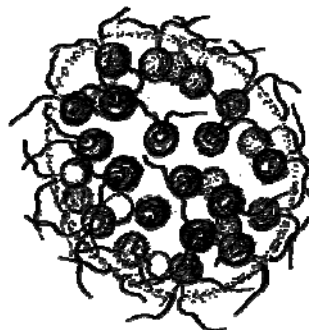
This colonial form is covered by a **mucus-like coating** which often forms strands interconnecting the colonies. This mucus is impregnated by a fatty oil with reduces the density and thus enhances flotation. The oil also gives the bloom a yellowish colour.



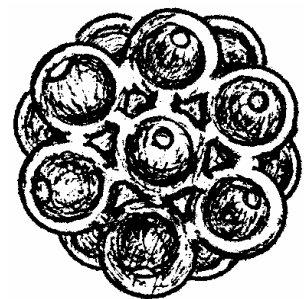
Ulothrix sp.



Eudorina sp.



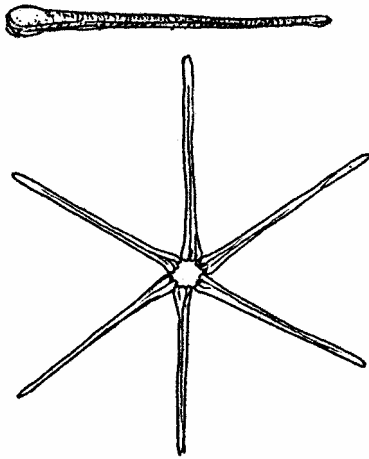
Coleastrum sp.



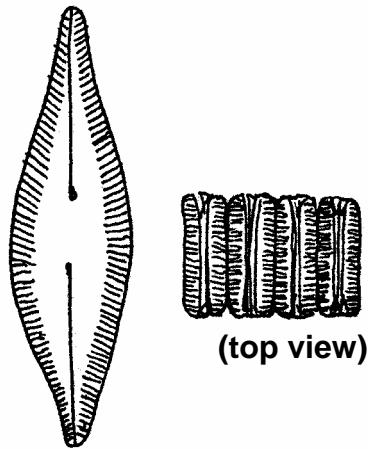
DIATOMS

“Diatom” means “**cut in two**”. This refers to the two valves or overlapping pieces of the cell wall. The cell wall is made of **silica and pectin** which makes it quite rigid and leads to a variety of beautiful and ornate shapes. The cell walls preserve well and have been found deep in core samples taken from lake bottoms. This information coupled with knowledge of the environmental requirements by the species found can give a clue to the condition of a lake years ago. Planktonic forms of this type of algae have extremely thin cell walls as an adaptation to their open-water existence. Another adaptation is their very small size. Some species are so small that they pass right through a plankton net with a mesh of 200 squares per inch! Some of the larger colonial forms in Swan Lake are illustrated.

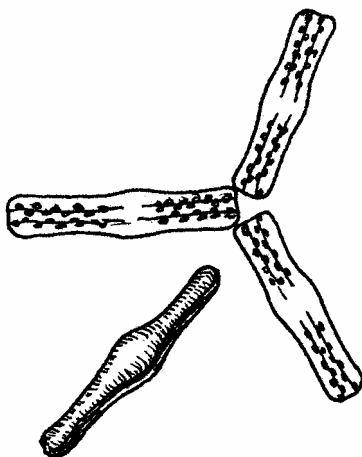
Asterionella formosa



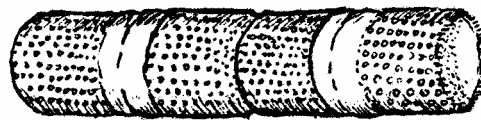
Navicula sp.



Tabellaria sp



Melosira sp.



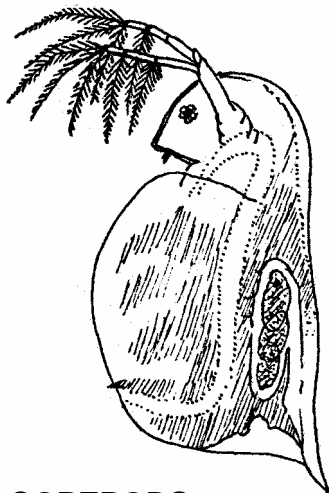
ZOOPKLANKTON

Zooplankton are the animal form of plankton. They eat their food; they are **Consumers**. Although they are still at the mercy of water currents, all zooplankton are capable of self-propulsion to some degree. Some species actually have daily migration patterns involving swimming to the surface at night to feed and then allowing them to sink down in the water column by dawn. This type of behaviour is thought to be stimulated by a combination of aversion to light and the need to rise to the surface to feed on the phytoplankton and on other zooplankton. Some zooplankton common in Swan Lake are described below.

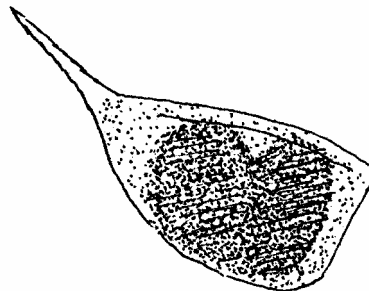
CLADOCERA

Cladocera are commonly known as “**water fleas**”. They are tiny crustaceans and are related to crabs, shrimp and lobster. These little animals swim along jerkily by means of an enlarged pair of antenna. The down-strokes of the antennae propel the animal upward then it sinks slowly using the antennae like a parachute. They are filter feeders and catch phytoplankton and organic debris in basket-like filters on the edges of their appendages. A population of cladocerans is composed almost entirely of females. Eggs are formed and passed into a brood chamber where they are brooded for varying lengths of time depending on the species and the environmental conditions. The unfertilized eggs all hatch into females. This phenomenon is known as **parthenogenesis**. During adverse conditions such as crowding or cold weather, certain females become stimulated to lay special eggs which hatch into males. These males then mate with the females and the resulting eggs are larger. The female’s brood chamber becomes covered by a hard coating which is later cast off and allowed to sink to the bottom. These **encapsulated eggs**, called **ephippia**, are capable of withstanding drying and freezing conditions.

Daphnia pulex



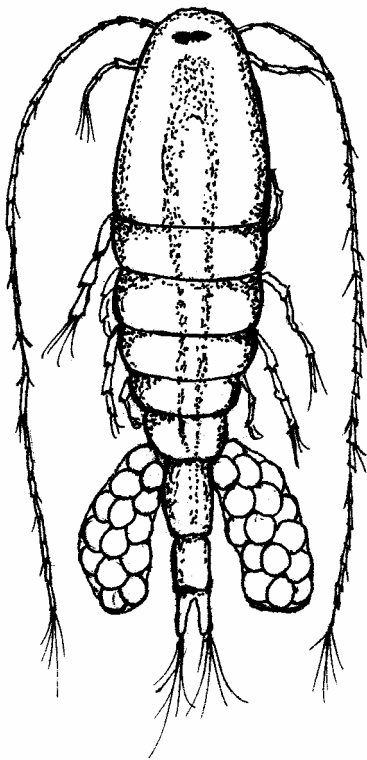
Ephippia (egg case)



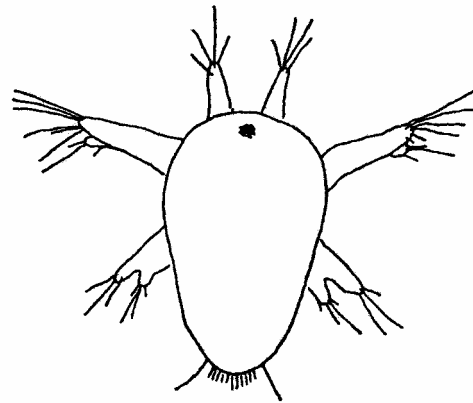
COPEPODS

Copepods are also tiny crustaceans. They propel themselves by extremely rapid oar-like beating of the legs, during which time their antennae lie back against the body. When the leg beating ceases, the antennae are extended laterally to prevent sinking. Copepods are chiefly **filter feeders**. Appendages which vibrate regularly between 600 and 2640 times a minute set up water currents which direct food particles into a specialized filter chamber. Some types of copepods are **predators**, seizing and feeding on other copepods and small zooplankton. Some are **parasitic** on fish ("fish lice") and other aquatic organisms. Reproduction in copepods is sexual. The eggs typically hatch into a larval form, called a **nauplius**, and pass through five or six larval stages, called **naupliar instars**, before passing into a small copepod form. It takes another five copepod instars before the young attain adult size and maturity. This course of development may take as little as one week or as long as one year. Like the cladocerans, the copepods can produce thick-shelled **dormant eggs** capable of withstanding drying and freezing.

Copepod



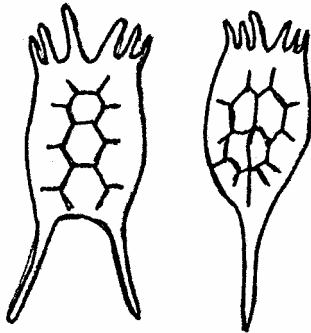
Nauplius larva



ROTIFERS

Rotifers are microscopic organisms known as “**wheel animalcules**”. This name is derived from the presence of a crown of **cilia**, which, when beating, gives the appearance of a rotating wheel. The body covering is frequently thickened to form a conspicuous encasement which may be divided into distinct plates or sections and is usually ornamented with ridges or spines. In crawling or bottom-dwelling rotifers, the body terminates in an attachment organ or “**foot**”. In truly planktonic rotifers, the foot is usually reduced or absent. Most rotifers are **sedimentary feeders**. The ciliary crown around the mouth creates currents which cause the food to settle within the ring of cilia and near the mouth. However, some forms are **carnivorous**, capturing their prey by either grasping or by trapping. Like the water fleas, rotifers are capable of both sexual reproduction and parthenogenesis. Rotifers produce two types of eggs. One kind cannot be fertilized and results in only females being produced. The second type, if fertilized, will secrete a heavy shell and become dormant to resist adverse environmental conditions. However, if this second type of egg does not become fertilized, male offspring are produced through parthenogenesis.

Keratella sp.



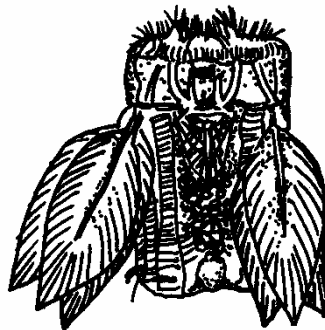
Filiana sp.



Rotaria sp.



Polyarthra sp.



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